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NATURAL PHENOMENA AS POTENTIAL INFLUENCE ON SOCIAL AND POLITICAL BEHAVIOR: THE EARTH'S MAGNETIC FIELD

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NATURAL PHENOMENA AS POTENTIAL INFLUENCE ON SOCIAL AND POLITICAL BEHAVIOR: THE EARTH'S MAGNETIC FIELD

DISSERTATION

A dissertation submitted in partial fulfillment of the requirements for the degree of Doctor of Philosophy in the College of Arts and Sciences at the University of Kentucky

By
Jackie R. East

Director: Dr. Stephen Voss, Professor of Political Science
Lexington, Kentucky
2014
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ABSTRACT OF DISSERTATION

NATURAL PHENOMENA AS POTENTIAL INFLUENCE ON SOCIAL AND POLITICAL BEHAVIOR: THE EARTH'S MAGNETIC FIELD

Researchers use natural phenomena in a number of disciplines to help explain human behavioral outcomes. Research regarding the potential effects of magnetic fields on animal and human behavior indicates that fields could influence outcomes of interest to social scientists. Tests so far have been limited in scope. This work is a preliminary evaluation of whether the earth's magnetic field influences human behavior it examines the baseline relationship exhibited between geomagnetic readings and a host of social and political outcomes. The emphasis on breadth of topical coverage in these statistical trials, rather than on depth of development for any one model, means that evidence is only suggestive – but geomagnetic readings frequently covary with social and political variables in a fashion that seems inexplicable in the absence of a causal relationship. The pattern often holds up in more-elaborate statistical models. Analysis provides compelling evidence that geomagnetic variables furnish valuable information to models. Many researchers are already aware of potential causal mechanisms that link human behavior to geomagnetic levels and this evidence provides a compelling case for continuing to develop the line of research with in-depth, focused analysis.

Keywords: geomagnetic field, behavior, conflict, crime, volatility.

Jackie R. East

September 1, 2014

NATURAL PHENOMENA AS POTENTIAL INFLUENCE ON SOCIAL AND POLITICAL BEHAVIOR: THE EARTH'S MAGNETIC FIELD

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September 2014

Dedication

This is dedicated to my wife Renee and son Evin, who suffered more from the writing of this dissertation than I.

Acknowledgement

Stephen Voss demonstrated dedication to his teaching and research profession and stuck with me on the journey from first year grad student to Ph.D. through twelve years, three committees, and three comprehensive exams. Horace Bartilow's enthusiasm for the subject matter of the dissertation and heartfelt encouragement aided my progression through many difficult moments in the completion of this work. My committee worked tirelessly to ensure I produced a quality work that contributes value to academic discourse. I acknowledge their efforts, and the patience of the Graduate School as the Army prevented me from meeting dozens suspense and timelines for completion of the Ph.D. program. The Graduate School and the Department of Political Science have exceeded that expected in support of our nation's military. Therefore, I must admit that any error or omission in this work is my responsibility alone.

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Humans can retain information, subject it to logical reasoning, and direct their own actions rationally. These capabilities serve as the foundation for many conceptions of human progress and learning. Indeed, belief in this rationality is so pervasive and ingrained in the human self-image that it constitutes a fundamental assumption of much of economics and political science.

However, the world provides any number of individual-level and aggregate-level anecdotal examples that strain the ability of social scientists to describe them in terms of reason or rationale – daily examples of behavior that is “outside the norm,” surprising, shocking, and seemingly pathological. Such actions by individuals or groups threaten the influential perception of humanity as reasonable and rational. Any one perplexing example in isolation might lend itself to some kind of complex and particularistic explanation, but the combined weight of these many troublesome events should motivate a search for less-idiosyncratic explanations as to why otherwise rational individuals or groups might stray from sensible cause-and-effect behavior.

1.1 Individual-Level Anecdotes

Take the case of 19-year-old Derrick Smart. Smart was an average student who had no history of trouble, no documented instances of violence or abnormal depression. Initially his behavior on 16 November 2000 was no different. He remained home with his 78-year-old grandmother while the rest of the family left for the day to pursue their normal activities, and he assisted the elderly woman throughout the morning, ensuring that she was not only comfortable but also entertained. Then, sometime in the afternoon, with no known provocation, Smart walked into his grandmother’s bathroom and struck her on the head with a mallet, causing extensive brain injury. Leaving her corpse in the bath, he promptly changed out of his blood-soaked clothes and placed them in the trash compactor but otherwise took no precautions to hide evidence before leaving the house for the afternoon. Smart’s father found the body later that evening and called police, who arrested Smart that night when he returned home still wearing a bloodstained bandana. It was the first instance of violence attributed to the young man, yet despite his attempts to cooperate with authorities in other ways, he never could communicate a motivation for committing murder at that time or place – other than to report to the police that he had been hearing voices (Coleman, 2003).

Another example of such “out of nowhere” violence is 45-year-old David Crespi. He was a senior vice-president in the audit division of Wachovia Corporation, a company with $26 billion in annual revenue. Crespi had a large salary, manageable debt, no reported marital problems, or concerns, and was on track for a significant bonus and promotion at work. On January 20, 2004, while home alone with his twin five-year-old daughters, he retrieved a knife from the kitchen and fatally stabbed them 32 times, leaving the knife in one of them (WSOCTV.com, 2006). After killing his two children, Crespi called 911 and surrendered himself to police, not attempting to escape punishment for the murders (News, 2006). Some considered Crespi unstable before this tragic incident since he underwent treatment for depression and had attempted suicide prior to that time. However, he previously had demonstrated no violent impulses toward anyone else. When asked why he killed his daughters instead of himself by Oprah Winfrey during a 2006 interview, his only response was that he had promised his wife he would not hurt himself. Neither he nor his doctors ever divulged a motivation for directing hostility toward the girls.

These two cases are far from the only such examples of horrific crimes committed by individuals who previously seemed stable and nonviolent. Indeed, the purpose of telling them is only to remind readers of the many similar news stories that they might have encountered in the news over the years. Inexplicable acts of the most violent nature occur all the time. However, lack of reason or rationality does not reside solely in individual acts of violence, nor does inexplicable change always move in a negative direction. Educators, for example, almost certainly have encountered the unpredictability of performance in academic environments – which can fluctuate from one individual to the next or from one period to the next, in a manner that defies explanation. Rationality may lay the foundation for attempting to understand educational outcomes, but the record often undermines such a straightforward approach.

I offer as an illustrative example the story of John R. Chaney, whose life suddenly changed for the better with no apparent catalyst for change in rational calculus. Chaney's academic performance over time exhibited the sort of inexplicable decline and surge that frustrates any attempt at explanation. Chaney initially epitomized the sort of student who desires to excel academically and has the resources needed to excel but just cannot do it. Indeed, he was a model of student failure: Chaney maintained a failing grade point average throughout his first year at the University of Louisville, then after two semesters transferred to a small liberal-arts institution an hour away where, despite the significant change in context, his performance did not improve at all. At the new school, he vacillated among majors, struggled academically, and finally graduated with a business finance degree and a C- average. After another year, he attempted to get an MBA at the University of Louisville and again suffered dismal academic achievement, which sent him into the job market for a few years (Chaney J. R., 2007).

Then Chaney's performance suddenly changed. He enrolled in an associate's medical program degree in Indiana, not far (geographically or culturally) from the other schools where he had languished. Chaney's grades leapt upward – he earned a B+ average – and he scored among the highest in the state on the nursing exams, earning a coveted spot in a pre-doctoral Bachelor of Science program in Indianapolis, Indiana (acceptance rate below 10%). In interviews, Mr. Chaney could not offer any rational explanation as to how things turned around. Little distinguishes the period of his poor academic performance from that of his successes – not his economic/financial situation, his relationship status, his distance from his family, his living conditions, nor his general health and lifestyle (Chaney J. R., 2011). If anything, his underlying health had worsened during the period of success; his renewed efforts coincided with (and may have brought on) mental, sleep, and other health disorders. Unless we are to assign his slight increase in age with what would seem to be disproportionate importance, almost *nothing* objectively had changed in Chaney's life. He is just one of many possible examples of how a single individual's behavior can swing widely over time, defying rational explanation, in less-dramatic yet obviously consequential ways.

1.2 Domestic Group-Level Anecdotes

One is tempted to dismiss individual-level examples of inexplicable behavior as "outliers" or natural stochastic outcomes, anomaly associated with analysis of disaggregated behavior. Out of a world population of billions, perhaps several people will wake up that day and, by the odds, inexplicably murder someone, or experience a random surge in academic ability. However, examples of puzzling irrationality involve aggregates of individuals and require an entirely different logic to explain.

Consider the domain of labor activity. Organized workers often engage in irrational and unreasonable activities that in the end yield plainly suboptimal results for the actors driving the outcome. One anecdote comes from New York, where the New York Transit Authority union decided to institute a labor strike in order to (1) guarantee retirement at 55, (2) fight back a possible increase in pension and medical contributions, and (3) receive guaranteed paid maternity leave for present and future employees of the Authority. Their decision to strike flew in the face of the "Taylor Law," which forbade strikes by city employees. They also lacked advantage: Potential passengers could access substitute transportation methods for commuters, making them less dependent on striking transit workers. Yet their effort was certain to alienate millions of New Yorkers who would need to identify and use those substitute methods – and indeed, city dwellers were already expressing a distinct lack of sympathy in the days before the official start of the strike.

Even the international leadership of the Union warned against a strike and threatened sanctions against the New York arm if it executed one (New York Times, 2005). They did so not due to lack of sympathy with the union's workers, but in large part because the Taylor Law left little to the imagination. It created an explicit framework laying out disincentives to strike. First, it provided for a $1,000 fine per strike participant on the Union. Second, laws required each strike participant forfeit a day's pay for each day on strike. A three-day strike, for example, would cost an employee participating in the strike six days of pay. Finally, the law directed prison time for the president of the union for contempt of court (New York Times, 2005).

Bizarrely, the union struck anyway, and the expected penalties swiftly came down upon them. In accordance with the Taylor Law, the court imposed a fine on the union for conducting a strike – it came to $1 million per day – and imposed a forfeiture of pay for employees participating in the strike. The court also declared the Union and its president in contempt. The union dragged out this strike for six days but then suddenly, despite having received little new information since initiating the effort, the union caved. They accepted a deal offered by the city that was the same as had been put forward the day before the strike started. Union leaders accepted a plan that increased their contributions and maintained the current retirement age. The only significant concession: It added maternity leave to the workers' contracts. What was the cost of this poor negotiating strategy? Twelve days of lost pay, a $6 million fine to the Union, frustration on the part of transit users, restrictions on automatic union dues collections, increased restrictions on the right to strike, alienation from the international arm of the union, and a seven-day prison sentence for the union president (New York Times, 2005).

In another example, on the other side of North America, 70,000 Californians employed by three food store chains decided to strike to save themselves and future employees from having to pay increased health costs. The strike went on for five months. During that time, the stores hardly suffered at all: They hired non-union employees, continued to offer products and services, and saved much more in wages and benefits ($1.6 billion) when they lost during the strike (an estimated $1 billion). The workers gained little: At the end of the walkout, the final contract gave no raises, increased worker healthcare contributions by up to 3% of monthly base pay, significantly reduced pension benefits, and reduced starting wages for new employees (Stone, 2004). When compared to the conditions offered to the union from management prior to the strike, the result was an abysmal failure.

It is tempting to pass off this error as the sort of mistake that occurs when people operate under conditions of uncertainty – yet, as with the strike in New York, this California strike was obviously doomed to outside observers. Alternatively, one might suspect some kind of institutional explanation, positing that the interests of the leadership deviated from that of the regular members, but some kind of failure in the reasoning process still would be required to explain the widespread support within the union for this failed enterprise. Rather, it is the sort of irrational group activity that commonly appears in the course of labor struggles.

1.3 State-Level Anecdotes

Aggregate, or collective, irrationality does not rest only in the realm of group-level negotiating behavior. Governments regularly execute unreasonable policies and they carry out irrational policies – policies that offend the sensibilities, values, and ethics of the nation itself once they are exposed. Sometimes governments commit the worst of these atrocities against their own citizens. Just in the last hundred years, examples include genocide (*e.g.*, Turkey and Germany), firing upon protesters and demonstrations (*e.g.*, South Korea), and medical experiments that violate the human rights of subjects (*e.g.*, various countries, including the United States).

That governments engage in such abhorrent behavior strains credibility, but at least observers might suppose that leaders go too far in the hopes (however slight) of increasing their power or authority. What would be even more surprising to people today – given the modern tendency to harbor distrust of government – is how willingly the victims participated in these state-sponsored acts. Citizen reaction can be irrational to the point of seeming to defy all explanation.

The Kurdish reaction to Iraq’s Directive SF/4008 is an example of irrationality. The Secretary General of the Ba’ath Party’s Northern Region issued the directive on 20 June 1987, and designated many areas of northern Iraq as “prohibited regions.” The Directive was part of the “Anfal Campaign,” a government initiative named after the eighth chapter in the Qu’ran (which describes the triumph of 319 followers of Muslim faith over 900 pagans). It targeted general acts of defiance, as witnessed in several northern towns in Iraq where citizens had been unhappy with increasing policies of governmental repression.

Clause 5 was the most significant part of this directive. Clause 5 directed that “all persons captured in those villages shall be detained and interrogated by the security services and those between the ages of 15 and 70 shall be executed after any useful information has been obtained from them, of which we should be duly notified.” The author of Directive SF/4008 claimed that the “Anfal Campaign” was part of the “final solution” to the Kurd problem in Iraq. It seemed to direct the killing of every male of military age captured in rural Iraqi Kurdistan (Watch, 1994).

A directive contains mere words and is the domain in which rationality and reason operate, but the mandate those words communicated translated into concrete action. For eight months, the Iraqi army detained and resettled men and women from areas in which an insurgency was operating against the Iraqi Baathist government of Saddam Hussein. Most wound up in a concentration camp called Tapzawa. Immediately upon arriving at the camp, guards segregated men and women and evaluated the men according to their apparent ability to use a weapon. The army moved those over the age of 15 to men’s “barracks,” and in the days that followed, they lived in grossly overcrowded quarters and suffered routine beatings. Then, after several days, and with no known additional provocation, the Iraqi army trucked the men off to be killed (Human Rights Watch, 1995). Witnesses stated:

> Some groups of prisoners were lined up, shot from the front, and dragged into pre-dug mass graves; others were made to lie down in pairs, sardine style, next to mounds of fresh corpses, before being killed; still others were tied together, made to stand on the lip of the pit, and shot in the back so that they would fall forward into it – a method that was presumably more efficient from the point of view of the killers. Bulldozers then pushed earth or sand loosely over the heaps of corpses. Some of the gravesites contained dozens of separate pits and obviously contained the bodies of thousands of victims. (Human Rights Watch, 1995)

Much like the vast majority of Jews trundled off to Nazi concentration camps, whose passive acceptance of their fate continues to puzzle scholars so many years later (Levi, 1995), these more-recent victims also put up little resistance to their imminent demise. It bears remembering that these victims were hardly passive or cowardly individuals, the Iraqi Army too them from areas and towns conducting an insurgency against the government. Yet once in custody, apparently not one of these prisoners attempted to fight, to save himself, or to escape. In fact, the accounts of this operation by

Iraqi military personnel highlight how easy, docile, and accommodating the men were, as they had expected much stiffer resistance (Human Rights Watch, 1995). That is, the behavior of the victims defied rational explanation even to the perpetrators who were closest to the event.

This chilling account is but one example of many other recitations of acts of civil war, genocide, and gendercide. During the Yugoslavian civil war, in 1991, the Serbian Army shelled large parts of Croatia into submission. Afterward, an alliance between Serbia and Bosnian Serbs resulted in a wave of genocidal and gendercidal activities in Bosnia against both Bosnian Muslims and Bosnian Croats. One such event was the massacre at a little known place called Brcko, a strategic choke point on the Drina River targeted for systematic gender-selective slaughter during the Serbian Offensive in 1992. Mark Danner (1998) summarizes the findings of his investigation of this massacre as follows:

> During the late spring and early summer of 1992, some three thousand Muslims were herded by Serb troops into an abandoned warehouse, tortured, and put to death. A U.S. intelligence satellite orbiting over the former Yugoslavia photographed part of the slaughter. 'They have photos of trucks going into Brcko with bodies standing upright, and pictures of trucks coming out of Brcko carrying bodies lying horizontally, stacked like cordwood,' an investigator working outside the U.S. government who has seen the photographs told us (Danner 1998).

These examples all portray states executing extreme policy decisions against a powerless and disarmed citizenry. Not all extreme policies target the weak; states behave similarly against capable and armed opponents as well. The history of war reveals numerous examples of states descending into war despite conditions that clearly do not favor them. A count shows that from 2003 to 2011, the world experienced 43 civil and international wars of varying degrees of destruction (Marshall M. G., 2011). Most of these conflicts included at least one Great or Regional Power – which is to say, one of the sides enjoyed overwhelming military, economic, and scientific superiority. Yet their opponents decided to fight rather than to negotiate or surrender. In extreme cases, participants see defeat and instead of following the "rules" and surrendering, they degenerate into insurgencies and mobilize "suicide" weapons to inflict damage on the "victorious" powers. Observers strain to frame the behavior of states, domestic actors, and opposition groups as manifestations of rationality. Moreover, while it is possible to trace the buildup of hostilities until they result in open conflict, it is much harder to identify exogenous sources for the rise and fall of these tensions. To outside observers, it seems as though regions or peoples simply descend into madness.

1.4 System- and Market-Level Anecdotes

The existence of counter-productive and irrational aggregate behaviors is not restricted to domestic and international relations in the *political* sphere. Counter-intuitive and counter-productive trends, not to mention shocks, appear in the economic realm as well. While not obviously as abhorrent, or even measurable, as civil or international war, the consequences resulting from economic volatility can be quite destructive to individual welfare.

World stock markets declined across the world on 19 October 1987. The crash started in Hong Kong and spread west through international time zones, sweeping through Europe and hitting the New York Stock Exchange's Dow Jones Industrial Average (DJIA) on a Monday. The one-day loss of over 22% sank the DJIA to 1738, equating to a 508 point loss – which is to say, the largest one-day percentage decline in history (that is, until the day following the 11 September 2001 terrorist attacks, when such a reaction may have made more sense). During the 19 October 1987 declines, the Hong Kong Index lost 45%, the Australian Stock Market lost 41%, Spain lost 31%, and the United Kingdom lost over 26% of its value.

This crash lacked a structural basis. The market recovered within weeks and for the entire year of 1987, the DJIA would increase from a start of 1897 to an end of 1939, for more than a 5% gain. If investors agreed under stable conditions that the market should be priced between 1897 and 1939, why would it irrationally push prices up as high as 2246 and then as low as 1738 in a short period?

Other examples of such excessive optimism and over-investment exist. The most recent concerned housing, but the U.S. market repeatedly exhibits wide swings despite all of the controls, advice, and experience that would militate against such a thing happening. In addition, economic activity more generally follows periods of contraction and expansion that are not optimal. Bubbles, recessions, economic collapses, widening trade gaps, wild currency fluctuations, and worse result from "irrational exuberance" (Bernstein P. , 1998; Greenspan, 1996), from misreading or misunderstanding information. Economists have struggled over the years to "describe" or model economic expansions, bubbles, and contractions and even develop warning signs that they are occurring. However, few can explain what influences humans into making such awful decisions, or predict when or where that will happen.

Many of these economic "problems" appear to result from emotionally charged reactions that represent a breakdown in the rational faculties of economic actors. Indeed, those economists who do try to explain these events often depend on "relative rationalist" and "behavioralist" (Greenspan, 1996) explanations and models that relax the rationality assumption underlying much of formal theory. That is, they recognize that the behavior is irrational, and struggle to predict when this mass irrationality will appear.

Second- and third-order effects of economic instability caused by irrational pricing in markets also can be harmful. These effects include destruction and loss of capital, erosion of buying power, unemployment, and decline in economic activity, erosion of human capital, and disruption in interstate economic relations. Economists and governments have every incentive to discover the cause of this type of irrational market activity and implement rules to mitigate the occurrence and impacts, yet it defies explanation.

1.5 Contributions of This Research

What pushes people and groups into irrational actions? What causes a young man to deviate from his normal habits, enter his grandmother's bathroom, and then slam a mallet into her head? What causes a father to choose the specific time when, and place where, he kills his young daughters? What causes a people to accept the consensus that it is acceptable to round up every male in a village and then kill them, and those men to cooperate in their own slaughter? What is it that pushes people into the irrational, especially to a point of irrationality that guarantees they will not escape without serious consequences? The primary point of this research project is that, while each of these events might trace in large part to influences and processes unique to the outcome in question, other phenomena could contribute to the occurrence and frequency of such events as a whole.

1.5.1 An Innovative Explanatory Variable

The primary contribution of this research will be to introduce the sort of predictor traditionally neglected in social science. A growing sub-culture of researchers have been trying to integrate into their models assorted variables that measure nature's impact on behavior and decision making. Natural processes and variables inform human behavior, and several disciplines currently are at work researching how these natural forces could play themselves out to result in important outcomes. Much of this effort has been disjointed, dispersed geographically, and spread across various disciplines – but as a whole, it suggests the value of extending behavioral research beyond the customary social indicators dominant in Political Science and cognate fields.

This study has chosen one particular explanatory factor to demonstrate the possible power, relevance, and usability of environmental variables when integrated into social science models and theory: the geomagnetic field (GMF) of the planet. To serve as a test case for the potential power of natural influences on human behavior, the GMF brings several benefits: (1) The geomagnetic field varies, (2) is easily measured in any time scale, (3) is easy to work with, (4) is readily available for free, and (5) is easy to integrate into existing and new models. Scientists collect the variable(6) in over 150 locations around the world, and (7) covers times as short as one second or as long as annual averages. Finally, (8) the earth's magnetic field has several different measures that provide both local and system-wide influences that vary not only temporally, but also spatially.

Just as "ecological" theories have had a long life in social and economic science, so, too, has the idea that geomagnetic fields have a measurable and varying effect on human behavior. A small sub-discipline merging physics, psychology, and biology have been at work since the 1970s on these questions. While not garnering a large following and constituting no formal association, independent researchers, government agencies, and even businesses have been quietly developing research on the possible impact of this highly parsimonious, cheap, readily available, and easy-to-use variable. Just as important, the variable has behind it a compelling *theory* that, if borne out, could ground traditional research agendas that integrate magnetic fields into their models.

That said, connecting geomagnetic waves to human behavior operates outside of existing disciplinary research paradigms, and because the research is still in rudimentary stages, readers at this point may be reluctant to accept relationships – even strong statistical relationships – as meaningful. I should stress, therefore, that I do not offer the earth's surface-measured magnetic field as a possible replacement for other social-science explanatory variables. Those explanatory variables generally should not correlate with geomagnetic data, so the inclusion of such a variable would not invalidate existing relationships found among traditional social science variables. Instead, the inclusion of a variable that takes very little in the way of additional resources to collect, gather, or use could provide a way of controlling for the volatility that may otherwise make models less than compelling and at the same time reduce the estimation error surrounding traditional relationships.

Should overlap exist between geomagnetic data and a conventional explanatory variable, such that they do challenge each other, no question of causal order ought to arise. The nature of the variable, so obviously outside the influence of most short-term human activities, makes it difficult to conceive of a situation in which another social-science variable could possibly impact it – thereby eliminating much of the concern over endogeneity that otherwise might exist with such a novel variable of interest. There might be other *natural* phenomena that correlate with geomagnetic fields. Therefore, it is too much to ascribe excessive influence to the precise one used here. Nevertheless, any such potential rival would represent no less of a deviation from standard social-science explanations; the importance of nature as a whole would hardly be undermined.

1.5.2 Modeling Volatility

In an effort to demonstrate the flexibility and usefulness of GMF in social-science research, this dissertation will visit a wide range of disciplines and policy interests. The intent is not to provide anything like a definitive study of how GMF might influence any one social or political outcome causally. Instead, the intent is to display how consistently GMF overlaps with such outcomes despite the lack of any obvious explanation as to why the causal direction would work in reverse, and despite the lack of any social, political or economic "root cause" that plausibly would shape both GMF and the dependent variable.

Tracing phenomena in the natural world to the observed behavior of human beings not only operates outside dominant research paradigms, it can make people uncomfortable. They envision men in aluminum-foil hats, or science-fiction stories in which the government manipulates people using subliminal messages from their television sets or fluoride in their drinking water. Therefore, it is worth stressing: This is *not* a work arguing for determinism, in which nature's influences make anything happen or somehow dictate specific outcomes. Rather, my interest is in what might cause human behavior to be especially unpredictable – whether in a good or a bad way. Specifically, I propose a source of destabilization that could produce extreme outcomes indirectly by interfering with rational cause-and-effect behavior, which would make it more difficult to predict (let alone artificially control) social and political outcomes.

The traditional method of answering the sorts of social and political questions I will explore in this research has been to isolate remarkable cases and classify them for study. Grappling with these sorts of puzzles normally prompts a scholar to focus on explanations for negative or bad events. Disciplines publish work about murder, civil war, extreme market losses, and so on. Conventionally, analysts attempt to explain variation in these human behaviors through the inclusion of explanatory variables that predict specific outcomes. To whatever extent the predictive model fails to establish a deterministic outcome, the analysis treats any remaining fluctuation in outcomes as stochastic "noise."

Isolating the inquiry in that fashion can be unduly limiting, because it implies a direct cause-and-effect process challenged by the irrationality of some outcomes. Many events, or counts, that researchers study are outlying events along an unmeasured spectrum of possible outcomes. For example, murders can represent the countable extreme on a continuum running from extremely hostile to extremely benign orientation, but research necessarily ignores a swath of that spectrum, resulting in lost information and truncated data sets. By focusing on the rise and fall of specific quantities, models could miss the important trait of the processes studied that natural phenomena might influence volatility, or a dispersion of outcomes spreading out from the "mean" or average. In fact, depending on the particular data and the particular model being used, the result of ignoring this volatility can go beyond uncertainty and inefficiency, and instead through random chance cause a proliferation of "statistically significant" explanations that are not true – conclusions that might prompt initiatives and programs that cannot do what they intend.

Human behavior certainly exhibits more than enough volatility to challenge social scientists developing predictive models. Theoretically, in a volatile world, there would be inexplicable acts of goodness, sacrifice, and love of equal scale to those irrational, and often horrendous and inexcusable, behaviors discussed earlier. These "good" acts are unlikely to appear in the sort of data available to a social scientist. They might be equally irrational and unreasonable but methodologists do not view as remarkable the way we view traditional deviance. What becomes reportable, collectable, and observable is when a husband commits domestic violence, not when a husband surprises his family with a trip to Disney World.

If quantities rise and fall not only because of factors that directly affect their level, but also because of factors that increase or decrease volatility in the underlying (and possibly not measurable) orientation of the actors, then both the spikes and the troughs will follow a rhythm, a systematic relationship, that common statistical models would not identify. With ideal data, analysts would find the pattern in the "error term" of a model, and applying physical-world variables should allow analysts to capture volatility that otherwise is locked up in the error term of many social-science models. That is, a theory initially built not on the explanation of (countable) bad outcomes, but instead on the sources of volatility, ideally should model this stochastic variation.

However, commonly studied data rarely allow a comfortable attempt to predict volatility. For that reason, explaining variance usually was not feasible in this thesis, due to limitations in available data or my toolkit of models. In such cases, I will need to follow precedent, and I too will be restricted to using predictive models focused on extreme outcomes, allowing the relationship between GMF and some extreme outcome to capture the underlying volatility indirectly. Such models still hold value because variables that lead to stochastic variation can predict, indirectly, the occurrence of extreme events.

While it may appear that GMF explains events, counts, and other quantifiable outcomes, it is important to remember that at the heart of the theoretical argument is general volatility. Data on “compelling” cases may be the only thing available to study, but not because GMF would fail to exhibit a similar relationship with cases that fall on the other end of the continuum of human behavior had they been “collectible” or “measurable.” Crime is a good example, in that *negative* deviant behavior produces a visceral emotional reaction and compels research that would help deter it, but crime is rare – and the wide variation observed in the modal behavior, the absence of crime, is lumped together as an undifferentiated non-event.

Therefore, while the models presented here often contain dependent variables such as crime counts, or counts or probabilities of international disputes or coups, analysts ideally evaluates the volatility of these actors that magnetic field variable(s) may help to tease out of the error term. In one case, analysis of the volatility in stock markets, I do attempt to predict volatility itself rather than just the level or conditional average of some countable outcome.

Finally, concern with temporal autocorrelation is inherent with the use of time series data. The use of autocorrelation diagnostics and a deep analysis of such problems within the hundreds of models presented is outside the scope of the purpose of this presentation. However, periodic discussion of diagnostic results is appropriate in some places during the presentation. Depending on the model type and the availability of multiple panels diagnostic tests include the autoregessive integrated moving average model (ARIMA), the xtpoisson, xtprobit, xtlogit, or xtregression.

1.6 Structure of the Dissertation

The remainder of this dissertation will proceed as follows: Chapter Two provides a discussion of what the earth’s magnetic field is, and the biological and physiological process that may be the mechanism by which magnetic fields might influence human behavior. It summarizes the general literature on how magnetic fields may affect human mental processes. It also details the physiological processes that occur within the brain and the body in response to geomagnetic stimuli. It discusses how neurons and information exchange within the brain is impacted by magnetic fields generally. Finally it summarizes the general state of research into how geomagnetic fields specifically affect animal and human behavior and some of the analysis that point to magnetic fields being relevant and compelling explanations for various abnormal outcomes. It also explains what the geomagnetic field (GMF) is in relation to the environment. It also includes discussion of the solar-magnetic field (SMF), which relates to the GMF. The chapter tells what causes the earth's magnetic field, discusses how it varies, breaks the whole into its component parts, and defines what those parts are.

Chapter Three contains examples of simple descriptive models linking magnetic fields to a variety of dependent variables. This chapter shows how GMF operates within various linear and count models. In many instances, a figure depicted the rage of influences of magnetic fields on the dependent variable follow the models. The purpose of these models is to provide a compelling argument for the possible significance and relevance of natural phenomena variables in social-science models. None of these examples will provide much context or theoretical grounding within the specific discipline referenced, but will aggregate into a general statement regarding the possible direction of relationships and significance. In many cases, the circumstantial evidence compels a deeper analysis be carried out in later chapters.

Chapter Four lays out the theories that deal with inter-state behavior with a focus on interstate disputes. This chapter shows how the GMF variable, as a proxy for the influence of natural phenomena on actor behavior, may help models dealing with dispute initiation, war outbreak, conflict resolutions, and domestic security crises. The chapter is full of count, probability, and regression models that capture how the environmental variable may relate to different dependent conflict variables. The analysis depicts some compelling and intriguing relationships. Many models have accompanying figures showing how the relationship looks over different values of the GMF variables.

Chapter Five's structure is much like Chapter Four, except this chapter looks at one of the predominant questions in criminology research, the motivation, and opportunity model of crime, and looks at what happens when analysts add an environmental variable to the model. It looks at a wide range of crimes, starting with the least violent and ending with murder, and ranging from the city domain to the nation. The models attempt to show how the inclusion of the magnetic field variable(s) change(s) an established model, and therefore indicate the usefulness of the variable in modeling "irrational" and "unreasonable" acts – which means such an explanatory variable can enhance the explanatory and predictive power of existing models. Once again, I make no implied argument for determinism in the nature of the variable or the models that include it. Rather I present GMF as a variable that captures an increase or decrease in volatility of human behavioral outcomes by predicting extreme events as environmental conditions change over time and space.

This point is worth emphasizing: Magnetic fields do *not* cause crime. They do not cause one human to end the life of another brutally. I do not argue that just because the GMF is a certain measure that another rape *must* happen. There is no reason to suppose that an external force could control someone by manipulating magnetic fields, the way a mad scientist in pulp fiction might have tried to control someone with "gamma rays." GMF is just a variable that may cause human behavior to suffer from increased dispersion away from the mean, away from the rational or reasonable. As the possible outcomes move away from the mean, and the distribution of outcomes becomes greater, the likelihood of having an extreme act deemed deviant, or irrational, might increase. The "deviant" or "irrational" act could be the giving away of one's kidney to a complete stranger. Alternatively, it could be the cutting out of a kidney from a complete stranger in a back alley. Unfortunately, for this analysis it is not possible to assemble a complete dataset of the full range of positive *and* negative "deviant" and "irrational" outcomes. Instead, we can only work with the half of the distribution that captures the extreme negative outcomes. In this case, those outcomes are crimes.

Chapter Six evaluates volatility directly and evaluates aggregate investor behavior. In particular, I will attempt to model the daily volatility of the Dow Jones Industrial Average. The chapter uses daily magnetic field measures in models to show how environmental variables may be useful on a time scale that is generally beyond a researcher's ability to conduct a parsimonious and affordable analysis. The overall model I use is derivative, taken from prior work attempting to explain market volatility using Presidential signaling on the economy. Many of the previous Presidential signaling models showed a weak, insignificant, or unclear relationship between the President's signals on the economy and the Market's reaction to these signals. However, , the addition of a variable that helps capture the influence of the environment on human behavior, perception, and decision making, may be able to give these models more inferential power. They may explain a greater amount of variance in stock market moves. It may even save a series of political hypotheses that possessed intuitive theoretical power but had fallen shy of expectations.

Chapter Seven, the conclusion, considers some of the broader theoretical implications of the intriguing evidence supplied by the empirical chapters. The growth of revisionist approaches such as fuzzy logic and chaos theory is a direct response to the pesky problem of relatively large error terms and difficulty that "traditional" models suffered when attempting to *predict* outcomes. A natural variable as a possible explanation for volatility, or variance, in human behavior may or may not come into conflict with these perspectives, which treat variance as acceptable and expected due to the uncertainty created by the world itself. This chapter also discusses the possible implications of my research for public policy, how it could be relevant to policy creation and analysis. Technical information on the sources of data used including the data used to construct control variables is included in a Technical Appendix at the end of the thesis. It provides this location information, should it be useful to others judging the research approach or seeking to replicate any of the statistical work.

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Chapter 2 Geomagnetic Fields and Political Science

While we may not realize it, the sense natural phenomena shapes human behavior already pervades human culture and language in a form of integrated acceptance that goes well beyond proof's ability to support. There are several illustrations: the belief that (1) temperature influences crime, (2) lack of sunlight correlates to suicide and depression, (3) more women get pregnant during the winter, and (4) climate influences work ethic.

The link between temper and temperature is ingrained throughout the language, as seen from phrases such as "hotheads," "tempers flare," anger "simmers," tensions "come to a boil" – while, at other times, a situation might "cool down" – in referencing the relationship between temperature and violence and crime. Shakespeare illustrates the perceived linkage between internal and external temperatures in *Romeo and Juliet*.

> *I pray thee, good Mercutio, let's retire. The day is hot, the Capulets abroad, and if we meet, we shall not 'scape a brawl. For now, these hot days, is the mad blood stirring*. (Act III, Scene 1, Lines 1-4)

The connection linking anger and violence to temperature appears in scientific research. The most detailed study of this relationship, a two-year study of property crimes in Minneapolis, Minnesota, looked at 281 different temporal variables, including holidays, school closings, time of day, day of week, and temperature, among others. The analysts argued that temperature was a significant predictor of property crime events (Cohn & Rotton, 2000). Their study found that violence increased with temperature, although admittedly only a little: At about 80 degrees Fahrenheit, competing interests of aggression and escape started to bend the curve on rising violence versus temperature. That is, moderately high temperatures cause people to lash out, but the highest temperatures produce such discomfort that people exhibit a flight response.

Researchers have worked this natural phenomenon into their "opportunity and motivation theory" of crime. Opportunity is a function of spending time outside and around others. As temperatures rise, more people retreat inside, so opportunity declines and crime falls. A re-examination of the Minneapolis data five years later, controlling for time of day, documented an increase in the strength of the relationship between temperature and assaults (Bushman, Anderson, & Wang, 2005). The findings do not seem to be restricted to the United States, as a similar study of England and Wales found a similar relationship (Field, 1992).

We believe heat relates to violence against others, but my second example suggests that other natural environmental variables correlate to violence against the self, such as depression and suicide. The relationship to the lack of light and depression has a clinical title: Seasonal Affective Disorder (SAD), or winter depression. SAD appears to involve a number of potential influence factors such as brain chemicals, ions in the air, and genetics. The result is that people are particularly sensitive to the lack of light.

One line of research regarding SAD explains the relationship as mediated by the production of melatonin. A natural variable, light and its availability, is central to melatonin production. Seasonal change compounds this variation, which triggers increased production of melatonin during winter months as opposed to summer months. Melatonin is one input into the maintenance of circadian rhythms and sleep patterns. The air, meanwhile, is full of negative ions in the springtime and not in the winter. Researchers have determined that ion therapy, a manipulation of the natural environment, proves quite effective at treating SAD. Sufferers sleep on a special conducting bed sheet and a stream of negatively charged ions bombard them. No one is sure as to what the mechanism and the process is that ties season, light, ions, and sleep together to moderate depression. However, researchers are convinced that environmental factors, including seasonality, light, and environmental ions trigger SAD. The most effective treatment seems to be changing the quality and duration of light exposure as well as the concentration of negative ions in the environment.

Contrary to the situation of Seasonal Affective Disorder and its conclusion that a lack of quality light is a contributing factor in inducing depression, a growing body of research connects suicide to *too much light*. Violence against self is connected to exposure to too much light in several studies. The Harvard School of Public Health has completed research that shows sunlight positively correlated with suicide (Trichopoulos) and negatively correlated with the occurrence of schizophrenia in dark-skinned people (McGrath). A study in Australia indicated that long, sunny days correlated with suicide and not temperature, rainfall, or barometric pressure (Lambert, 2003). The study hypothesized that the neurotransmitter serotonin is likely involved. Other research had discovered serotonin imbalances in the brains and cerebrospinal fluids of suicide completers. Serotonin and melatonin are both sun-influenced hormones. Of course, studies has found that several other factors associated with this relationship exist, such as the presence of a history of depression among men and neurotic, stress-related, or somatoform disorders (Reutfors & al., 2009).

Trending toward violence against others and self may seem two sides of the same coin, in terms of natures' effect on human behavior. The third example speaks to a happier outcome: the generally accepted trend that human conception increases in frequency over the winter months. Cultural expressions often attribute observed patterns of intercourse and fertility to physical comfort. Consider, for example, the comical sentiment expressed in Cole Porter's "It's Too Darn Hot" from *Kiss me Kate*.

> According to the Kinsey report
> ev'ry average man you know
> much prefers to play his favorite sport
> when the temperature is low
> … (Porter, 1948)

Analysis suggests that environmental factors in the late 19th and early 20th centuries drove seasonality of reproduction. However, in the mid- to late-20th century, these environmental factors no longer correlated with seasonality of reproduction. Human culture, society, and technology largely overcame the earlier relationship in an industrialized nation (Doblhammer, Rodgers, & Rau, 1999). Contemporary seasonal variation in childbirth more likely traces to environmental drivers of hormone production (Wehr, 2001). Most research ties the situation to "photoperiodism," resulting from the production of hormones such as melatonin, dopamine, and serotonin. Individual level of analysis that controlled for both individual fertility and couple's sexual activity as well as intensity and timing of their activity confirmed these findings. This study collected incredibly personal data on couples because of their participation in a systematic program of fertility and family planning at 12 clinics throughout Europe. A study found that seasonality only mattered for women, aged 27-31, and that in most situations intensity and number of sexual encounters during "fertile" periods was the strongest explanation for "seasonality" (Rizzi & Dalla-Zuanna, 2007).

Yet another research program places seasonality of reproduction squarely on the body's production of the hormone kisspeptin. This hormone is produced The body produces this hormone in response to environmental conditions such as reduced availability of resources, reduced hours of activity, *etc.,* to preserve resources. In humans, a deficit in the receptor for kisspeptin has been associated with severe reproductive impairment. Kisspeptin also has the power to trigger ovulation in women and testosterone production in men (D'Anglemont de Tassigny & Colledge, 2010).

It seems that technology and hormone production, coupled with the environment, drive reproductive behavior in humans. Economists largely accept my final illustration of how environmental factors might affect human behavior: that of adverse weather. In modern times, there is no compelling reason why individuals must stay home or shop less when it is merely rainy outside. Yet economists, economic analysts, and investors discount bad earnings and revenue reports as well as poor economic activity if they can identify that a region was suffering from rain or snow conditions.

These adverse conditions can fall far short of blocking access routes or locking automobiles into driveways. Just an extended period of rainy weather, or cold and snow, can be used to legitimate poor performance of retail or other economic activity. The justification is that precipitation alters how individuals feel, motivating them to reduce or delay consumption. This drop in spending causes a general decline in local or regional economic activity. Short of flooding or blizzard conditions, the effect on people is one of altering behavior rather than constraining behavior.

2.1 Influence of Natural Phenomena in Sociology and Psychology

The tradition of explaining human actions with reference to the natural world is not limited to these commonly discussed examples. Several research programs exist that advantage measures of natural phenomena to help explain socially and politically relevant human behavior in a thoroughly formal way. Sociology, psychology, and biology seem to be the primary disciplines with subfields that utilize models and theories with natural phenomena as primary causal variables influencing human behavior. Economics and political science have smaller research literatures that evaluate the relationship between natural environment and human behavior, but often the direction of effect is unclear. Several multi-disciplinary research programs, meanwhile, also exist that focus on natural phenomena and environment as either critical explanatory variables or as the dependent variable.

One of the earliest research programs that correlate human behavior and human adaptation to the environment started with Charles Darwin's research on natural selection. The link between Darwin's concepts and the modern work on natural selection, human ecological sociology, and environmental sociology is clear and direct (Huttel, 2002) and (Catton W. R., 1982). Given that the misuse of Darwinist concepts when applied to human society is widely known, I need not belabor that example here.

Another example: Sociologists assert that spaces and places, because of the physical layout and use of area, can evoke emotional responses. These spaces and places can also stimulate positive or negative behavioral responses. A 1977 study found that the layout and environmental conditions of the physical area in which teachers worked correlated to their general attitudes and behavior connected to the school building (Lewis, 1977). More generally, while social determinism with Sociology became useful as the ideas of biological determinism lost traction among researchers – that is, although explanatory variables in the categories of social and cultural conditions dominate the field -- the rise of the environment movement in the 1960s and 1970s changed that. By calling for the application of the "systems perspective" to make new and more relevant and complete inferences, scholars brought environmental determinism into vogue (Dunlap, 2002).

Human behavioral ecology, as a subset of Sociology, leverages evolutionary theories such as natural selection and adaptation to explain expressed traits or behaviors that might result from environmental stimuli. In the 1970s, a new research project called the New Ecological Paradigm (NEP) grew in importance. NEP placed environmental variables in the primary role for explaining human behavior. NEP asserts that while humans have the capacity for innovation and ingenuity, we still exist in interdependent relationships with other species and our natural environment. This program acknowledges the influence of social and cultural forces but stops well short of claiming social determinism, recognizing cause, effect, and feedback loops in natural ecosystems affect humans (Catton & Dunlap, 1978).

While these assumptions explicitly refer to the impact that changes in environment have upon the relations between and among individuals, as well as societal relations more broadly, the execution of the Political Ecology research program focuses on the material conditions of a society rather than some "natural" biological or physical impact on behavior (Walker 2005). This program expresses interest in the impact of pollution, natural disasters, pandemics, weather, *etc.*, on human behavior (Blaikie, 1985).

Several subfields of psychology also leverage the concepts found in ecological sociology to define and develop the role of the environment. A subfield of psychology, Human Behavioral Ecology, seeks to explain human behavior as a response to ecological and social factors in the environment. (Human Behavioral Ecology also appears in Anthropology.) It portrays human behavior as resulting from evolutionary changes that responded to both ecological and social conditions. In these research programs, the dependent variables are human behavior and human evolution while the primary explanatory variables are natural and environmental phenomena or conditions.

The subfield of Environmental Psychology spans a wide range of research areas, including natural environments, social settings, built environments, learning environments, and information environments. At its core, the subfield desires to develop a model of human nature that predicts how the environmental conditions will affect behavior. The goal of such a model is an understanding of how to create environments that maximize good behavior and minimize deviancy (Ittelson, Proshansky, Rivlin, & Winkle, 1974). One of the first works in this field discussed how the sun and moon affected human activity, the impact of extreme environments on human mental and emotional processes, and the effects of colors and form in engineering (Hellpach, 1939).

Evolutionary Psychology (EP) attempts to use the modern evolutionary perspective to identify which human psychological traits are evolved adaptations from interaction with the environment. The mechanism for the evolution could be natural selection, sexual selection, or some other mode of selecting traits. Evaluating the physiological mechanisms in the body is the norm in evolutionary biology. The main assertion of Evolutionary Psychology (EP) is that the mind possesses a modular type structure like that of the body. These structures have different modular adaptations, which serve different functions. Evolutionary psychologists assert that many human behavioral outputs result from psychological adaptations resulting from interaction with the environment (Dunbar, Barret, & Lycett, 2005). Evolutionary adaptations include empathy, mate choice, cooperation, etc. (Wright, 1995).

Similarly, Cultural Ecology examines the relationships between societies and the natural environment to include ecosystems and non-human life. The central argument is that the environment is a major explanatory variable to explain social organization, human institutions, and hence human behavior (Anderson, 2009). Anthropology applies Cultural Ecology to explain many strange human behaviors such as hoarding or gifting. Cultural Ecology informed subfields of geography primarily through research in how the beliefs institutions in a culture regulated its interaction with the environment and how the environment frames social behaviors (Butzer, 1978).

2.2 Geomagnetic Mechanisms of Influence

A long, established, rich, and very compelling history of the leveraging of environmental and ecological variables to explain human behavior exists. In many instances such dynamics have become an ingrained part of western culture and much like the proposition that democratic nations do not go to war against each other, many of the ecological arguments are close to analytical laws. Political Science research has largely run in the direction opposite from the other disciplines who accept some influence from the ecological component to the human action. Political Science studies the influence of human action on ecological components of our world. This thesis challenges that orientation, following on traditions in Sociology, Psychology, Economics, and

Anthropology by seeking environmental variables that affect human action – albeit variables that are quantifiable and relevant to political areas of study.

The explanatory factor of interest is magnetic fields. These fields permeate the space around everyone. Generally, two categories of magnetic field interest me here. The first is the Geomagnetic Field (GMF) and the second is the Solar Magnetic Field (SMF). The Earth generates its' GMF, or Earth's magnetic field, where the outer core and the mantle meet. Where the outer core and the mantle meet is the core-mantle transition area and imbues the soil and rock with a magnetic field. The interaction of the Sun's activities and the Earth's Magnetosphere generates the Solar Magnetic Field (SMF). One well-known result of this effect is the Aurora Borealis seen near the Earth's poles, but variable magnetic fields also reach down to the Earths' surface. These naturally occurring magnetic fields change in intensity over time and space. The absolute intensity of a field, the intensity of the field relative to other times and places, and rate at which field intensity changes all vary based on the geological characteristics of an area.

Scientists have long been aware that these magnetic fields influence plant growth (Belyavskaya, 2004), animal behaviors (Spalding, Freyman, & Holland, 1971), animal navigation (Walker M. M., 2002), and recently it has been hypothesized as influencing climate change (Staff, 2009). Until recently, however, few researchers have extended those observations to ask whether magnetic fields somehow produce behavioral responses among human beings. That relative silence in the social-science literature may reflects a general reluctance to hypothesize natural-science influences on human behavior, given that there are several mechanisms through which these magnetic fields could impose behavioral effects on humans. The most likely is through interaction with the human brain, which operates using chemical and electrical signals that a magnetic field could alter or obstruct. Interference with these signals would in turn alter the manner in which the nervous system interprets, transmits, and codes information.

2.2.1 Neural Signal Transmission Using Chemicals

Many of the signals and most of the "thinking" and "deciding" actions that humans undertake on a daily basis involve the brain and its neurological systems. Generally, neurons communicate signals throughout the brain. Neurons are electrically excitable cells that transmit information using both chemical and electrical signals. In chemical transmission, neurons maintain voltage gradients across their membranes using metabolically driven ion (charged particles) pumps. The membrane potential comes about primarily from the interaction between the membrane and the actions of two types of trans-membrane proteins embedded in the plasma membrane. The membrane acts as both an insulator and diffusion barrier to the movement of ions. Ion transporter/pump proteins actively push ions across the membrane to establish concentration gradients across the membrane, and ion channels allow ions to move across the membrane down those concentration gradients, a process known as facilitated diffusion.

In the most fundamental example of this, the ion transporter Na+/K+-ATPase pumps sodium ions from the inside to the outside, and potassium ions from the outside to the inside of the cell. This establishes two concentration gradients: a gradient for sodium where its concentration is much higher outside than inside the cell, and a gradient for potassium where its concentration is much higher inside the cell than outside. The creation of these gradients is the first place that GMF/SMF could have an influence. While the cell's membrane is resistant to magnetic fields at the very small one micro-tesla range, GMF and SMF influences typically rise well above these levels, and therefore reach strengths are high enough to overcome membrane protections. The thin neuron membranes associated with many illnesses could increase the likelihood of influences on the neurological "system."

Ion channels embedded in the neuron's membrane and ion pumps generate intracellular-versus-extracellular differences in the concentration of ions such as sodium, potassium, chloride, and calcium. This results in changing voltage strength along the membrane as concentrations shift on either side of the membrane. Changes in the cross-membrane voltage will alter the operation of voltage-dependent ion channels. This is the second point in the "system" where GMF/SMF can influence the process. Magnetic fields should be able to alter the ion concentrations outside the cell, thereby affecting voltage changes. Because sizeable voltage changes would generate an electrochemical pulse, or "action potential," magnetic fields could either increase or decrease the number of electrochemical pulses generated.

This explanation of how magnetic fields affect the operation of the human brain is untested, but some research on simpler organisms does provide basic support for such a mechanism. For example, research on snails has shown that neurons exposed to magnetic fields at different strengths experience significant changes in the excitability and firing frequency of neurons. Magnetic fields disrupt normal neuron characteristics and their synchronized firing patterns by interfering with the cell membrane's properties. The research indicated that the possible explanation was an effect on both ion channels and relative ion concentrations (Moghadam, Firoozabadi, & Janahmadi, 2011).

The action potential travels rapidly along the axon of the cell. This activates synaptic connections with other cells. The signals "arc" across small spaces between axons and dendrites between different cells. This is another point in the "system" where the magnetic field could disrupt the process. It is possible that the fields could have an effect on the ability of ions and electric arcs to travel between the axon and the dendrites that allow for the transmission of messages between and among neurons. The effect could range from accelerating travel across the gap to retarding it.

2.2.2 Neural Signal Transmission using Electricity

In electrical transmission, neurons use electrical synapses. An action potential can transmit directly from one cell to another because of direct connection between excitable cells. The signal travels across "gap junctions." The free flow of ions between cells enables rapid non-chemical mediated transmission. Special channels ensure that action potentials move only in one direction through an electrical synapse. In electrical signal transmission, GMF and SMF can affect the conditions in the "gap junction" as well as the conditions in the special channel that ensures signals travel in only one direction. Finally, GMF and SMF can affect the ability of the two neurons to generate an action potential that results in an electrical transmission of a signal. Electrical synapses exist in all nervous systems, including the human brain, although they are a distinct minority (Purves, Augustine, Fitzpatrick, & al., 2001).

2.2.3 The Pulvinar

Another potential source of geomagnetic and solar magnetic effect is through the Pulvinar. The Pulvinar is part of the thalamus in the human brain and exists in a wide range of humans, although not in rats. GMF's ability to operate through the Pulvinar would account for a wide range of associations with GMF, including generally high levels of violence, aggression, and inability to gain consensus. When Pulvinar are affected, it can cause variance in the emotion of fear and responses to threat as well as perception of threat. Humans have two routes to activate the center of emotion and threat response. One is through the visual and association cortex and another through the thalamus, specifically the Pulvinar.

Although research provides little direct evidence that magnetic fields interfere with the functioning of the Pulvinar, the next step in the causal chain, the behavioral effects of Pulvinar functioning, has been documented scientifically. Experiments show that variance in influence on the Pulvinar has an associated response on the part of the individual's ability to process and respond to images of threats (Ward & Bamford, 2005). Other pathologies associated with the Pulvinar are negligent syndrome and attention deficits. Negligent syndrome is the inability to perceive or process information located in a given relative space. For instance,

> …in an extreme case, a patient with neglect might fail to eat the food on the left half of their plate, even though they complain of being hungry. When asked to draw a clock, someone with neglect draws a clock showing only the numbers 12 and 1 to 6, the other side being distorted or left blank. Neglect patients may also ignore the contralesional side of their body, shaving or adding make-up only to the non-neglected side. (Unsworth, 2007)

The other main pathology is the general class of attention deficits. The primary attention deficit is Attention Deficit Hyperactivity Disorder (ADHD). ADHD is a chronic condition that persists throughout an individual's lifetime. ADHD related symptoms generally result in a significant impact on education, employment, and interpersonal relationships. Research shows that adults with ADHD are more likely than their non-ADHD counterparts to experience automobile accidents (Swenson, Birnbaum, Hamadi, Greenberg, Cremieux, & Secnik, 2004) and less likely to complete their education (Cimera, 2002).

Adults suffering from ADHD manifest significantly lower rates of professional employment, even controlling for confounding psychiatric problems (Anthshel, Faraoane, & Kunwar, 2008). Adult ADHD sufferers may reach conditions in which their coping mechanisms become overwhelmed. When this happens, some may turn to smoking, alcohol, or illicit drugs. The result is that many adults end up suffering from one or more associated psychiatric conditions such as depression, anxiety, or substance abuse. Many with ADHD also have associated learning disabilities, such as dyslexia, which contributes to their difficulties (Eden & Vaidya, 2008).

Additional evidence that GMF may have an influence on transient electrical anomalies in the brain possibly resulting from hormone changes exists in studies of sudden infant death syndrome (SIDS) as well as adult cardiac arrhythmias. One study looked as the cases of SIDS and adult cardiac crisis in Sandury (Ontario) region in 1984. A factor analysis showed that 35-40% of the variance in occurrence of SIDS and cardiac crisis in the region correlates with variance in the geomagnetic field. The analysis indicated that geomagnetic influences on the brain is more relevant to explaining the number of SIDS and the number of cardiac crisis than blood than many other mechanisms evaluated, including blood flow (O'Connor & Persinger, 2001).

Another possible mechanism of “action” is in pineal serotonin-N-acetyl transference activity and the concentrations of melatonin and serotonin. Exposure to magnetic fields can disrupt normal circadian rhythms in rats as a result. Disruptions like these have been associated with depressive disorders in humans. If the pineal dysfunction in rats because of magnetic fields exists in humans, the dysfunction can contribute to the onset of depression or will exacerbate existing depressive disorders (Wilson, 1988).

2.3 Research and Experiments: Effect on Perceptions

Regardless of the specific mechanism, most studies examining GMF effects on biological systems focus on animals that use the magnetic field to navigate, namely creatures such as birds, sharks and sea turtles. Birds and sharks both use the GMF to navigate during migration and are affected by changes in these fields (Kimley, 1993), (Bastian, 1994), (Kalmijn, Gonzalas, & McCiune, 2002) and (Paulin, 1995). Research has shown that artificially manipulating these fields causes birds to be unable to migrate (Moore, 1980) and affects interaction with others of its species. In sharks, artificial manipulation of the GMF, generally through the placement of the shark in concrete and metal tanks, results in agitated behavior, a reduced aggressiveness, confused behavior and listlessness, an inability to eat, and eventually death (Kalmijn 1969 and 1982). Likewise, GMF has been blamed for whale, dolphin, and shark beaching (Klinowska, 1988), (Lohmann, Cain, Dodge, & Lohamann, 2001), (Lohmann, Lohmann, Erhart, Bagley, & Swing, 2004), (Semm & Beason, 1990), (Skiles, 1985) and (Phillips, Freake, & Borland, 2002).

Research on GMF and SMF affecting humans generally starts with the Russian researcher A.P. Dubrov, who was able to conduct research and publish works that indicated that the GMF effect on humans was compelling and relevant to decision making and hence, rationality (Dubrov A. , 1978) and (Dubrov A. , 1980). After Dubrov’s work in the 1970s, Dr. Michael A. Persinger and his protégés account for the largest percentage of publications in the area of geomagnetic influences on animals and people. Dr. Persinger has been conducting laboratory research “verifying and determining of the contribution of geomagnetic activity and experimentally-induced pulsed magnetic fields to brain function and anomalous experiences" since 1981 (Persinger M. A., 2006).

The growing field looking at geomagnetic effects on humans includes experimental and statistical studies and covers a wide range of areas. One of the largest of the research programs deals with human cognitive ability and perception. Many oddities previously attributed to "paranormal" phenomena could represent the peculiar operation of magnetics. For instance, various cultures explain the Aurora Borealis as anything from spirits going to heaven, to heaven itself. Cultures attribute the Borealis to dragons, spirits, and reflected light. It has only been in recent decades that scientists have been able to explain the Aurora (Stamper, Lockwood, & Wild, 1999). Other examples, such as "sensing" or seeing UFOs or being haunted, may represent nothing more than magnetic interference with the brain's data processing. Magnetic field variance has been statistically correlated with perceptions of UFOs, Ghost (Nichols & Roll, 1999), (Nichols & Roll, 2000) and (Spittiswoode & James, 1997), extra sensory perception (Schwartz, 2006), religious experiences, and even poltergeist episodes (Gearhart & Persinger, 1986).

Researchers suspect the magnetic field activity created images of the Virgin Mary in the minds of people visiting a site in Canada. The site was a former magnetite mine that had been accumulating about 15 million gallons of water per month for more than 10 years. Between 1992 and 1997, seismic activity had moved closer to the location. A study of the area found GMF activity that was similar to that created in the laboratory and resulted in sensed presences (Suess & Persinger, 2001). An experiment with 16 subjects found that 75% of the eight who experienced an above average number of partial epileptic-like experiences reported a "presence" when exposed to certain geomagnetic fields. None of the eight subjects with a below-average number of partial epileptic-like experiences reported a "presence" (Cook & Persinger, 2001).

Under laboratory conditions, researchers placed 12 men and 12 women under varying geomagnetic fields and asked to imagine alien invasions. The results of the experiment indicated field strengths affect aspects of imaginings and alter suggestibility of individuals (De Sano & Persinger, 1987). In another situation, researchers took magnetic field measurements at a house inhabited by two adults who reported above average partial epileptic experiences. It was found that magnetic fields were found to be correlated with the occurrence of reported "waves of fear," tactile sensations, nightmares, apparitions, and sensed presence (O'Connor, Koren, & Persinger, 2001). A 1992 study of pilots found that a relationship existed between helio-magnetic (i.e., solar magnetic field) exposure and intensive homeostatic levels accompanied by a decreased functional activity of the central nervous system. This led to a sharp decline in flying skills (Usenko, 1992).

In another experiment, researchers exposed 53 men and 86 women to weak magnetic field for 30 minutes a day over 96 non-sequential days. They recorded their experiences after having the field applied. The results showed a statistically significant relationship between global geomagnetic fields and incidents of experiences attributable to memories. The relationship was gender dependent. Women reported more experiences at lower magnetic values while men reported more experiences at higher values. This finding was the basis for re-analysis of 395 separate individual reports of “precognitive experiences” over a 100-year period. This reanalysis confirmed that at higher geomagnetic field strengths, men reported more experiences than women did, and women reported more experiences at lower geomagnetic field strengths (Persinger M. , 2002).

The previously cited experiments and studies all provide compelling, if somewhat problematic, evidence for some sort of effect of geomagnetic fields on individuals' perception of their environment and that the influence may vary with gender. However, these influences only indirectly relate to the areas of interest of Political Science, public policy, criminology, and Economics. Yet it is easy to see how altered perceptions could affect all sorts of outcomes within these domains.

2.3.1 Effects on Memory

Beyond immediate perceptions, geomagnetic fields affect memory as well. One experiment indicated that GMF affected the details of recall (Michaid & M.A., 1985). In another experiment, fifty men and women were exposed to generated magnetic fields or to a “sham” field and asked to code statements as being “foreign language” or not. Researchers executed a refutation process under experimental and controlled magnetic field influence Subjects were evaluated for their tendency to accept refutations of what were in fact falsehoods versus their tendency to maintain their correct assessment. During magnetic influence, participants accepted twice the number of refutations as true when they were false, as did subjects acting in a “sham” field. The results indicate that GMF may affect a person's susceptibility to being convinced or accept false statements as being true (Ross, Koren, & Persinger, 2008). This and the previous evidence indicates a telling ability of GMF to influence individual perception and memory in ways that moves individual understanding, processing, and use of information away from the “logical and rational” in ways that have significance to key theories in political science, criminology, and economics.

Even more directly relevant to the study of political science, criminology, and economics are two experiments done on rats related to geomagnetic influence on aggressiveness and violence. The first, published in the *International Journal of Neuroscience*, discussed three separate experiments on groups of male rats exposed to either a “sham field” or a magnetic field. For the last 20 minutes of magnetic exposure, researchers recorded the numbers of boxing, biting, mounting, eating, drinking, and grooming events for each group. Magnetic fields accounted for between 25 and 50% of the variance in the number of biting and boxing events respectively. Magnetic fields did not affect other behaviors. The evidence supported group aggression being a function of the varying strength of geomagnetic fields (St-Pierre, Koren, & Persinger, 1998). Further analysis of the data from these experiments indicated that the geomagnetic effect was strongest (statistically) in manifestations of biting, the most violent of the aggressive behaviors. After controlling for weak serial correlations, it was determined that the other aggressive behaviors could not be definitively correlated with the geomagnetic field. The researchers hypothesized that the effect of the magnetic field manifested itself in the *most* aggressive behavior (St-Pierre & Persinger, 1998).

2.3.2 Effect on Psychological Health and Well Being

Much of the medical and physiological research looking at the effect of magnetic fields on the human body has focused on cancer. Unfortunately, in an attempt to get to the issue of the relationship between cancer and electrical fields, these studies often missed an opportunity to look at mortality, specifically deaths at the hand of self or others, in relation to magnetic fields. A study over 21,000 electrical workers in Quebec between 1970 and 1988 was one of the first to evaluate electric fields and mortality. The study leveraged a control group in order to determine Rate Ratios in causes of mortality. In this study the only significant rate ratios, and at the 95% confidence interval, was death due to accident and *violence* in workers exposed to each of three types of fields; electric, magnetic, and pulsed electromagnetic fields. Occupational accidents only explained a small portion of the risk ratio. Some association, but not significant, was found among the fields and brain cancer and suicide (Baris, Armstrong, Deadman, & Theriault, 1996).

A study of 540 adults living near extra-high-voltage transmission lines attempted to refute several studies associating fields with depression, suicides, and other adverse psychological effects. The hypotheses of the researchers centered on earlier studies failing to adequately control or account for confounding variables and having inadequate measurements of exposure to fields. The 540 subjects completed neuropsychological tests in memory, attention functioning, mental health, and other areas. Researchers took field measurements in each room of the subjects' homes to provide an estimate of total time exposure. The researchers used joint multivariate multiple regression, controlling for the effects of confounding variables. Their results showed no field effect on memory and attention, but a significant association with psychological and mental ailments. There was also association with poor coding test performance and adverse psychiatric symptomology. These results were independent of the participant's beliefs about effects of electromagnetic fields (Beale, Pearce, Conroy, Henning, & Murrell, 1997).

A later analysis attempted to clarify the relationship between fields and the suicides among utility workers. Researchers reexamined the previous cohort of 138,000 male electric utility workers in the United States, focusing on the prevalence of suicide among the group. The nested case-control study examined mortality from suicide in relation to the workers field exposure. There were 536 suicides among the group and 5,348 eligible controls. The data indicated an increased odds ratio of around two for increased chance of suicide over the control group for lineman and electricians. Researchers found a stronger association between field exposure and men under 50 years old than for the entire cohort. Representing a 95% confidence interval the odds ratio for men under 50 was 2.12 – 3.63, relative to the control group. A lineman or an electrician exposed to electric and magnetic fields in the previous year, controlling for other variables, had odds of between two and three ½ times those of the control group of committing suicide in a given year (Van Wijngaarden, Savitz, Kleckner, Cai, & Loomis, 2000).

The amount of evidence supporting a relationship between electromagnetic fields and suicides is compelling and growing. Oleg Shumilov of the Institute of North Industrial Ecology Problems found that between 1948 and 1997 geomagnetic field activity had three peaks every year. He also found that the geomagnetic peaks matched the peaks in the number of suicides in the Russian city of Kirovsk (Brahic, 2008). While Shumilov was collecting his data, a research project ending in 1994 suggested a relationship between depression and magnetic activity. In fact, the analysis showed that magnetic activity during the period resulted in a 36% increase in the number of men admitted to hospitals for depression (Kay, 1994).

The Institute of Cancer Epidemiology in Denmark conducted several studies in an attempt to show the relationship between these fields and diseases. Publics were becoming increasingly concerned with the “fields” they were being exposed to on a daily basis, and the growth in use of cell phones was a contributor to public concerns. Researchers evaluated all the employees in the Danish electrical industry. The Danish Cancer Register did not identify increased cancer risk, as suggested by public concerns. However, there did seem to be a link with increased mortality from amyotrophic lateral sclerosis, or ALS, and field exposure.

Physiologically, human stress responses and decision-making skills seem affected by magnetic fields. Whether the effect is normatively adverse or positive is dependent on the type of field, the intensity, the rate of change of the field, and the group or individual. It is unclear if the effect of magnetic fields on individuals and groups is enough to drive a fully rational individual who is not prone to violence, or suffering from socio-economic status conditions that encourage violence, to violent acts. It is also unclear if magnetic fields themselves are a powerful enough predictor or causal variable to push safe drivers into risky behavior that results in accidents. Likewise, it is unclear the effect of GMF has on causing an airline pilot to make mistakes that end in crashes. Further, GMF causing groups of business people to fall into irrational and risky investment behaviors seems problematic. So too, does GMF is tilting the perception of national leaders and decision makers so they initiate and join unwinnable wars. Even asserting GMF has an impact on individuals’ consciousness motivating them to vote for candidates who are losing or already winning elections seems dubious. Nevertheless, evaluating the estimated effect, significance, and goodness of fit of models including GMF provides some evidence these effects are real.

2.4 Government Research on Magnetic Influence

While the number of medical and social research publications was pointing to a substantial relationship between magnetic activity and psychological health, the world’s national and trans-national institutions were largely staying away from the debate. The closest the research comes to endorsement by an authoritative government body occurred in 2006. Admitting to the relationship only after he left his official position in 2006, a former head of the European Geosciences Society asserted that geomagnetic-related health problems affected between 10% and 15% of the European population. Also in 2006, an Australian government funded study found a relationship between geomagnetic activity and the count of suicides (2006). While not government sponsored, the South African Institute for Health, in an effort to get at the issue of suicide's relationship with magnetic fields, conducted a review of thirteen years of South African suicide data. The review demonstrated a link between suicides and geomagnetic activity (Staff, 2006).

In the United States, the closest that the federal government has come to acknowledging an effect of magnetic fields on humans, either psychologically or physiologically, is a study of market behavior conducted by the Federal Reserve. This is the most authoritative and respected institution to evaluate an aggregate effect of magnetic fields on a population's behavior. A study commissioned by the Federal Reserve Bank of Atlanta showed a relationship between geomagnetic activity and daily stock market returns. The research paper found that geomagnetic fields had statistically and economically significant effects on daily stock market returns. Increases in activity resulted in negative performance for all U.S. Stock Indices (Krivelyova & Robotti, 2003).

2.5 Magnetic Effect Politics, Economics, and Decision Making

None of the research conducted to date has asked questions directly related to decision-making and behavioral outcomes. The closest the research comes is the Federal Reserve study of daily market returns, and even this is indirect. Nevertheless, the psychological and physiological studies suggest that magnetic fields would interact with the environment and the characteristics of individual and groups, and may contaminate the choices made.

For instance, groups of economic actors have choices to make. One possible set of choices leads to accurate evaluation of corporate values and stock prices. Another set of choices leads to an inaccurate assessment that overvalues stock prices and corporate values. The second set of choices result in an extraordinary increase (or decline) in a stock index that is followed by an extraordinary decrease (or increase) when the market is in need of correction. The result of the latter would be high volatility, indicating an inability of the market to determine a value of the basket of stocks that make up the market adequately. Periods of high or low volatility could be associated with magnetic activity or measures, as supported by the U.S.' Federal Reserve's study.

The relationship between car accidents at intersections and global magnetic actively is an area that has received some attention. The hypothesis is that magnetic fields could influence the decision maker's ability to perceive correctly the conditions in the intersection. If the driver correctly perceives the conditions at the intersection, no accident will occur regardless of whether the driver races through or slows to stop. If the decision maker incorrectly perceives the intersection and slows to a stop nothing probably occurs. If the decision maker incorrectly perceives the conditions of the intersection and races through the intersection, then an accident would be probable. This example becomes more complicated and the likelihood of accidents arising out of incorrect perception of the conditions at an intersection more likely when one takes into account that in a theoretical intersection multiple approaching cars are available at any point in time. The more drivers moving through an intersection in a period, the higher the probability that one of them would *eventually* perceive the intersection incorrectly even though each may have the same very low probability of misperception (Westerland & Dalkvist, 1999).

Most decisions involving human actors probably revolve around moral situations. This is especially true in the recent research indicating that brain stimulation correlates with altered morality (2010). The study results showed that stimulating a specific region of the brain interfered with participants' ability to assess hypothetical situations dealing with morality. People's moral judgments actually changed when activity in specific areas of the brain were disrupted. The research team used the technique of "transcranial magnetic stimulation" to disrupt activity in the right temporoparietal junction of the brain. The method applies a magnetic field to a small area of the head, which interferes with the brain's ability to work properly. Participants often perceived as morally permissible attempts to harm even when others did not harm, while at the same time judging as morally wrong accidents that were not motivated by any attempt to harm. One conclusion of the study was that magnetic interference might have resulted in an inability to judge intentions, forcing recourse to the outcome as the only understandable variable the evaluator could process. In a similar manner, criminals with a reduced ability to determine the morality of an action because of the influence of magnetic fields might judge acceptability of their potential behavior using inappropriate cues.

Regardless of how it plays out, the mechanisms are largely the same. Magnetic fields that effect perception, while at the same time decreasing individuals resistance to suggestion, could create conditions where one may "sense" things that are not real, "feel" things that are not connected to reality, lose bearings on their moral or emotional compass, and break free of the risk-benefit calculus that normally goes on inside a person's mind.

2.6 Earth's Magnetic Field as Explanatory Variable

The mounting evidence is that earth's magnetic field may have an effect on human psychological, sociological, behavioral, and physiological outcomes. In particular, research shows that there may be a relationship between magnetic fields and negative human behavior. The implications for magnetic fields as a powerful predictive and explanatory variable are wide and varied.

2.6.1 Cost

First, the variable is cheap to collect, relatively easy to use and understand, and the period of measure can be as short as a second. This means researchers can analyze incredibly precise and discrete periods. Unfortunately, since other "standard" social science variables do not cover such small analytical periods, its application will be at first limited. In the analysis presented in this work, the smallest period analyzed is the day.

Second, the prevalence of monitoring stations all over the world and the existence of extensive data ranging over 150 years provide a systematic, free, easily attainable, and easily used data set. Further, should more precise geological locations need monitoring or more expansive area covered in more detailed – such as a series of intersections, classrooms, schools, court rooms, *etc*. – the devices used to measure magnetic fields are inexpensive, easy to use, and easy to monitor.

The ability to collect field data anywhere, its low cost to use, and a temporal division as small as one second mean a radical transformation in how researchers should view parsimonious models and data collection. The ability to scope down data collection to very small and specific geographic and temporal space allows researchers to minimize problems of ecological fallacy when using aggregate-level variables (King G. , 1997). While the use of field variables, if found to be sufficient to model processes and relationships, will not eliminate this problem if other data in the model suffers from it, the use of magnetic fields can surely minimize it. Consider revolutionary models that can model the day a leader makes a decision to commit a crime using socio-economic variables and the values of the Geomagnetic and Solar-magnetic components and indexes for that *specific* day. The availability of detailed hourly, minute, or even by the second measures of GMF and SMF could allow the "mapping" of risk acceptance over a detailed period. Another example would be to use hourly GMF and SMF data to structure the type and nature of learning activities in schools, or court cases, or voting, etc., to the minute or hour. Their nature and pervasiveness may mean that including them makes most models slightly more complex. However, with the ease of availability of the data, they should make the research no more resource-intensive.

2.6.2 Shifting Theory Away from Problematic Assumptions

Another implication from using magnetic fields is that researchers studying models that have rational-actor assumptions finally have a variable that should provide a useful indicator of when that assumption would be less likely to apply. It is arguable models based on rational choice assumptions are perfectly satisfactory without accounting for a critical environmental variable that affects the underlying assumption of rationality, or that at least introduces additional variance into the phenomenon studied. However, such an argument immediately demands a rejoinder that questions the validity or necessity of the rational actor.

It is unknown at this point by reviewing the literature what the extent of any interactions are, how important the magnetic field is as a component of each interaction, and whether the interaction masks or even replaces the non-magnetic field associated independent variables until the models are run and compared. As models and analysis indicate later in this work, it is highly likely that fields, as defined by the various indexes and components of the Geomagnetic and Solar Magnetic fields, would contribute in critical ways to the development of efficient (if not unbiased) models. If this is so, the implications for data gathering, model building, and political and social scientists understanding of critical social and economic relationships are compelling.

2.6.3 Direct influence on Policy Making and Individual Choice

Transforming costs and altering the framing of principle assumptions of theory and hypotheses are compelling enough reasons in most instances supporting the argument for the inclusion of this new and relevant variable of interest. A, the case made for the value of magnetic field is in terms of policy and application. One such use could mimic the smog and ozone warnings that are a regular part of many large cities' quality of life and health programs. Another comparison is weather forecasting and reporting, which is an important part of many communities' crisis preparedness and mitigation programs. Magnetic field reporting and modeling can be a critical tool in the policymaker's toolkit for anticipating adverse outcomes, risk taking, and decision-making. One can imagine geomagnetic data used when budgeting, allocating resources, districting schools, selecting locations for trials, exams, conflict resolutions, etc. With the use of GMF in policymaking and analysis, one could try to predict or model where additional acts of violence likely would occur, shifting protective resources in response. This would allow a more "rational" and sophisticated budgeting process.

A significant effect by magnetic fields would offer a highly specific and *cheap* method to assist in resource planning and distributions. It would be more scientific than "we send police there because crime happens there," or "we save up overtime for holidays because that's when people commit crime." By providing a *geographical non-personal profile* of where and when crime is more likely to happen, concerns of *racial* and *social* profiling to apportion resources to combat socioeconomic issues perhaps would be curtailed.

With GMF fully integrated into the communities' normal weather and conditions reporting, individuals and groups could gain invaluable information that would allow better management of time, risk, and safety. What if alongside ozone alerts, smog alerts; traffic accident warnings, traffic transit times, and adverse weather warnings, drivers and pedestrians had access to route and intersection specific magnetic field warnings. Alerts could inform decision makers of intersections that have a higher probability of resulting in accidents (Westerland & Dalkvist, 1999), or interchanges, or even high-density traffic or pedestrian dense areas. Perhaps traffic lights could adjust in their timing to anticipate the heightened risk drivers will race through an intersection.

In the area of international relations, the locations of summits, conferences, and meetings could affect the outcome of these events. GMF may affect Peace and Conflict resolution efforts in the locations of the efforts. The choice of magnetic field influences that promote cooperation, rationality, and not aggressive agitation could be useful in resolving conflicts and disputes. Geo-engineering, landscaping, and creating conditions of field activity that promote cooperation, rationality, and suppresses agitation and aggression provides information useful in nation building, policing, community development, resolution of ethnic tensions within polities, and encouraging economic and social development. Of course, these sorts of precautions would require firm evidence that geomagnetic fields influence diplomatic outcomes, but the effect would not need to be particularly strong before it interacts with the dire consequences of failure to be worth taking seriously.

2.7 The Geomagnetic Field

The impact of the magnetic field in human and policy terms should be compelling. A diverse and wide breadth of research in many different disciplines provides the foundation for using the Earth's magnetic field in human and policy studies. One cannot yet assert that the depth of analysis, research, and understanding reaches the same extent as that breadth, but in some subfields, it goes deep enough to make researchers increasingly confident in their studies. The increasing number of authoritative and government-sponsored research efforts over the last 20 years demonstrates this. Some understanding of what the earth's magnetic field is, as well as the characteristics and nature of its variation, should he possessed before using the variable. Readers not interested in the technical side of the data may wish to skip to the next chapter.

2.7.1 Measures of the Field

The publication of William Gilbert's *De Magnete* in 1600 initiated rigorous scientific study of the Earth's magnetic field. Before that, date people were interested, and some studies conducted, but this work started the scientific process of unraveling the mysteries of the Earth's geomagnetic field. Electric currents at the core of the planet and high above its surface generate the Earth's geomagnetic field. All of these currents contribute to the "total geomagnetic field." The geomagnetic field, measured at a particular instance at a particular location, is the accumulated manifestations of many physical processes occurring everywhere in the world and around the planet out to the sun. The analysis in this work uses only a small portion of the information contained in the geomagnetic and stellar magnetic fields. The information is limited to that collected and studied at ground-based observatories, although space-based observations are available to the public.

The general measures used to define and describe the magnetic field consist of eight different components. The magnetic-field components – labeled X, Y, Z – define the Cartesian components of the field north, east, and down. The observatory components (H, D, Z) are the horizontal intensity, the declination (i.e., the difference between magnetic north and true north), and down. The final component is "I," or inclination. All these components join together to constitute "F" or total field (Jackson, Jonkers, & Walker, 2000) and (Bloxham & Jackson, 1993). These values change over time, and at different rates, proving sufficiently variable that they are useful to use in models that hypothesize physiological and psychological effects on actors. The most common form of measurement of the field intensity is the Tesla. In the state of Kentucky in 1976 at the earth's surface, for example, the total intensity varied from 24000 nanotesla (nT) to 66,000 nT. Other units used in measurement are the Gauss (1 Gauss = 100,000 nT) and the Gamma (1 gamma = 1 nT) (Survey, 2010).

We have traditionally used three primary tools to measure the geomagnetic field. The oldest and most widely used is a compass. Compasses can provide measurements of the direction of the geomagnetic field. Later magnetic variometers collected measurements of the Z, H, and B. There were several different types of these variometers in use, but all provided similar precision and accuracy of measurement and required accurate leveling and stable platforms, limiting them to land. These types of instruments were the ones used in geomagnetic stations that provided the older, pre-1945, data in the data sets used in studies within this work. Engineers designed these instruments to measure within +/- 1nT. This is approximately 1/50,000th of the background GMF. Generally, scientists measure the direction of the field in mils or degrees.

During the Second World War a new measurement device was introduced and used primarily to locate submerged submarines from the air and is known as a fluxgate magnetometer. The device was capable of measuring the Z and H component of the field under certain circumstances to within +/- 1nT but was much more capable of measuring the total field (F), to within +/- 1 nT under most conditions. The modern method of measuring the GMF is using a proton precession magnetometer, used for both survey work and observatory monitoring. The general precision of the device used in fieldwork is within +/- 1 nT for the total field, although greater precision is possible when necessary (University of Washington, 2010). This is the primary device used to conduct magnetic surveys from the air and is the tool that provides most of the post-1945 data.

2.7.2 Field Components

Measuring the magnetic field is only the first issue with using it in models. Next comes knowing what is being measured. The magnetic field is actually an aggregate of multiple vector (direction and value) force measurements. For data used in the studies contained in this work, the intensity of the total field (F) is described by the horizontal (H), vertical (Z), and north (X) and east (Y) component of the horizontal intensity. Instruments measure these components in units of gauss, but report in nanotesla, where 100,000 nT equates to 1 Gauss. The magnetic declination is the angle between magnetic north and true north and labeled “D.” The angle is positive in value when the angle is east of true north and negative when west of true north.

Magnetic inclination is the angle between the horizontal plane and the total field vector (Metadata Catalogue). If the field is perpendicular to the Earth, then the measure of the angle is 90 degrees. Scientists believe that animals in navigation use this angle. Magnetic inclination is perhaps the more difficult of the concepts to understand through written description. An example may be useful to understand the measurement and what it means. In a compass, the needle is freely suspended and capable of spinning around as well as moving up and down (when considered parallel to the ground). Magnetic *declination* and the effect of the field lines of the earth result in the needle spinning and aligning in a north-south azimuth. The magnetic *inclination* pulls down on the north-seeking end of the needle. If the north-seeking and south-seeking ends of the needle were equal length and the center of gravity of the needle allowed pivoting up and down, then the magnetic inclination would drag one end of the needle towards the ground.

The maximum effect is to have the needle pointing directly at the ground, which would be a 90-degree *inclination* or perpendicular to the ground and the magnetic field. Modern compasses compensate for this effect by making one end of the compass arrow longer (weighted) than the other end so that the center of gravity offsets the general effect of the magnetic inclination. In order to do this, most commonly produced compasses come in 5 different versions to account for the general inclination of the five differentiated bands of magnetic inclination: magnetic north, north magnetic equatorial, magnetic equatorial, south magnetic equatorial, and magnetic south (Goulet, 2009).

Geological and solar events affect declination significantly. A “secular” change pattern that can change the declination by one degree every 2 to 25 years is a characteristic of the Earth’s poles. For instance, the north magnetic pole has moved over 1,000 kilometers since Sir John Ross first reached it in 1831. Since mid-2002, the rate of displacement has been accelerating. It is currently moving at about 39 kilometers per year versus the previous average of 6 kilometers per year (What is Magnetic Declination, 2010).

The solar wind also affects declination. This wind distorts the Earth’s magnetic field depending on the season and time of day. Generally, the effect increases as one moves from the equator to the poles. At the equator, the effect is “generally” negligible. In Ottawa, Canada, the effect can be measured at an average of +/- .1 degree of distortion, while 500 miles from the north magnetic pole the effect can be a +/- 9 degree distortion.

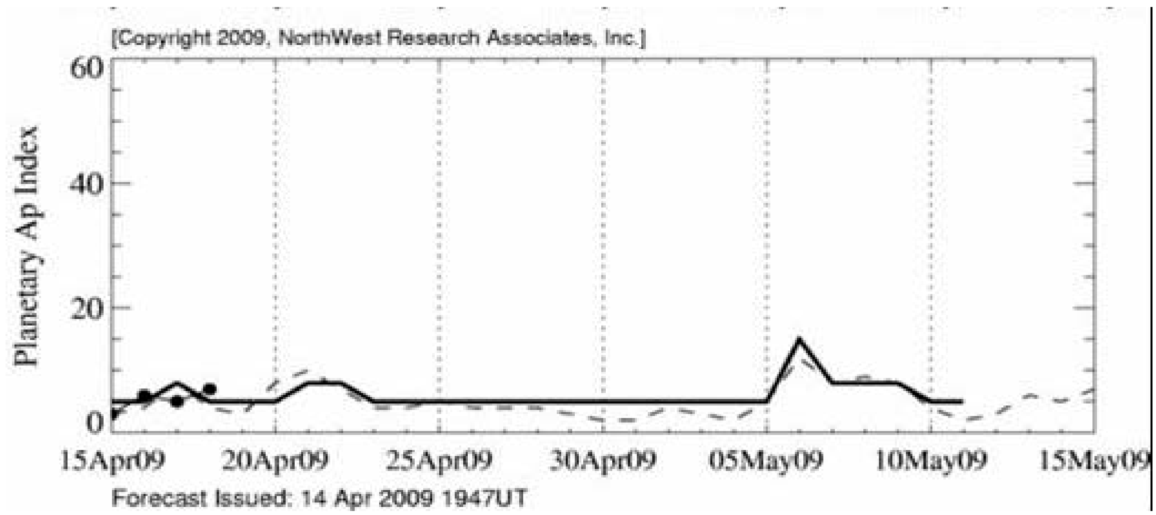
2.7.3 Use of Earth’s magnetic field variables in models

While the application of magnetic field variables may complicate models and require the collection of data on additional cases because of the sheer number of geomagnetic components, including primary ground field components as well as a solar index component, the effort can be simplified through the use of the total field, F, since it is actually an aggregate measure of effect of the initial five components caused by solar interactions with the ground level field. It is essentially an index.

Geomagnetic field measurement effects also are complicated, though “Current systems” caused by regular and irregular solar radiation changes. The Space Physics Interactive Data Resource hosted by the National Geophysical Data Center is the repository for measurements of the interaction of the solar wind with the magnetosphere, the magnetosphere itself, interactions between the magnetosphere and the ionosphere. Ground stations measure these interactions and effects as a variation for a “normal” quiet day on a scale developed in 1938. The scale is quasi-logarithmic logic index of a 3-hour period of magnetic activity relative to the “quiet-normal” day for an observatory and is the K-index.

Analysts transform the K- into a Kp-index. The Kp index transforms the 0 to 9 range K-index into a scale of thirds of a unit. Researchers refer to the Kp-index as the planetary index and it has a value range of between 0 and 27. The planetary index measures solar particle radiation by its magnetic effects. Finally, researchers derive a three-hour Ap (known as equivalent range) index from the Kp index. The range of the Ap index is from 0 to 32. Solar data is available in one-hour increments from the National Oceanic and Space Weather Center. The Space Weather Prediction Center provides 90-day forecasts and a long-range predication for each solar cycle. Analysts update forecasts weekly (Administration, 2011).

Figure 1 Predicted and Actual Ap Index Values 15 April 2009 to 15 May 2009



Another solar magnetic index used in the studies within this work is a C9 index. The C9 index is a transformation of an index called the Cp index, which is a qualitative measure of the overall daily magnetic activity from the sun. The qualitative measurement is a result of the sum of the eight (one measure every 3 hours for eight measures in 24 hours) Ap amplitudes. Figure 1 presents a chart of Ap over a 30-day period. Cp ranges from 0 to 2.5 and moves within the range in increments of one tenths. Zero represents a “quiet” day while 2.5 represent a highly disturbed day. The C9 index transforms the 25-step (0 to 2.5 in one tenth increments) Cp index into a scale of 0 to 9 with zero being “quiet days” and 9 being “highly disturbed” days (Northwest Research Associates, 2009).

Existing total force intensity data is available for a number of countries as well as cities. The comprehensive data collection offers a variety of magnetic field temporal measurements, ranging from mean values every minute to mean values every year. Ninety-six different countries have collected GMF data, starting in 1813. Many model us the geomagnetic variable as well as the global measure of solar magnetic activity as a variable of interest. Researchers refer to these measures as Ap, Kp, and K indexes.

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Chapter 3 Impact of the Earth's Magnetic Field

The previous chapter established a theoretical framework for the influence of the earth's magnetic field on outcomes involving human behavior. The framework presented included both a summary of the literature concerning the possible influence of the earth's magnetic field on human behavior and an explanation of possible mechanisms of influence. While both the theory and the literature may be intriguing, neither provides evidence that the effect is real or that it would be relevant to any of the issues that concern the discipline of Political Science. If there is an effect, it may not manifest itself in the relationships that yield political, or politically relevant, outcomes. The effect may be small or lacking significance. Once models account for other explanations for variable behavior GMF may not be significant, have a noticeable effect, or fit specified models well. Thus, the next step in advancing this science must be to subject the ideas to empirical testing.

A time may come when, to establish a solid causal inference able to link natural phenomena to socially and politically relevant outcomes, researchers might want to focus on one or two especially critical outcomes and probe the question of causality in detail. This research is in its infancy, however, so it is unclear whether such research would be fruitful or instead represent a dead end. First, scholars need enough circumstantial evidence to warrant taking on that research agenda. Providing such suggestive evidence will be the burden of the remainder of this thesis. The following chapters evaluate a large number of relevant social and political outcomes to evaluate whether the outcomes correlate to occurrence of GMF values..

3.1 Direct Effects of Geomagnetic Fields

The earth's magnetic fields may influence human behavior not through any direct "mind control" but by exerting a destabilizing effect that increases the chance occurrence of certain extreme or remarkable events. If so, a survey of statistical models could present a trend in correlations as a side effect of how the relationship between magnetic fields and human behavior *manifests* itself in the collected dependent variable. Given the way researchers collect data and what data is collected, the pattern resembles a direct effect.

As discussed earlier, this research hypothesizes that the earth's magnetic field increases the volatility of possible outcomes resulting from human behavior and human choice. However, because of the way data is collected as well as what can be observed, only one end of the spectrum of volatile behavior is generally "counted." Although the influence of the earth's magnetic field may increase occurrences of counts in two different directions through the "flattening" and spreading out distributions, researchers generally only record the counts that are of "interest" and sitting in one tail of the distribution. For instance, researchers observe an increase/decrease in robberies, but not an increase/decrease in voluntary giving that may accompany the counted increase.

While capturing both sides of the volatility dilemma is rare, it could be happening inadvertently. For instance, in Michigan many forms of crime are down year-over-year (FBI, 2011). Analysts confirmed the trend in mid-year crime reports and they believed the trend to have continued into the holiday season near year's end. While for most of the year any news or reports of "non-crime" events increasing or decreasing due to volatility, or the direct effect of the magnetic field for that matter, went largely unnoticed. Then leading into the holidays events started to be recognized. One such event was the "secret" paying off lay-a-way accounts in Michigan K-Marts. Reporters first documented the phenomenon in Michigan. Recognition of such acts quickly spread. Anonymous persons paid thousands of dollars on others' law-a-way accounts (Tuttle, 2011).

Table 1 Changes in U.S. Regional Uniform Crime Reports, 2011 (FBI.gov)

Region	Violent crime	Robbery	Property crime	Burglary	Larceny-theft
Total	-6.4	-7.7	-3.7	-2.2	-4.0
Northeast	-3.6	-2.6	-3.8	-1.6	-4.6
Midwest	-9.7	-8.1	-4.4	-3.2	-5.3
South	-5.8	-8.6	-3.0	-1.6	-3.1
West	-6.6	-10.2	-4.0	-2.7	-3.9

The increase in both non-murders and murders comes from an increase in volatility resulting from the influence of magnetic fields. Analysts expect Volatility to affect the distribution on both sides of the mean equally. Models with relationships represented by such distributions have an unchanged mean, but a greater probability of an event or value found in either extreme of the two-dimensional distribution's tails. Models that do not account for the increased volatility from the influence of the earth's magnetic field will find their distributions "spread out" and "flattened." The model may also suffer from greater unexplained variance and real-life occurrences of extreme behaviors. However, the rate of occurrence remains unchanged, or nearly so.

Why not measure the variance directly using a heteroskedastic model or some method of modeling variance in the effect of independent variables, rather than modeling the effect on the dependent variable? It is possible to conduct heteroskedastic analysis on some of the data available for analysis and model variance directly. However, the nature of this study is to provide a less-than-exhaustive look at how the earth's magnetic field could be affecting some "core" areas of attention. For this purpose, modeling data as a simple rate provides a more approachable method that expands the available audience. The next step in validating the underlying mechanism of influence is to model directly the variance and determine how much influence of the earth's magnetic field the variance captures. This analysis also informs researchers on how other variables of interest affect the dependent variable because of the magnetic field's influence on those independent variables. For now, the discipline has not yet come to a consensus on the value of such models in terms of either time or efficiency (Keele & Park, 2005). Even with the introduction of technologies to speed up such analysis (Corneliben, 2005) the use and interpretation of these models is problematic, tend to bias under most circumstances, and can lead to incorrect inferences (Keele & Park, 2005).

Anyhow, effects on variance are not the only possible way geomagnetic fields could influence outcomes, even if that is the most-likely way. It is possible models suffer from effects of omitted variable bias when they do not account for the increased volatility resulting from earth’s magnetic field. Debate rages in the discipline concerning the validity of concern over omitted variable bias (Achen, 2005) caused primarily by the lack of mathematical evidence supporting any sort of predictable effect of omitted variables. The problematic methodological solutions for solving the issues of bias due to omitted variables fuels this debate (Clark, 2005) and (Gary King, 1994). The default solution is “more variables and data,” which is in many instances a problematic tilting at windmills. Often more variables and more data are not available, or so costly as to be prohibitive. Further, the mathematics of regression may not support additional data yielding what we can know as less-biased estimators (Clarke K. A., 2005). More variables may lead to mispecified models. More data and more variables, while always welcome, are not always a possible solution to methodological problems.

However, the mathematical evidence points to more problems when omitted variable bias is present than when irrelevant variables are included in models. Extraneous variables lead to models that are more inefficient. The more the extraneous variable correlates with relevant independent variables in the model, the more they will unnecessarily drive up standard errors (Voss, 2000). Establishing that relationships seem to exist and remain stable throughout analysis, and in particular that the impact of including a geomagnetic variable is statistically significant, would provide reason to include such a “control” variable in predictive models.

I do not expect that this explanatory variable would dramatically alter most research literatures. Theoretically, I have no reason to assert or argue that most of the traditional explanatory variables used in models of human behavioral outcomes would no longer be significant or relevant. Further, available analysis provides only limited evidence suggesting these traditional variables even have their measured effect attenuated by the inclusion of magnetic variables in models. One expects, theoretically, that few variables are spurious or that the bias of their estimators would be so large as to call into question "core" inferences in most literatures. However, the existing state of the research program can meet two requirements that including magnetic variables in some models may accomplish:

1. Control for conditions that may be associated with over-dispersion.

2. Allow for analysis of new temporal domains, such as the day, and provide an available independent variable that allows for models that look at relatively short periods of analysis.

Statistically, we have no way of knowing, without a theoretical grounding, whether the earth's magnetic field is an omitted variable resulting in biased estimators or will act as an extraneous variable and make existing estimators inefficient.

The theoretical story of how the earth’s magnetic field operates, what the possible mechanisms of influence are, and in what way such a variable could impact models far from demonstrates that a causal relationship exists or that it reaches levels that are substantively meaningful. The nature of the variable, and the rules governing whether a variable is relevant and omitted as well (as it potentially results in biased estimators when omitted), provide sufficient reason to argue for the inclusion of the earth's magnetic field in models of both individual and aggregate human behavior.

An omitted variable must have two characteristics:

1. The omitted variable occurs before the included variables, causally if not temporally.

2. The omitted variable has an influence on the dependent variable.

It is difficult to argue that the magnetic field is not first among possible independent variables. It is naturally occurring, continuous variable, generated by the earth, and not influenced by other socially relevant variables. It is safe to say that it is causally prior to all other regularly utilized variables even if causally related to a dependent variable. The evidence provided in previous research with magnetic fields, while at times mixed, has demonstrated a relationship or influence with a diverse set of dependent variables representing human behavioral outcomes.

Further, consistent findings in this work point to strong and compelling influence on human behavioral outcomes by the earth's magnetic field. Often, given the nature of the earth's magnetic field and its existence as a "first" variable, it would be correlated with independent variables that are themselves human behavioral outcomes. For instance, in modeling crime, the earth's magnetic field occurs before unemployment and income. During this period, the magnetic field correlates at extremely high levels with crime when included in a bivariate model. The total local geomagnetic field for Kentucky has an average expected effect with a very low probability of zero. The relationship of the field strength and the crime index count has a high goodness of fit with a Poisson relationship. Similarly, tables shows the magnetic field heavily correlates with unemployment (positively) and income (negatively).

Table 2 Kentucky Crime Index and the Local Magnetic Field

Dependent Variable	Model Type	**Total Local Magnetic Field** Coefficients and Standard Error	Significance Level	Obs	Psuedo R2
Crime Index Kentucky 1970-2008	Poisson	**0.212**	0.000 ***	20	0.9724
		0.000562			

Table 3 Correlations among Field, Unemployment, and Income

	Correlation	
	Unemployment Rate	Per Capita Income
Total Local Field	0.948	-0.9981

It may be useful to take a small step back and look again at the two possible ways that adding magnetic variables could demonstrate its effect on the dependent variables of interest.

3.2 Direct Effects and Omitted Variable

Theoretically, if a relationship between magnetic fields and the dependent variable exists, it is most likely that the magnetic field variable(s) will have a direct influence on the values of the dependent variable. The theory of Occam's Razor (Keuzenkamp, McAleer, & Zellner, 2002) argues against suggesting that traditionally used explanatory variables are in some way mediating variables transmitting the effects of magnetic variables to the dependent variable. Most readers would view such a suggestion without any evidence dubiously. However, this is not so much the case when hypothesizing a simple and direct relationship.

Usually analysts assume the following systematic linear relationship between y and X variables exists:

Equation 1 Standard formula for systematic relationships

$$Y = X\beta + \varepsilon$$

When using matrix expression define the components as:

y and ε are n x 1 column vectors (i.e. there is only one value of y and ε for each value of X)

X = n x k matrix (i.e. X is all variables and all their values influencing Y)

β = k x 1 column vector (i.e. there is one expected value of β for each variable composing X)

We can estimate b, the k x 1 vector of parameter estimates; β, using matrix form as

$$b = (X'X)^{-1}X'y = Ay$$

If we were unaware of all the explanatory variables that should appear in X, we could not use the appropriate formula for y:

$$y = Xb + e$$

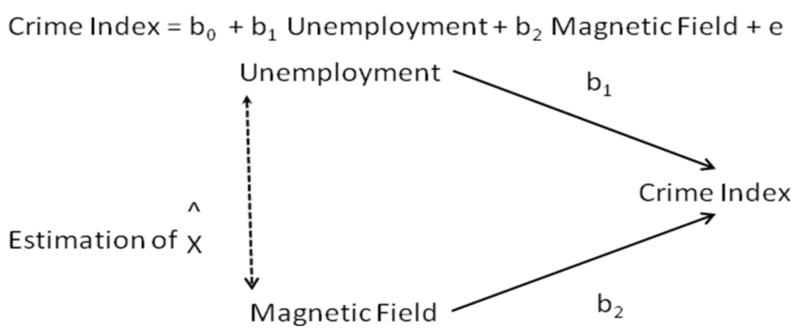
Instead, we would have to split X into two parts, the part that we have collected and know about, and the part we have omitted. The formula we work with in this case is:

Equation 2 Formula of a regression with explanatory variables partitioned

$$y = X_1b_1 + X_2b_2 + e$$

The example of crime in the previous section using this model graphically depicted is as follows.

Figure 2 Graphic of the Magnetic Field as an omitted variable in the model of Crime



In the above formula, y represents all collected values of the dependent variable. X_1 represents all the values for the collected and included independent variables and b_1 represents all the values for the expected influence of a unit change in each X_1. X_2 and b_2 represent the same concepts with different numerical values, while applying to the omitted independent variables that should have been included in the formula/model.

If X_2b_2 is not included in the model, then the omitted information does not disappear. Instead, changing the ☐ term and the standard independent variables conserves the omitted information. The omission makes one less confident in the b_1 values and the estimated values of y, $\hat{Y}$. It is possible to define the impact of the omission on the used independent variable. If we only regress y on X_1 instead on the entire X, then we will not derive the b vector. We may derive a b_1 vector, but only under specific and stringent circumstances. For ease of reference, consider the b_1 vector that the partial model derives as b_1^*. One derives this vector as follows:

Equation 3 Coefficient of effect derived with an omitted variable.

$$b_1^* = (X_1'X_1)^{-1} X_1'y = A_1y$$

This formula is the same as its predecessor, except it represents the specific set of Xs that generate the b_1* in this model, $A_1 = (X_1'X_1)^{-1} X_1'$. Instead of the correct coefficient for $b_{1,}$ the model estimates:

Equation 4 Formula for the coefficient with omitted variables

$$b_1^* = b_1 + A_1X_2b_2$$

To determine if these coefficient estimates would be unbiased, the expected value of b_1^* can be derived mathematically. If $b_1^* = b_1$ then there is no bias from the omission of the independent variables. However, as we see below, generally $b_1^* \neq b_1$.

$$E(b_1^*) = E(A_1y)$$

Because X_1 is presumed to be a fixed component, so too is A_1.

$$E(b_1^*) = A_1 E(y)$$

Substitute the formula for y for the y component of the formula.

$$E(b_1^*) = A_1 E(X_1b_1 + X_2b_2 + e)$$

Next, distribute the expectation operator.

$$E(b_1^*) = A_1 [E(X_1b_1) + E(X_2b_{2)} + E(e)]$$

Apply each expectations operator. Remember that X_1 and X_2 are fixed. The expected e term, if all relevant X are included in the model with no omission, is 0.

$$E(b_1^*) = A_1 [X_1E(b_1) + X_2E(b_2)]$$

Distribute A_1. The model assumes that b ia unbiased.

$$E(b_1^*) = A_1 X_1\beta_1 + A_1X_2\beta_2$$

Remember, AX = I for any X. Substitute the value I for each AX term (with matching subscripts) and the following results.

Equation 5 Estimated coefficient centered on the truth with bias identified analytically

$$E(b_1^*) = \beta_1 + (A1X_2)\beta_2$$

This demonstrated that under general conditions the expected value of $b_{1,}$ b_1^*, is the unbiased β_1 estimator plus the $(A1X_2)\beta_2$ term.

Remember the two requirements for omitted variable bias:

1. The omitted variable correlates with the dependent variable.

2. The omitted variable correlates with the remaining explanatory variables.

To get out of matrix notation, we can consider the effect of omitted variable bias assuming only one omitted variable. This allows focus on the product of two correlations versus some n number of correlations:

Equation 6 Formula for an omitted variable correlating with an explanatory variable

$$b^* = b_{ry} + b_{ro}\, b_{oy}$$

b_{ro} represents the relationship between the relevant explanatory variable and the omitted variable. b_{oy} represents the relationship between the omitted variable and the dependent variable. The formula allows the derivation of a chart of direction of bias and a chart showing the effect on magnitude of an omitted variable.

Table 4 Direction of bias of a relevant omitted variable

		bro is	
		+	-
Boy Is	+	+	-
	-	-	+

Table 4 shows the effect of multiplying values with different combination of signs, which is what occurs in the b_{ro} b_{oy} term. The + sign indicates an increase of the value of b^* away from its true value, or a positive bias. The – sign indicates a decrease of the value of b^* away from its true value, or a negative bias.

Table 5 Effect of the direction of bias on the magnitude of the bias

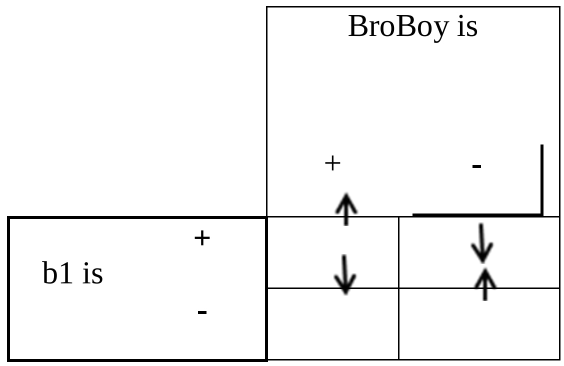


Table 5 shows the effect of the different signs on the magnitude of the bias in b_1 as an estimator of a unit change in X_1 effect on the dependent variable $\hat{Y}$.

3.3 Indirect Effects of Geomagnetic Fields

The previous discussions focused on direct effects, with attention to the issue of omitted variable bias. Explanatory variables also can have indirect effects. As discussed earlier, it may be premature to assert that mediating effects or indirect effects exist in the relationship among explanatory variables that include earth magnetic field variables. However, it is appropriate to discuss what such a relationship would generally mean and what it may look like in any survey of models including magnetic variables if found that such a relationship could exist.

Authors describe the indirect effects in terms of “mediating” variables. Mediating variables reside in the “space” between independent variables and the dependent variables. Some effects from the independent variable pass through the mediator variable and onto the dependent variable. The mediator can act as a lens, increasing or decreasing the effect of the independent variable as it passes through onto the dependent variable. This is the indirect effect.

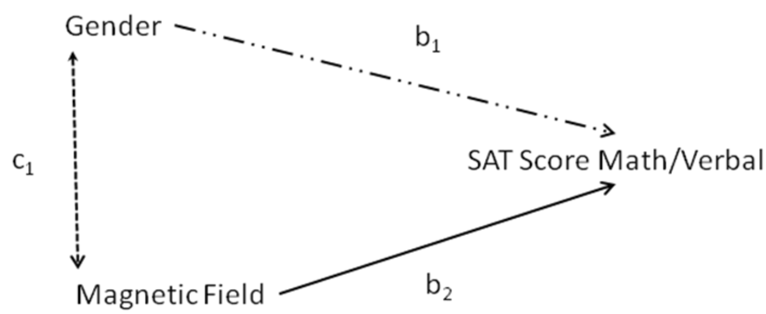
Consider the possibility that magnetic fields influence scores on the Scholastic Aptitude Test. Literature indicates that the earth’s magnetic field would affect the test taker’s ability to process information, perform high order reasoning, and “intuition”, as well as senses of well-being and anxiety that would help a test taker feel confident a lack of confidence in derived solutions. This influence would affect precision of solutions generated from like or similar processes performed by test takers. Solutions would take longer to devise, and they would be less likely to correct. Repeated attempts to gain derived answers to assist in narrowing down possible solutions shows how the influence of the magnetic field could result in much less dependable and efficient information to solve problems.

The literature on the influence of geomagnetic fields indicates that the fields may have different measures of effect on females versus males. The literature on SAT score trends indicates that males and females have differing trends in performance for both verbal and math portions of the test. The magnetic field possibly could have an indirect effect on SAT scores through the mediation of gender.

Figure 3 Model of the direct, magnetic field, and indirect, gender, effects SAT scores.

$$\text{SAT Score} = b_0 + b_1\,\text{Gender} + b_2\,\text{Magnetic Field} + e$$

$$\text{Gender} = c_0 + c_1\,\text{Magnetic Field} + e$$



$$\text{Total Effect of Magnetic Field} = b_2 + (C_1 * b_1)$$

While magnetic fields may have a direct effect on SAT scores, the possibility exists that the magnetic field has an indirect effect. Test taker gender may mediate the indirect effect.. The mediation effect could take on any number of possible forms. It could be that the variance in derived solutions will be greater in one gender than another because of magnetic influence. Alternatively, the variance may shift in one direction or another for one gender versus another. Finally, it is possible that magnetic field effects, when mediated through gender, reduce the variance of one gender when compared to another. Whichever way it works, exclusion of geomagnetic variables would prevent a full analysis of test performance.

3.4 Survey of relationships among fields and outcomes

A theoretical grounding in the literature, a plausible mechanism for the effect of magnetic fields, and a somewhat detailed explanation of how an effect can manifest itself in different ways in something as “mundane” as SAT scores begs the question of whether the “theoretical” story can be supported with statistical analysis and general inferences made from that analysis. Theoretically, one can see how impacting the variation in derived solutions to a question also influences how close the available derived solutions across the population would be to actual available options: With an exam, increasing the variance in how people derive answers would increase the chance of choosing the wrong answer in many cases. Often, therefore, geomagnetic variables would correlate with a dependent variable containing outcomes.

Analysts address this question most simply by using a series of regressions that look at the relationship among several different measures of the earth's magnetic field with a wide range of readily available and arguably interesting dependent variables. Seeing whether these patterns hold up by the addition of a few traditional, low-controversy variables also will be possible in this chapter. Later chapters will follow with richer and more detailed explorations of full models. Appendix 1 through Appendix 4 at the end of this chapter contains the statistical results of the large number of models summarized in the chapter. The tables group statistical models by level of complexity of the variables included in the models and model type.

These tables represent a survey of possible correlations among the earth's geomagnetic fields and some dependent variables of interest that cover a wide range of social science interest. The first appendix includes models with the Ap and the C9 indices as measures of global geomagnetic activity. Analyses treat Ap and C9 as system effects in models. The second appendix uses the measure of the Total Geomagnetic Field, the F Field, as the only independent variable in the model. The Total Geomagnetic Field is the ground level measure of the total effect of the earth's magnetic field. The third appendix breaks the Total Geo-magnetic Field measure of activity down into its *localized components*. Analyses average each of the localized components across polities to represent national- and state-level measures of earth magnetic fields. The final appendix contains models using various measures of magnetic field as the explanatory variable of interest as well as some traditional control variables.

3.4.1 Discussion of Presentation Tables

The two models used in the analysis are linear regression and Poisson count models. This survey uses a diverse series of dependent variables to model using magnetic fields. The dependent variables fall into several different general categories. These categories are economic, social, academic, and political. The economic category includes models of the misery index, unemployment, inflation, labor force participation, percent change in gross domestic product, labor strike activity, aviation accidents, interest rates, and budget deficits. The social category includes models of crime counts in various categories such as murder and rape, abortions, and suicide. The academic category has a set of models of SAT performance. The political category includes models of Supreme Court behavior, changes in national Freedom House scores, aggregate voter behavior in the United States, and U.S. election outcomes. There are 110 different models in the survey. Based on the preponderance of evidence provided by those models, combined with the previous discussion of the causal mechanisms and a review of the relevant magnetic research, the survey results compels further analysis and research. Chapter

Four will look at the international relations implications. Chapter Five will look at the relationship between different crimes and the earth's magnetic field. Chapter Six will look at the role of the earth's magnetic field on economic and financial processes.

The appendices show two formats of tables. An orientation to the tables may be useful to the reader. The first type of table lists the dependent variables of interest in the model along the left hand side of the table. Adjacent to the variable name and indication of scaling, if applicable, is the type of statistical model used to model relationships; regression or Poisson, *etc*. Along the top of the table are the various independent variables used in the models. Within the data information area of the table each explanatory variable has their coefficient reported in **bold**. The standard errors of the estimates associated with the explanatory variable are listed and displayed below the coefficient and are *italicized*. Additional data reported in the tables include the level of significance as indicated by a number of stars, the number of observations included in the sample, and the adjusted R^2 of the model. This table does not report information applicable to the constant in the models.

The second type of table lists the explanatory variables of interest in the model along the left hand side of the table. Adjacent to the variable name with indication of scaling, if applicable, is the type of statistical model used to model relationships; regression or Poisson, etc. Along the top of the table are the various dependent variables that the explanatory variables are used to model. Within the data information area of the table each explanatory variable has its coefficient of affects reported in **bold**. The standard error of the estimates associated with the explanatory variable are listed and displayed below the coefficient and are *italicized*. Additional data reported in the tables include the level of significance as indicated by the number of stars, the number of observations included in the sample, and the adjusted R^2 of the model. This table reports constant information for each model.

3.4.2 The magnetic variables Ap and C9

Analyses treat Ap and C9 as explanatory system variables. They are measured for the whole globe, represent the earth's magnetic field as a whole, and measure the activity of the field at the earth's surface. They could be considered the ultimate system variable. They are also the simplest variables to understand conceptually. The problem they present is that they are categorical variables that fit a lot of information and volatility of magnetic field values into a tidy range of 0-9 for C9 and 0-24 for Ap. Based on this, one would think that the trend for each would be toward very low significance, if any significance at all as the effects were "washed out" by lack of variability over the earth as in the local measures of the magnetic field. Further, if these measures did happen to correlate with some of the relevant outcomes, but did so spuriously, one would not be surprised to see unstable or inconsistent measures of effects across models of similar phenomena. It may be that the direction of the effect would be unstable across similar models as well.

However, a survey of the models shows that this is not the case. Ap and C9 tend to exhibit significant bivariate relationships in a wide variety of models, and the direction and magnitude of effect seems to be relatively stable across models of diverse variables of interest. Of the models using system field variables, Ap and C9, 25 out of 38 models of the various relationships had either Ap or C9 as a significant variable. It is unlikely that a coefficient value different from zero occurs by chance in the sample. Of the 25 significant magnetic variables, all but two had directions of effect that were in line with what one would expect theoretically. Misery Index, unemployment, crime counts, abortions, and bond interest rates (higher rates equate to higher measures of systemic economic risk) are models where Ap or C9 coefficients are significant and all have direction of effects that match expectations based on the literature and hypotheses concerning the mechanism of influence.

In the economic category, neither Ap nor C9 proved to be useful in modeling either inflation or percent change in annual gross domestic product (GDP). These models accounts for two of the eight total models, five for Ap and three for C9, without significant magnetic variable. C9 failed to be significant in a model of daily Argentine strikes, but Ap was significant at the .1 level. In every other economic model, C9 was significant at a similar or higher level than Ap. C9 also explained more variance in the economic dependent variable than Ap in all other economic regression models. See Appendix 1. Ap failed to rise to the required level of confidence in modeling the three-month Treasury bond rate, the Federal Discount rate, or the Federal Funds interest rate. However, C9 proves to be significant with a confidence better than .05 and approaching .01, for these same models. Many of the "standard" economic indicators correlated with the Earth's magnetic field. The models of unemployment, labor force participation, and mortgage interest rates are the dependent variables in models in which C9 explains more than 30% of the variance in these variables.

Table 6 Summary of significant and evaluated models

Number of times significant out of models ran, by type and total.					
	Economic	Social	Political	Academic	Total
Ap	12/17	10/12	2/4	0/5	23/38
C9	14/17	8/12	0/4	3/5	25/38
TOTAL GMF	14/16	10/12	1/4	3/5	28/38

The social category includes crime counts such as murder and rape, and counts of abortions by different demographic groups. In the social category, Ap is significant in two more models than C9. However, C9 is consistently significant at higher levels of confidence. The only models that Ap fails to be significant is in modeling the number of abortions performed on minorities and the proportion of abortions to live births for minority women. C9 failed to be significant in the same two models. However, C9 further fails to rise to significance in two additional models of abortion: proportion of abortions to live births for all races of women and the number of abortions performed on white women. In these models, Ap is significant and offers reasonable explanatory power. See Appendix 1.

The political category is small and consists only of four different models representing two different subjects. The first subject is Supreme Court behavior. These models suffer from very small sample size, only 11 observation years, and the dependent variable relies on the behavior of a small number of people, so it is no surprise that neither variable of interest was significant at better than .1 levels or better. Ap is reported as significant at exactly the .1 level of confidence with and an adjusted R^2 indicating the ability to account for 19% of the variance in Supreme Court Consensus over the 11 observations. The second category consists of one model, representing the relationship between the earth's magnetic field and the change in Freedom House Score of international states. Only Ap demonstrates a significant with better than .05 level of confidence. C9 does not provide information at a confidence level that meets the .1 or better criteria. Temporal autoregression diagnostics indicate low impact of temporal autoregression using the global Ap index. The significance of the magnetic variable is less than 0.1. However, a model using the total field measured by the geomagnetic station in Fredericksburg, Maryland as the variable of interest shows a very low likelihood of temporal autocorrelation in the model.

The final category evaluated is academic. This category consists solely of various Scholastic Aptitude Test results. Ap fails to rise to confidence levels that meet the .1 threshold. C9, however, is significant in modeling the total SAT scores of males and females, and Male and Female SAT Math scores. Both Ap and C9 fail to model male and female SAT Verbal scores. This could be a result of the nature of Verbal test questions. Verbal test questions are full of contextual information that assists in correcting for the influence of both Ap and C9 as indicated in the earlier example of the magnetic field's effect on decision-making. Female and male math and verbal scores demonstrate a low probability of temporal autocorrelation inflating the significance of the geomagnetic variables. ARIMA models show the magnetic variables significant below the .05 level after accounting for temporal autocorrelation.

3.4.3 Local Magnetic Variable: The Total Field; F

There is one general "local" measurement of the earth's magnetic field. It is the total field, and annotated as "F." The F field can be broken down into multiple components, each representing a vector measurement of the multi-dimensional influence of the earth's magnetic field. The total field, "F," is an explanatory variable that aligns with the established literature, the possible mechanisms of influence, and the use of system variables in the previous section. The total field, "F," is a measure earth's magnetic field at the local address, city, county, state, country, or other political or economic boundary. Analysts can use the total field as a proxy or used as a point of inference for the surrounding geographical areas. The implicit assumption used here is that analysts use the "local" measurement in one local in the adjacent areas as a proxy for the value of the adjacent location. It is clear that this is *not* precisely the case as each specific geographic location and time will have its own "F" field measurement. However, there is limited availability of data beyond the collection point, so for purposes here analyses assumes that the "F" field measurement will not change significantly from the point of measure to the point midway between the point of measure and another point of "F" field measurement. Over large geographical areas such as continents and oceans, there are models that predict the "F" value, as well as the values of the "F" components, but this analysis does not use them. Table 7 shows the number of models with F reaching significance.

Table 7 Summary of significant and evaluated models using the F, total field

Number of Times F Significant out of total models ran by type					
	Economic	Social	Political	Academic	Total
F	1/1	1/1	6/6	4/4	12/12

Dependent variables are evaluated on the size of their impact to the dependent variable (coefficient), the level of confidence analysts have the impact of a variable is not zero (significance level), and the goodness of fit of the model used to determine the relationship among independent and dependent variables The economic category consists of only one model; change in annual U.S. Federal budget deficit. This model uses the total field measurement near Washington D.C. This model shows that the regression explains more than 20% of the variance in the percentage change in budget deficits and "F" is significant at better than the .01 confidence level.

The social category consists of one model; the number of age adjusted suicides. This model contains annual data for states of the United States that have monitoring stations that have provided "F" values. The analysis averages the "F" values for the year and correlate with the number of suicides. "F" is significant at less than the .01 confidence level. See Appendix 2.

The political category consists of a series of models of Supreme Court behavior and voting behavior and voter behavior. The Supreme Court behavior models include models of the numbers of cases NOT heard by the court each year, the percentage of consensus, the percent of cases affirmed, and percent of cases decided that overruled lower courts. All of these models show "F" being significant at least at the .1 level of confidence. Of note is the explanatory power of "F" in explaining the variance in the number of Supreme Court cases NOT heard, but accepted during the court session, which is more than 70%. "F" explains almost 40% of the variance in Supreme Court consensus. These models have low likelihood of suffering from temporal autocorrelation; at worse, accounting for a time trend reduces field variables to the .1 level of significance.

As for voter behavior, "F" is significant in models of the change in the percentage of votes cast for third party candidates in state elections for the Senate and House of Representatives and a model of the probability that the winner of an election is a Republican candidate. The model data came from individual states with observatories that collected ground level magnetic field data in the form of the "F," or Total, field. Unlike with most of the models reported in this thesis, adjusting for autocorrelation does undermine results for the total field measure; voter-behavior models contain time trends that, when factored out, leave in doubt whether the correlation with geomagnetic fields might be accidental. These models require a richer, deeper analysis.

The academic category contains four models of SAT scores; male math, male verbal, female math, and female verbal. The Total field, "F", explains almost 50% of the variance in male and female math scores at the state level. It explains much less of the variance in male and female verbal scores, even though for all four models the Total Field is significant better than the .01 level of confidence. In Appendix 1, the C9 and Ap indexes did not rise to significance in modeling national SAT scores. However, at the state level in Appendix 2, the Total Field did rise to significance. Male and female math and verbal SAT scores suffer little from autocorrelation. Each of the four models has magnetic variables of interest significant at .05 or better after applying diagnostics.

3.4.4 Local Magnetic Variable: Components of the Total Field

The total field can be broken into a number of components often collected and reported by geo-magnetic observatories around the world. Scientists model these components infer and predict them through space and time. At different periods on the history of the collection of the components, various individual components have been in greater "vogue" than others have, and thereby have been collected more extensively. Further, some components are much easier to measure and are more useful. For instance, the horizontal field is easily measured using a compass and has been collected for hundreds of years. The vertical field is less easily measured and has a shorter collection life as a result. To make the issue more confusing different observatories collect different components, some observatories change the number and type of components they collect as their resources available and customers change over time. However, as the following table shows, the components are generally significant in the models they are present in across a wide variety of subjects.

Appendix 3 shows the influence of the individual components of the Total Field, "F." "F" is composed of various components, some of which have been measured and collected extensively, and some of which have not. The components of the Total field are the "H," "V," "N," "I," "D," "E," "X," "Y," and "Z." Table 8 shows the number of times that each component is significant at the .1 level of confidence or better, followed by the total number of times the variable appears in models.

Table 8 Summary of significant and evaluated models using field components

Number of times components are significant out of models ran by type.					
	Economic	Social	Political	Academic	Total
H Component	1/2	1/1	11/11	3/4	16/18
V Component	1/2	0/1		3/4	4/7
N Component	2/2	1/1		2/4	5/7
I Component	1/2	0/1	1/1	2/4	4/8
D Component	0/2	1/1	6/6	3/4	10/13
E Component	1/2				1/2
X Component			11/11		11/11
Y Component			11/11		11/11
Z Component			9/11		9/11

There are only two economic models in the economic category. The first is the change in the Federal budget deficit. It is a regression model that can potentially explain 50% of the variance in change in federal budget deficits by the change in the V, N, and I components of the total earth magnetic field. The second model is of the federal budget deficit in billions of dollars. This model could potentially account for up to 50% of the variance in the annual size of the federal budget deficit. The federal deficit model finds the H, N, and E components significant at the .1 level of confidence or better. For these models the component measurements from the observatory in Fredericksburg, Maryland as a dependent variable with budget deficit numbers generated by congressional and presidential budget politics in Washington, D.C. and the nation's general economic health and security situation.

There is only one social model within the category of the same name. The model is of male suicide counts. The model has only 12 observation years, so it has a very small "N" that make the model results problematic. However, the model could potentially explain 91% of the variance in the numbers of annual male suicides in the United States. This model averages all component values available from observatories throughout the United States and the high covariance between the geomagnetic field variable and the dependent variable calls for diagnostic analysis and further study before making definitive explanatory claims. None of the components was significant in models of female annual suicide counts or total gender irrelevant annual suicide counts and is not in the appendix. The H and N components were significant at the .1 level and the D component was significant at the .05 level. See Appendix 3.

There are 11 models in the political category. The eleven models roughly fall into the groups of 1) Vote Counts, 2) Vote Percentages, 3) Probability of Winning, and 4) Distance between Candidates. The vote count group models the total number of votes counted for candidates or parties. The vote percentage models look at the percentage of votes that a candidate or party received. The "probability of winning" model examines the chance that a party would win based on the sample. The "distance between candidates" model has the number of votes between the winning and the losing candidate or party as its dependent variable. An interesting note is that almost all components in the political model are significant at least at the .1 level and most were significant at the .05 and .01 levels. Only twice, and both cases the Z component, was a component in a political model *not* significant at least at the .1 level. Both times the Z component was not significant involved models of third party voting behavior.

The group of political models of total vote counts shows interesting results. The model for total number of votes cast in a state during an election for congress that includes the common primary components of the total field, H, X, Y, Z, and D, have each of the components significant at the .1 confidence level or better and may explain more than half of the variance in total votes cast during an election. The same components are significant in a model of the number of votes cast for the Republican or Democratic candidates in a state during congressional elections. These models may explain more than 50% of the variance in votes for Republicans or Democrats in an election. Each of the five components is significant at the .05 or better level of confidence in all evaluated party vote count models. The components do less well when modeling third party vote counts. Only the H, X, and Y components are significant and the model explains much less variance in vote counts; only 10%.

The model of "thrown away" votes captures all the votes cast for all of the losing candidates and the votes cast for the winning candidate beyond the number of votes needed to win. Ideally, if information were available and understood, voters would stop voting for the winning candidate as soon as they have enough votes to win. Further, losing candidates would get no or very few votes. It costs to vote and to vote for a candidate who is or will lose is not a good investment in resources. The total magnetic field components H, X, Y, and Z may explain 18% of the variance in the number of votes cast in an election for the losing candidates or cast for a winning candidate beyond that which they need to win. All these votes are termed “wasted” and the magnetic field components provide some information for explaining the variance in counts of such votes using regression models.

There are three models of percent of votes for candidates 1) the percent of votes cast for the winning candidate, 2) the percentage of votes cast for the second place candidate, and 3) the distance between the winning and the losing candidate vote counts expressed as a percentage of the votes. All the models have each of the explanatory variables of interest, H, X, Y, Z, and D components, significant. The Z component is significant at the .1 level. The D component is significant at least at the .05 level. The H, X, and Y components are all significant at the .01 level. Each of the three regression models explains about 24% of the variance in the percentages of the sample.

Of the models that found geomagnetic or magnetic field variables of interest significant most suffered some from temporal autocorrelation. Generally the effect was to decrease significance to the next level. Some examples went from .001 to .01 significance, most went from .01 to .05 significant, a few went from .05 to 0.1, and very few were far from significant after diagnostics were applied. Across all the models evidence is that temporal autocorrelation is a concern and a deeper analysis is necessary before causes identified and controls recommended. Of particular concern were the models of voter behavior.

3.4.5 Magnetic field variables with control variables.

The last groups of models in the survey are models that have magnetic field measurements as well as some simple control or other explanatory variables of interest (See Appendix 4). This should provide some preliminary information as to how magnetic variables significance changes in models with other variables of interest. The set of models includes two voter choice models (political), two abortion models (social), five interest rate models, and a model of the U.S. federal deficit (economic) with the categories and significance success and failures depicted.

The voter choice models in Appendix 4 include the ratio of winner-to-loser votes and a control variable for the republican candidate winning the election. The first is a model of the relationship between the explanatory variables and the total number of votes cast in individual congressional elections. The second models the relationship between the explanatory variables and the total number of “Thrown Away” votes. This is the number of votes cast to losing candidates or to winning candidates beyond that needed to win the election. In these models, the two non-magnetic variables of interest are the ratio of votes among the competing candidates and whether a republican candidate wins.

The vote-ratio is significant and in the expected direction. Close elections result in higher votes cast than in landslide elections. Voters hope that their votes can make a difference and fear the outcome if they do not participate. There may be other social and peer pressure issues at work as well. Close elections also result in more people “throwing away” their vote as they continue to vote for runner up candidates and continue to pile on votes to the winner as to ensure victory. During close elections, third party candidates act as “spoilers” and get more votes as well, increasing the count of “thrown-away” votes. The candidate winning being a republican is significant.

In the model of total votes cast, the inclusion of the addition of the vote ratio variable results in all total field components in the model being significant at the .01 level. Generally, the significance of the Y and the D component both increased with the additional variables over the models without the additional variables. It is less likely that the coefficient of influence for the magnetic field variables is zero in the more specified model.

In the modeling of the relationship between components of the magnetic field and the total number of votes “thrown-away,” the component values change. First, the components H and Y are no longer significant with the inclusion of the new independent variables. Second, the X component is significance at better than .01, and its direction of affect has changed. Third, the Z component decreases in significance but is still better than .01 and the sign of the coefficient was stable. This brings the sign of the X component in line with theory. The additional non-magnetic explanatory variables result in fewer thrown away votes, but changes the sign of the X component so that it now increases the number of thrown away votes as it increases in value.

Table 9 Summary of evaluated models using measures of magnetic field with controls

	Political	Social	Economic	Total
C9 Index		2/2		2/2
H Component	1/2		3/6	4/8
V Component			6/6	6/6
N Component			6/6	6/6
I Component			6/6	6/6
D Component	1/2			1/2
E Component				
X Component	2/2			2/2
Y Component	1/2			1/2
Z Component	2/2			2/2
Control Variables	4/4	4/4	11/12	19/20

There are two abortion models in this part of the survey; total number of abortions and the rate of abortions by white women. Each model also included explanatory variables for total white people living below poverty and the unemployment rate of white people. Both had significant coefficients. More people living below poverty reduced the number of abortions while unemployment increased abortions. The rate or number of abortions by minority women did not see any magnetic field variable significant, but C9 was significant in the models of white women presented. On average analysts expect increasing the C9 index, measuring magnetic activity globally, to covary with increased abortions and is significant at the .1 level in the model of total number of abortions by white women. However, C9's significance increases to the .05 level of significance in the model of the rate of abortions by white women per 1,000 live births. The C9 index is associated with increased counts of abortions as well as increases in the rate of abortions among white women. Diagnostics indicate that analysis of total abortion counts and counts of abortions among white women does not suffer from temporal autocorrelation.

However, analysis of abortion counts among minority women does suffer from temporal autocorrelation. This requires additional statistical analysis and evaluation.

The last part of the survey looks at the economic dependent variables. Specifically, it looks at six different models that have as their dependent variables different measures of risk and uncertainty in the economic realm. Five models depict the expected relationship between several magnetic variables and economic variables and the different types of bond and interest rates in the United States monetary system. Analysts often use interest rates to identify or measure the amount of risk and uncertainty in a system. Higher interest is often associated with higher risk as well as higher uncertainty. Included in the models are the four components of the total magnetic field, the U.S. unemployment rate, and the U.S. inflation rate. In every case, unemployment and inflation are associated with an estimated increase in interest rates except in the model of the Federal Funds Rate; the rate banks charge each other to borrow money over-night. In the model of the Federal Funds Rate, unemployment does not have a coefficient that is significant below the .1 level. In almost all the interest rate models, the geomagnetic components are significant at the .1 level or higher. Additionally, in almost every case the direction of the coefficient of affect is stable across interest-rate models. The H component is the only exception to either of these observations. The H component is barely significant at the .1 level in the model of 3-year treasuries, *not* significant at the .1 level in the corporate AAA rated bond interest rate or the High Grade Municipal Bond interest rates. The H component is significant at the .05 level in the model of the interest rate that the Federal Reserve charges to banks who borrow money from them. Each of these models explains more than 60% of the variance in interest rates.

The economic models with additional controls include a repeat of the U.S. Federal Deficit model with inflation and unemployment rate included as explanatory variables. This model shows the relationship between deficits and magnetic fields is significant; but it only contains four of the six magnetic variables included in this model without the additional non-magnetic control variables. The two excluded magnetic variables were not significant and including them reduced the significance of the other magnetic variables. Overall, adding the non-magnetic variables and eliminating the magnetic variables that were not significant resulted in a model that accounted for 93% of the variance in the U.S. annual federal budget deficits. This is almost twice the model without the additional controls could explain.

There is a model of the annual U.S. budget deficit in billions of dollars. This model explains nearly 93% of the variance in the size of the annual U.S. budget deficit. Each magnetic component is significant at the .01 level or better and the included variable for inflation and unemployment are both significant. Autocorrelation among the magnetic fields and unemployment and inflation is a concern.

Diagnostics results are inconsistent across the different models. There is no general trend of the finance models suffering from temporal autocorrelation. Indeed only the model of the United States budget deficit and the total field strength measured at

Fredericksburg, Maryland demonstrate temporal autocorrelation strong enough to reduce the magnetic field significant to well above 0.1. In all other cases, diagnostics indicate a low risk of temporal autocorrelation and when present it only results in deflation of significance levels to around .05.

3.5 Enough to continue with detailed analysis?

The ultimate answer to the above subtitle must be that, yes, more research is warranted given the insights of previous literature, identification of possible mechanisms of influence, and a series of intriguing and compelling relationships between magnetic fields and outcomes of interest. The sheer number of significant relationships greatly exceeds what one would expect given conventional levels of statistical significance, even accounting for the tendency of small-n aggregate data to produce correlations. The fact that most coefficient signs align with theory, and the potential explanatory power of models with magnetic fields, add more strength to the argument that further research is necessary.

The survey of models using magnetic explanatory variables, even though some included additional controls, does not offer a definitive answer to whether use of such a variable provides value. It neither adequately addresses concerns about the traditional causal mechanisms discussed, nor supports a particular theory as to how magnetic fields may come to influence outcomes. What the survey does tell us is that over the course of 117 models of the relationship between measures of the earth's magnetic field and magnetic field activity and the dependent variables of interest, the preponderance of relationships not only were so strong that they were unlikely to occur by chance, they also offer the potential to increase the explanatory power of existing models. Perhaps the most compelling statistic concerning the survey of relationships is the percentage of magnetic variables significant and whose coefficients had signs in line with the previous literature on magnetic fields: 76% and 87% respectively. However, analysts can only say that there is some high level of confidence that the coefficient of effect for most magnetic variables in not zero at this time.

The wide range of outcomes and human behaviors covered in the survey may provide sufficient support for researchers to apply a wide range of dependent variables involving behavior and choice that increased variance in their dynamics affect. The nature of the survey did not allow an in-depth discussion of the theories behind each independent variable or for the inclusion more than a cursory example of additional non-magnetic variables in the models. Further, there was no attempt to tie the subject matters together in a thoroughly reasoned and integrated manner. The primary effort was to present a series of wide-ranging variables whose measures were available and consistent with the period in which the magnetic data were available. The analysis considered dependent variables that seemed to play an important role in economic, social, and political discourse.

Concern about temporal autocorrelation is reasonable given the wide use of time series panel data. However, diagnostics demonstrate a trend of no or low risk of inflated significance levels because of temporal autocorrelation. There are cases where strong temporal autocorrelation seems present, but it appears in models of types and with dependent variables similar to those that do not suffer from temporal autocorrelation. Further, many models suffer some inflation, but not enough so significance levels rise above an acceptable .05 or .1 level of significance. In most cases, a regression model that indicates a magnetic field variable is significant at or below the .001 level suffers less from temporal autocorrelation than those with significance of .01.

Table 10 Summary of Survey Findings

Number of Models	117
Percentage of Models With Significant Magnetic Variable	76%
Percentage of All Magnetic Variables with Signs in line with Theory	87%
Percentage of Regression Models With Adj R2 above .20	28%
Percentage of Magnetic Variables in Models Significant > .1	76%
Percent of System Magnetic Variables Significant >.1	75%
Percent of Local Magnetic Variables Significant>.1	77%

A survey of the literature on the effect of magnetic fields and other natural variables on human behavioral outcomes, discussed the possible mechanisms of influence, and reviewed a reasonable survey of potential relationships between magnetic fields and politically, economically, and socially interesting outcomes was discussed. Now, a deep analysis of a few issues in a range of disciplines is necessary to say if magnetic fields could be playing any real causal role in behavior, outcomes, risk, or any other dynamic. In the following chapters, the various measures of the magnetic field assists in modeling outcomes in international relations, crime, and economics.

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Chapter 4 State Conflict

The scholarship on both interstate and intrastate conflict adopts a variety of theoretical perspectives, which in turn divides into competing factions and perspectives. Use of magnetic fields in conflict research does not rely on adoption of one or the other of these theoretical perspectives, however. This chapter shows how the explanatory variable of interest for this research integrates cleanly into most of those competing perspectives.

Having set the stage for working magnetic fields into conflict research, this chapter then turns to testing the usefulness of geomagnetics in empirical models. It establishes that magnetic fields do indeed predict measures of conflict, even after models include appropriate control variables.

4.1 Realism

Realism has provided a cognitive framework for describing the interaction of states since Thucydides' 5th century B.C. work, *History of the Peloponnesian War* (Thucydides, 1972). Over 2,450 years later, Hans Morgenthau would pick up Thucydides' statements asserting that the basis of the war between Athens and Sparta lay in Athens' concern regarding Spartan power and its rise as a looming threat in the minds of Athenians. How would magnetic fields fit into this theory? They would impose their effects on the perceptions of states concerning their power relative to the power of others. Morgenthau's *Politics Among Nations* established *classical realism* (Morganthou, 1965). In 1979, in an attempt to bring scientific rigor and systematic analysis to the discipline, Kenneth Waltz formulated the adjustments to classical realism that known as *neo-realism*. Since the publication of Waltz' *Theory of International Politics*, various schools of thought has evolved as counter-weights to Classical and Neo-realism's hypothesis, axioms, and almost-laws (Waltz, Theory of International Politics, 1979).

The third generation of realism, termed *neo-classical* realism in Gideon Rose's "Neoclassical Realism and Theories of Foreign Policy" in the journal *World Politics* (Rose), is noted in the works of Randall Schweller and David Press (Schweller & Press, 1997), William Wohlforth (Wohlforth), and Aaron Friedberg (Fiedberg, 1993/4). Neo-classical realism recognizes that domestic, intervening variables are present in the neo-realist model. In Neo-classical theory, the distribution of power in the international system affects foreign policy decisions through an intervening variable of domestic perception or domestic incentives related to the international system. An example of this would be heavy industrialists encouraging states to purchase weapons, enter into arms races, and even threaten war in order to ensure orders for their production or for resource industries doing the same to ensure access to unrefined product they can process and then sell, such as oil. In this version of realism, the magnetic field, if its effect was real, would affect the process where interests first define, then measure, and evaluate their interests.

4.1.1 Classical Realism

Classical realism identifies the roots of international conflict in an imperfect human nature. It is the evil of men and women that allow international conflict to exist. Hobbes defines the state of nature as the nature of individuals, which generates conflict; social structures that resist such a nature can reduce or eliminate conflict (Hobbes, 1994). The magnetic field would influence the perception of individuals' threat environment. People capable of establishing social structures that can resist the state of nature are rare and often are overwhelmed in the state of nature. The outcome of international relations reflects this and leaves some room for classical realism to accept and integrate non-state actors into its theories, as happens later in neoclassical realism (Hobson, 2000). However, because classical realism rests on the assumption about the potential of the system to fall into conflict, any variable that impedes or enhances the trend towards stability or conflict will have relevance. Further, variables that influence the variance of outcomes between no-conflict and conflict would be relevant.

A pair of distinct characteristics describes the international system. Theorists following classical realism could incorporate the magnetic field when considering any of these characteristics if geomagnetics do influence stability. The first characteristic of the system is recognition that the system is a natural environment of conflict. The state, as a social construct, mitigates the state of nature through collective security, efficiencies of scale, and benefits of collective (*i.e*. the state) action. This does not translate into international cooperation of much breadth or depth. It does translate into "desire" for the conditions that allow for collective action. The second characteristic of the system is that observers can divide states into two groups based on their motivation. Status-quo powers desire or are motivated by mitigating or ending changes in the power distribution of the system. Revisionist powers desire, or are motivated by, changing the distribution of power in both real terms and perception in order to put themselves in a better position within the system. Variables that would affect the ability of the state to measure accurately the power distribution within the system would have a direct influence on the likelihood of an outbreak of conflict. Here, the magnetic field may have an effect as well.

Classical realism explains the struggle for power among nations as the outcome of the aggregate desire of people's desire to dominate others. This desire may relate to the effect of the magnetic field, if the field is relevant to human behavior and motivations. The state is the manifestation of the aggregate and is the tool used to exercise desires in the international system. In this way, the state is the actor on the international stage. Morgenthau describes the condition of anarchy provides the freedom for states to act in this manner. Without anarchy, the pursuit of power is constrained or eliminated. The presence of hierarchy allows for the assertion of a "global leviathan" as a control on other states' tendency to follow through on their desire for domination (Morganthou, 1965). Since the state is the manifestation of the will of the people, variables that affect the "will," or "thinking," of the people are relevant in classical realism.

Evidence provided throughout this work point to the earth's magnetic field influencing people's thinking processes. As a system variable, it appears correlated with systemic outcomes. The nature of anarchy seems as though the environment whose superstructure changes along with geomagnetic fields could influence it. Analysts should consider them for system-level models as possible control variables.

4.1.2 Neo-Realism

Neo-realism pinpoints the roots of international conflict in the structure of the international system. The structure is one of anarchy, with no "power" or "means" to ensure security outside one's own state. At the same time, the state is the superior level of analysis and the primary actor in neo-realism. Hence, it is the interest of the state, and not the people who aggregate to make it, that is important. Further, the state is a unitary actor; it is not possible or relevant to look at any intervening variables of "domestic" politics as they are irrelevant and do not influence the actions of a state pursuing its self-interest or reduction of its risk through dominance in the international system (Shweller). Authors have largely because of methodological development that preceded its most relevant years built up Neo-Realism using more rigorous and scientific approaches to international relations than classical realism (Sorensen & Jackson, 2003).

For Neo-realism, Waltz clearly defines power more narrowly than in previous works of classical realism; for Waltz, power is composed of the following characteristics (Waltz, Theory of International Politics, 1979):

Size of Population

Size of Territory

Resource Endowment

Economic Capability

Military Strength

Political Stability

Competence

The Neo-realist's response to why states are in conflict constitutes a challenge to classical realism. Neo-realism searches for causation beyond the state. It focuses on the system level of analysis. The system determines outcomes. More specifically, the system determines outcomes by the distribution of the specific powers defined by Waltz. The primary motivating factor, and the only one that is not transitory, is that all states desire to survive. Motivation for survival alone cannot yield power politics as it occurs in the current international system, however. The presence of anarchy is essential and the relevant characteristic to international relations theory (Waltz, 1979). That being said, it is hard to generalize about this theoretical approach, because a wide range of "Neo-realist" thought and developments appears across the literature: Robert Jervis and his arguments for "Defensive Realism" (Jervis, 1978); Stephen Walt (Walt, 1987), Charles Glaser (Glaser C. , 1994/5), and John Mearsheimer with "Offensive Realism" (Mearsheimer J. , 2003); and Robert Gilpin with his "Hegemonic Theory" (Gilpin, 1981) and (Gilpin & Gilpin, 2001).

The international system as defined by the presence of anarchy is not synonymous with a "state of war." Rather, the presence of anarchy creates a state of constant security competition (Waltz, 1989), within which states seek out opportunities to take advantage of other states (Mearsheimer J. , 1994-1995). In a system like this, each state is constantly deciding whether to use force or not in response to other's actions. This may result in war breaking out at any time and with any other state in the system (Waltz, 1979, pp. 111-112). However, Neo-realists expect that states will analyze each other's material capabilities when assessing the likelihood of mutual conflict (Mearsheimer J. , 1994-1995, p. 12). States will focus on defensive preparations to overcome the possibility of conflict and to overcome the risk of others' capabilities turned on them (Liberman, 1993).

Here lies the irony of the divide between Neo-liberals and classical realists. The Neo-realist criticizes the reliance of Morgenthau's classical realism on the psychological assumption that an unquenchable hunger for power drives actors. (Morganthau, 1946). However, neo-realists rest their theories on feelings of aversion to war: weariness, anxiety, fear of others' power. It is the psychological factors that they claim results in states planning on the possibility of conflict and worst-case scenarios. They've replaced the human nature of aggression, the heart of classical realism, with human nature of fear and generate comparable expectations (Fischer, 1992) – aside from a recognition that states may decide to pursue economic capability at the expense of short-term military capability (Waltz, 1989).

Variables that affect the ability of revisionist and status-quo states to perceive relative power, as well as variables that induce variance in decision-making outcomes, would be relevant to Neo-realist models. Likewise, variables "external" to the system, in particular those that affect fear and anxiety, could drive outcomes in Neo-realist models. In all of these cases, if the anecdotal and experimental evidence presented in the previous chapter is true, then Neo-realism could incorporate a role for magnetic fields creating measurable volatility in outcomes that adhere to the Neo-liberal theory.

Indeed, last chapter's survey of different models using the earth's magnetic field as variable of interest indicates that these fields may influence the very components of state power described by Waltz. This survey demonstrated a possible influence on national debt, gross domestic product growth, and national consensus, perceptions of risk, national education, inflation, and unemployment. It is conceivable that the earth's magnetic field may also affect how states perceive others in the system. Fields were significant in models of Supreme Court consensus. It could be that fields could also have significant coefficients of influence in models of cooperation, optimism, and pessimism among states.

4.1.3 Aggressive Versus Defensive Realism

Defensive realism sees defensive coalitions as the only thing standing in the way of an international system defined by “clashing despotisms” or a “single world empire” (Liberman, 1993). Offensive realists, meanwhile, assert that military action contributes to security. The two positions differ as to the commonality of security in the international system, with defensive realists more optimistic (Frankel, 1970).

Stephen Brooks (Brooks, 1997) argues that these competing perspectives on the chances of war outbreak underlie differences between the two orientations in how they interpret observed international systems. According to Brooks, when we assume a worst-case scenario – when states are conditioned by the assumption that a rising power inevitably will become hostile at some point in the future – then states tend to use offensive military action to remove or reduce risk (Brooks, 1997). It is only when a very high probability exists that a rising power will use military force to threaten national security interests does the threatened state resort to preemptive military force. For that reason, variables influencing the perception of the “probability of war” will be especially relevant to defensive realism (Brooks, 1997), and if previous research and the literature are correct then the earth’s magnetic field could be one such variable. It is likely that with increased volatility in outcomes, we will observe more instances of the use of offensive military action to pre-empt falsely perceived risks.

4.1.4 Neoclassical Realism

Analysis has identified critical divisions in the Neo-realist literature (Brooks, 1997). Arranged against the Neo-realism of Kenneth Waltz, as described above, is an approach termed “Neo-classical realism” (or “postclassical realism”) that despite a number of similarities is generally incompatible with his views. Three assumptions differentiate the two branches of realism. The first regards whether states make decisions based on the probability of conflict or the mere possibility of conflict (Wendt, 1992). The second is the issue of discounting the future in favor of the immediate.

The final distinction concerns state preferences. Neo-realism asserts that the *possibility* of conflict drives the actions of states and that those actions are based on worst-case scenarios, that states severely discount the future in favor of short-term military readiness, and that military preparedness always trumps economic capacity if the two come into conflict. Neo-classical realism argues that states base their decisions on their assessments of the *probabilities* related to security threats. It does not regard long-term objectives as necessarily less important than short-term military security, and recognizes that states trade off some military readiness in exchange for economic benefits – as long as the net gain in economic capability is large enough relative to the increase in risk resulting from the opportunity cost (Gilpin & Gilpin, 2001).

In Neo-classical, realism system variables and local variables are relevant if they influence the assumptions, inputs that drive assumptions, or outcomes of behavior. First, variables that influence the perception of states concerning the probabilities of conflict would be relevant. Second, variables that influence how inputs into the power mechanisms of the state translate into end-state power would be relevant. Finally, variables that affect the perception of others and their calculus of other's power would be relevant to Neo-classical models. It is possible that the earth's magnetic field offers such a variable. In particular, fields could affect the perception of states regarding their available security, influencing their perception of how flexible they can be.

4.2 Liberalism and neo-liberalism

Liberalism has its roots in John Locke's *Two Treatises on Government* (Locke, 1689). This treatise discusses two liberal ideas: intellectual liberty and economic liberty, the latter of which includes the right to have and use property. Political economist Jean-Baptiste Say and Destutt deTracy probably developed the term *laissez-faire* to reference economic liberty, which Rousseau later developed into political economy (Zamoski, 1993). Rousseau asserted the "natural freedom for mankind" and the importance of the social contract. The critical part of Rousseau's understanding of human nature is that individuals know their own interest best. Additionally, sufficient education was enough to restrain individuals in society without the need for oppressive government to enforce the social contract. He further asserted that the unity of a state arises from the combined actions coming out of the consent of the people, or the "national will," and allows states to exist without the pre-existing social and political structures required by such systems as aristocracy, feudalism, or monarchy (Durant, 1997).

Much of liberalism is rooted in the development of economic theory and this is where thinkers such as David Hume (Hume, 2009) and Adam Smith (Smith A. , 1759) made their primary contributions to liberal theory. Hume believed in fundamental rules of human behavior, and that these rules would defeat any attempt to control, regulate, or restrict human behavior. The more coercive these efforts were, Hume argued, the more individuals would resist them (Hume, 2009). Adam Smith proposed that individuals were capable of making both moral and economic decisions without intervention from the state. Further, individuals working through an aggregate called the "Market" could make quicker and better decisions than government. When citizens were free to follow their own initiative states are strongest. He asserted that individual self-interest would motivate individuals and allow them to operate in "positive" ways within an unregulated social order (Smith A., 1759).

Later, the ideas about natural rights would rest on the idea of the categorical imperative (Kant, 1993). Immanuel Kant asserted that a natural law existed that was superior to whatever received system of reason and morals people inherited or assumed. He advocated that fundamental truths were available to underpin systems of knowledge. However, in reaction to a series of economic depressions and the challenge of Communism, liberalism evolved from the Kantian view to a form of social liberalism of the sort proposed by T.H. Green. Green focused on the interdependence of human beings and the need of government to provide health care, education, and mitigate ignorance and prejudice (Dimova-Cookson & Mander, 2006).

Liberalism in international relations generally asserts that state preferences rather than their capabilities are the primary cause of state behavior. Preferences will change from state to state, and different states will have different preferences resulting from the unique characteristics that form that state. Liberalism rejects the notion of an anarchic international system. Instead, the system provides many opportunities for interaction outside the "high politics" of security and military power. The system allows cooperation, and gains via interdependence can sustain peace.

Friction in this situation would arise if an exogenous variable affected the ability of actors to perceive the value of relative gains. The situation worsens if the variable results in volatile outcomes that make the value of cooperation unpredictable. System variables that affect variance in economic outcomes thus would be relevant to liberal models. Finally, variables that affect preferences, or perception of preferences, would be relevant to liberal theory. Local magnetic field variables that affect individual decision makers and internal state dynamics could have an impact on state behavior in the international system. Incremental influences in the various sub-structures – economic, social, diplomatic, *etc*. – could influence the behavior of states, cooperation, and perception.

The term Neo-Liberalism came about in the 1930 and 1940s as the concepts of classical liberalism reemerged in the political and economic literature and thought. Neo-liberalism argues that states need only, and should only, be concerned with absolute gains made through cooperation and interdependence. It argues that relative gains are not important and uses game theory as a tool to illustrate how states in the system could choose mutually beneficial outcomes, or win-win situations. Neo-liberals portray an international system set up not to enable or facilitate win-win situations, but to provide a suitable space for the creation of institutions that do.

Neo-liberalism is a reaction to the Neo-realist's assertion that the primary concern of states is security. It is a response to how relative gains in a zero-sum anarchic international system in which no institution could realistically be expected to enforce agreements or protect sovereignty security influences state views of security. Neo-liberalism accepts an anarchic system as well as the fact that state interest drives interaction in the international system. However, it rejects that these concepts are as important as realists assert, or that they inevitably result in conflict. Robert Keohane's *After Hegemony* (Keohane, 2005) is a classic presentation of Neo-liberalism and, with Stephen Krasner and Charles Kindleberger, represents the Neo-liberal school of thought.

One of the concrete responses to Neo-realism is Robert Keohane's and Joseph S. Nye's theory of "Complex Interdependence" (Keohane & Nye, 1977). They explain this concept in terms of Neo-realist assumptions: States are coherent and the dominant actors;

force is an effective tool of policy; a hierarchy exists in the international system (Keohane & Nye, 1977). Their arguments countering the claim of coherency are that different and numerous channels of interaction exist outside the state system, that trans-governmental relations result from states not being coherent units, and that transnational relations result from states not acting coherently. This results in a blurring of the line between foreign and domestic political agendas, which prevents emergence of a clearly delineated hierarchy in international relations.

Magnetic fields potentially contribute to the international system described by Neo-liberalism as well. Military capability and the ability, or willingness, to use force exists within political and military interaction and alliances, all of which would be susceptible to the exogenous influence of a variable that generates volatility in these outcomes. Indirectly, they could mold a Neo-liberal international system by influencing sources of both soft and hard power, which in turn would shape relations within and among groups of countries. If magnetic fields affect cooperation, or consensus building, then they also would have an effect on the working of the institutions that mitigate or prevent war, just as they would affect decisions to use the military as an instrument of foreign policy.

The current economic and political system rewards domestic and economic processes identified with democracy and free-markets. This correlation, in conjunction with the effects of complex interdependence, results in the idea of a "democratic peace" – the idea that democracies should not go to war with each other (Doyle M. W., 1997). Therefore, system variables that influence the variance in outcomes of economic cooperation would be relevant to Neo-liberal models. Variables that influence states' ability to conduct the cost-benefit calculus of conflict also would be relevant to Neo-liberal theory. Finally, variables that influence the amount of signal noise that exists in the system should be of great importance to Neo-liberals, since the whole purpose of institutions is to reduce this noise. In all these ways, magnetic fields would be relevant for constructing models.

4.3 Militarized Disputes

Military threats, both direct and indirect, are inherent in the nature of international systems. Systemic or potential threats manifest by the fact that a polity has a military capability. How much and in what way military capability informs conflicts among states differs depending on the view of the nature of the international system. When the threat of military force is indirect, the conflict has not yet risen to one of violence and the use of force is not yet overtly the method of choice to bring about a decision. Indirect threats are always present, although not always of equal importance in resolving conflict among states (Karsten, Howell, & Allen, 1984).

Direct threats exist during moments in time when stable relations among or between members of the international system become unstable. This can be because of the introduction of some new variable, the re-interpretation, or new perception of an existing variable, or some other change in either party's views of the cost and benefits of the use of force.

In between the indirect and direct threats of the use of force exists a series of steps that "show force capability" but may not explicitly threaten. Actors use "showing of force capability" to communicate a capability in stark terms in order to influence the perception or calculus of the other parties in a conflict or dispute.

The waging of war and the playing out of disputes depend on the identity of the actor, the rules of the system, and the level of analysis: system, state, individual, or group. In this section, I review several theories that distinguish conflict along these lines. Again, the purpose is to set up how geomagnetic fields could integrate into predictive models within international relations, this time focusing specifically on modelling conflict.

4.3.1 System Theories

System Theories of war generally focus on transitions. System Theories argue that states are the primary international actors, but they operate within constraints and limitations set upon them by the broader world system. The key characteristic of these theories, therefore, is that the system drives state actions. The system allows, or does not allow, certain decisions, actions, or relationships (Waltz, 1979; Gilpin, 1981). In these theories, the system acts as an "invisible hand" shaping behavior. For instance, different systems gave rise to Tribalism, Empires, Feudalism, Nation-States, and perhaps in the future could promote the rise of non-state international actors (Porter, 1994). Multiple systems might exist simultaneously around the world, such as those found based around specific continents (e.g., South America) or around identifiable regions (e.g., Sub-Saharan Africa, East Asia). Measures of magnetic field activity can operate at the system level, are exogenous to the system, and offer clear prior temporal relationships.

4.3.2 State Theories

State theories recognize that an international system exists, but it is more anarchical; states may do whatever their capabilities allow them to do. The limits on state action are defined by their, and others, capability either to deter or to compel (Evera, 1999; Morganthou, 1965; Waltz, 1959; Brown, Lynn-Jones, & Miller, 1995). States in anarchy will leverage differences in technological capabilities to gain position in the international system. If the capabilities are viewed as transitory or short-lived, states may be more inclined to leverage the technology in a manner that damages stability and leads to war.

States go to war when the costs and risks of doing so are low and the benefits higher (Mearsheimer J. , 1990). This calculus generally rests on two factors: the distribution of power among states and the destructiveness of available weapons (which depends on whether they favor the defense or offense). These states may be susceptible to ideologies that are more inclined to engage in armed conflict. Ideologies of “otherness” or parallels of “manifest destiny” or “cultural supremacy”, *etc*., tend to drive states in anarchy to seek decision on the battlefield. This could happen in one of two ways. The first are actions on the part of the state to “actualize” or “operationalize” its ideology, leading it to attempt “domination” of other states or peoples. The second are actions on the part of the state to “actualize” or “operationalize” its ideology in a fashion that creates insecurity in others. In the second situation, other states seek to reduce insecurity through force of arms against the threat state. Geomagnetic fields can distort these processes of value formation and these perceptions of threat.

4.3.3 Actor Theories

Actor theories rest upon the assumption that states and systems do not make decisions, that they are not distinct actors. Ultimately, individual people exercise choice. Actor theories implicitly argue that no international system or state capability structure *results* in actions or conflict. Instead, they form incentives and disincentives within which individuals or groups of people make choices. In these theories it is generally argued that, regardless of relative power or capabilities or how well or poorly allied states are doing in a conflict, only the leaders or the people of a state can decide to wage war or produce a threat or escalate a dispute or make peace, *etc*. (Brodie, 1973), and (Jervis, Stern, & Tilly, 1989).

States possess institutions, laws, rules, and norms that limit citizen actions. Within a system of anarchy, these institutions must be powerful enough to mobilize or control the population sufficiently to maintain security. These states generally find that their systems and institutions allow for small groups of leaders to dominate decision-making, which allows leaders to pull, push, or lead their states to seek decision through battle.

States in systems of anarchy permit special interests to rise and gain influence and power through their contributions to security. In such a situation, the actor pursues its interests and may succeed backed by the power of the state. At the same time, other states in the anarchic system view the activities and goals of these special interests as indistinguishable from those of their parent state. In the historical literature, these special interests constitute powerful intra-state political alliances that can lead their state to war at the expense of the public. Some examples include England’s “stock” companies in the 1600 and 1700s, the Southern U.S. cotton industry in the 1850s, the American Sugar industry in the 1880s, the United States fruit industry in the 1920s, the German steel and ship building industry in the 1920s, the oil industry in the 1950-2010, *etc*.

In all of these theories, common themes are found. Decisions and outcomes are highly dependent on how those making the decisions see the world. Risk acceptance, decision calculus, and perception and interpretation all influence how polities or actors (regardless of the level of analysis) act in a situation. This then directly influences initiations, escalations, and outcomes within the international system.

An “international system” has been defined by Holsti as

> …any collection of independent political entities - tribes, city-states, nations, or empires - that interacts with considerable frequency and according to regularized processes. The analyst is concerned with describing the typical characteristic behavior of these political units toward one another and explaining major changes in these patterns of interaction. (Holsti K. , 1995, p. 23)

Whichever variety of “international system” one might have in mind, it operates within a space whose features will shape the system itself. These characteristics of the system’s superstructure, usually absent from International Relations research, are depicted in the outer circle that encompasses the international system portrayed in Figure 4. These characteristics have been viewed as either so random as to defy systematic study or fixed and therefore largely irrelevant as a variable of study. Yet these fixed characteristics often feature prominently in the study of international relations. Many form the foundations of state power. Terrain, resources, access to threats, economic power, and culture are all tied to the characteristics of the space in which international systems operate.

The last three chapters have laid the foundation for the theory that earth’s magnetic fields constitute an important influence on many of the activities of humans. The fields, exogenous to the international system, have been in existence as long as the space in which international systems operate. Science has reached a point where these fields are easily measured, and to some extent predictable. This has allowed for system-wide measurements as well as local measurements made and recorded. These field influences pierce through all the levels of analysis of international relations. They exist outside of the international system, penetrate through all the dynamics of the system, impact all institutions, affect the actions and perceptions of actors, and permeate the daily lives of each individual.

The question of the importance and relevance of these influences remains unanswered. Chapter Three’s litany of possible relationships only lays the foundation for addressing this question. In the current chapter, events and conditions of the international system and international relations are evaluated using the magnetic field as the primary variable of interest.

Figure 4 Superstructures in which actors behave

4.4 War and the Magnetic Field

The literature on interstate war generally suffers from an inability to conduct a day-by-day analysis as well as to include characteristics of the space within which the international system operates. Much of the available analysis uses variables measured annually or only available daily at an extreme cost that has been prohibitive and seen to be largely irrelevant and unnecessary. However, the use of daily measures of the magnetic field provides an opportunity to analyze any possible relationships between the field and ongoing conflicts. After all, parties decide every day whether to continue or end a conflict.

The model beginning this analysis looks at each day of the international system over a period of 80 years. Each day is coded for the presence of a war, and modeled using Probit. To predict the existence of conflict, I use the average Ap Index value for the 30 days prior to the day captured by the dependent variable. This model shows that Ap is significant. We can only claim the effect of Ap on the probability of war is not zero. However, using modeling software a graphical depiction of the 95% confidence interval of expected values of probability of war given specified values for the Ap index. The graphical depiction is a continuous evaluation of the covariance between the independent and dependent variable.

Accepting that magnetic fields may have an impact on outcomes allows for a deeper look at how the space within which international systems operate influences those systems (King, Tomz, & Wittenberg, Making the Most of Statistical Analysis: Improving Interpretation and Presentation, 2000). Figure 5 shows the predicted probabilities of war on a given day. At a zero value of Ap, it would be expected that there would be less than a 10% chance of war ongoing on the day. At an Ap value of 24, the probability of a war ongoing somewhere on earth is around 15%. At an Ap value of 60 the model estimates that there is between a 35% and 60% (95% confidence interval) chance that an ongoing war would be present on that day.

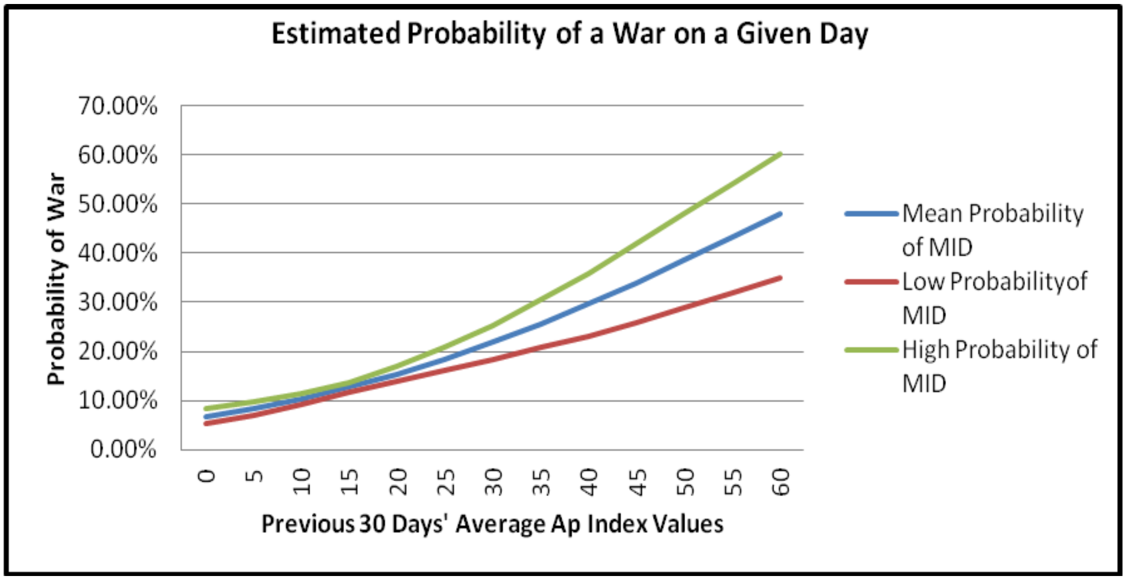
The implication of these findings, if true, could have significant repercussions in the validity of various views of the international system and relations. Both realism and liberalism view relations among actors in terms of the level of cooperation and conflict among them. In fact, at their roots, the fundamental principle that separates them is ability of actors to mitigate the characteristic of anarchy. Realism argues that there is little an actor can do and liberalism argues there is much that can be done. The analysis of the potential relationship between the earth's magnetic fields and conflict suggests, rather, that the amount of anarchy in a system is not fixed or static. It instead could depend on the magnetic influence of a period. A modeling of the sample and statistical findings shows a possible world where a war is six times more likely to be underway at high magnetic values than at low magnetic values. In periods of low magnetic field values, on the other hand, many interstate disputes do not escalate to war. This analysis can make no definitive claims on the size of the influence. It is relatively confident the influence is not zero. One can infer that it is likely a positive influence.

Table 11 Probit model of state of war for over 80 years.

	Observations 30,592			Prob Chi2 0	
Variables	Coefficient and Standard Error	Significance Level		Lower 95% Confidence	Upper 95% Confidence
Previous 30 Day Ap Index Average	**0.0243** *(0.0038)*	0.0000	***	0.0167	0.0318
Constant	**-1.5072** *(0.0643)*	0.0000	***	-1.6333	-1.3811

* 0.1 ** 0.05 *** 0.01

Figure 5 Simulated probability of war in a day and previous 30 days' average Ap index



One of the characteristics of the international system to which theorists look in order to determine the international system is whether war or disputes are ongoing. The previous models looked at the presence of war, rather than war initiative, which might cause concern with readers that the probabilities are overly sensitive to long-running wars. That is, they may reject the idea that each day represents an independent decision whether to continue a war, and instead wish to focus on war initiative because it is more likely to be independent of other observations with similar magnetic levels.

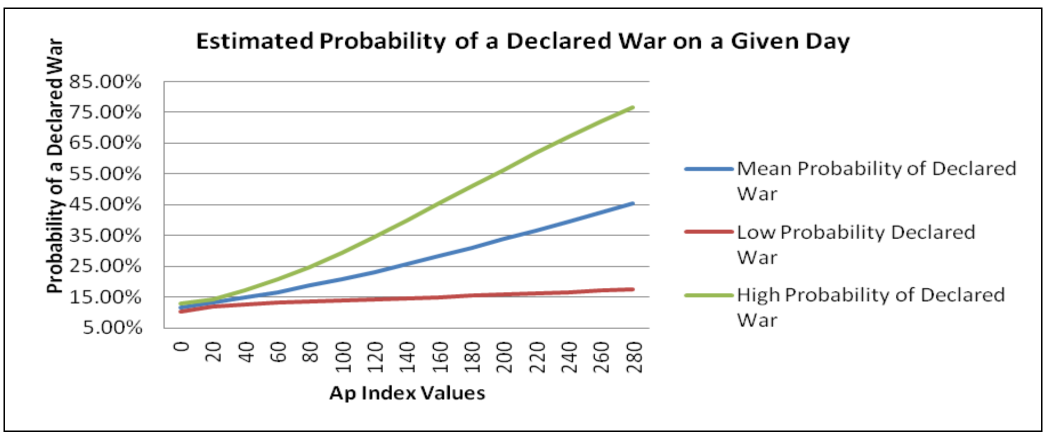
The analysis moves from looking at ongoing wars to focus instead on the start of conflict. The estimated and simulated probability for there to be an initiated dispute on any given day begins at low levels when the Ap index is low, but extrapolates out to an extreme of approximately 50% at severely high levels. Using the previous 30 days' average of Ap values instead of the Ap Index value on the day analyzed provided a significantly "tighter" range of estimates.

Table 12 Probit model the likelihood of war starting in a given day

PROBIT Model for War Starting in a day given its Ap Index Value

	Observations	3592	Prob Chi2		0.0178
Variables	Coefficient and Standard Error	Significance Level		Lower 95% Confidence	Upper 95% Confidence
Ap Index on Day War Starts	**0.0039**	0.0150	**	0.0008	0.0070
	(0.0016)				
Constant	**-1.2013**	0.0000	***	-1.2713	-1.1313
	(0.0357)				
*0.1	** 0.05	***0.01			

Figure 6 Simulated estimated probability of a declared war on a day given day



4.4.1 Number of States Involved in Militarized Interstate Disputes

We move now to an analysis of the number of states involved in a militarized dispute on any given day, controlling for if the system is embroiled in a state of war. High values on the magnetic field variable, as a potential barrier to cooperation, presumably would cut in two different directions for this model. On the one hand, the ability to negotiate cooperative militarized behavior – to create a bandwagon effect, to entice cooperation in balancing activities against an enemy power – should decline under those conditions. The magnetic field measure, hypothesized to affect cooperation among individuals, should exhibit a negative relationship with the number of states involved in a militarized dispute on a given day. Those same high values would tend to increase the risk of war, pulling more countries into a militarized dispute, but of -course, we can control for that contradictory influence by distinguishing periods with an ongoing war. Table 13 presents an analysis covering more than 3,500 days of possible conflict, during which time the Ap Index ranged from 0 to 279 points.

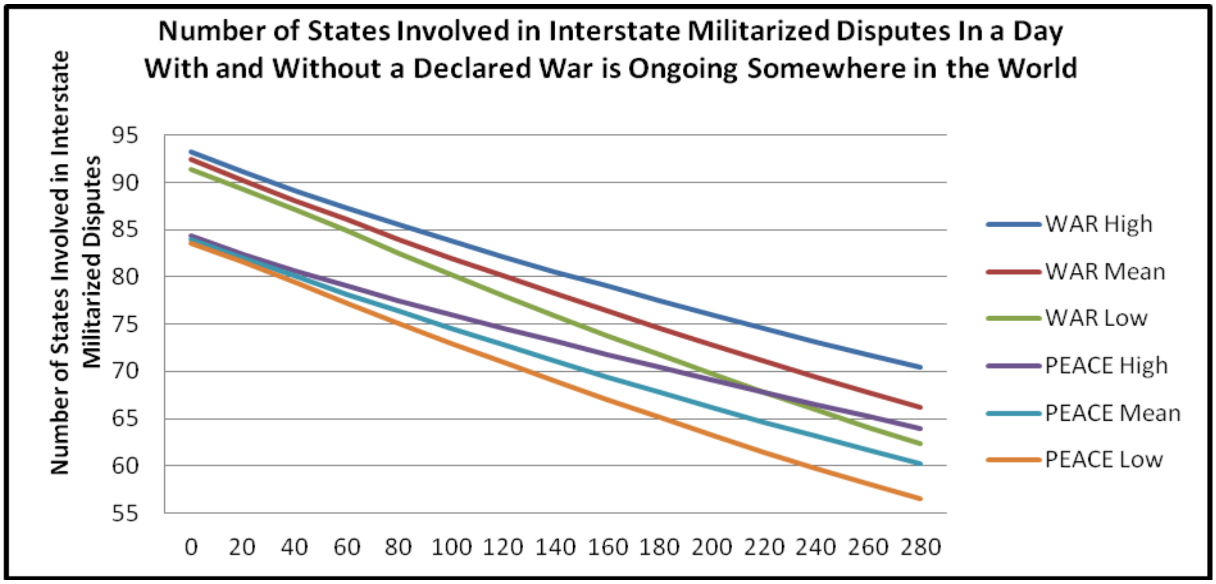
Table 13 Poisson model number of states in a dispute

	Observations	3592	Prob Chi2		401.51
Variables	Coefficient and Standard Error	Significance Level		Lower 95% Confidence	Upper 95% Confidence
Day's Ap Index	**-0.0012** *(0.0001)*	0.0000	***	-0.0014	-0.0009
War In Effect	**0.0959** *(0.0053)*	0.0000	***	0.0855	0.1064
Constant	**4.4304** *(0.0026)*	0.0000	***	4.4254	4.4354

*** P<.01

In this model, the War variable is significant as a control variable. More states find themselves in MID's during wartime. The Ap Index is still a significant variable even after allowing the multicollinearity with War. The accompaning graph, Figure 7, shows how the simulated expected number of state participants changes with the Ap value when war is ongoing in the international system and when war is not ongoing in the international system. The graphic depicts one possible world based on the sample used and repeated modeling of expected values.

Figure 7 Simulated number of states involved in a dispute



In this sample, the international system is filled with disputes short of war at the lower magnetic values. That result merely describes the state of the sample world, however. It was not a fully specified model and therefore not intended to explain why geomagnetic waves would correlate with dispute involvement. The next set of models takes the next step and attempts to model action using the system variable of earth magnetic field as the primary explanatory variable.

4.4.2 States Initiating or Joining Militarized Interstate Disputes

The next model, predicting when states initiate a new dispute, does not assume that the effect of magnetic fields will be monotonic. The theoretical work on magnetic fields suggests that extreme values, whether high or low, could interfere with standard decision-making. Thus, it uses the earth's magnetic field in two variables, a base term and a squared term. It also contains a control variable for the number of states already involved in disputes, due to likely contagion effects. This variable will help us infer whether states seek to engage in disputes under "cover" of conflict within the system.

As seen in Table 14, the previous 30 days' Ap average is significant in the model, in a negative direction, as is the quadratic term, but in a positive direction. Thus, the relationship between geomagnetics and dispute initiative has a clear bend. Also, as the number of states involved in disputes increase, states are more willing to initiate additional disputes within the system.

Table 14 Probability of a new dispute being initiated on any given day.

	Model Type: Probit	
	Observations = 30,595	Pseudo R2 = .0330
	Coefficient and Standard Deviation	Significance
Average of the Previous 30 Days' Ap Values	**-0.0102** *(0.0052)*	0.048 **
Average of the Previous 30 Days' Ap Values Squared	**0.0002** *(0.0001)*	0.052 *
Number of States involved in Conflict in the International System	**0.0059** *(0.0002)*	0.000 ***
Constant	**-1.530** *(0.049)*	0.000 ***

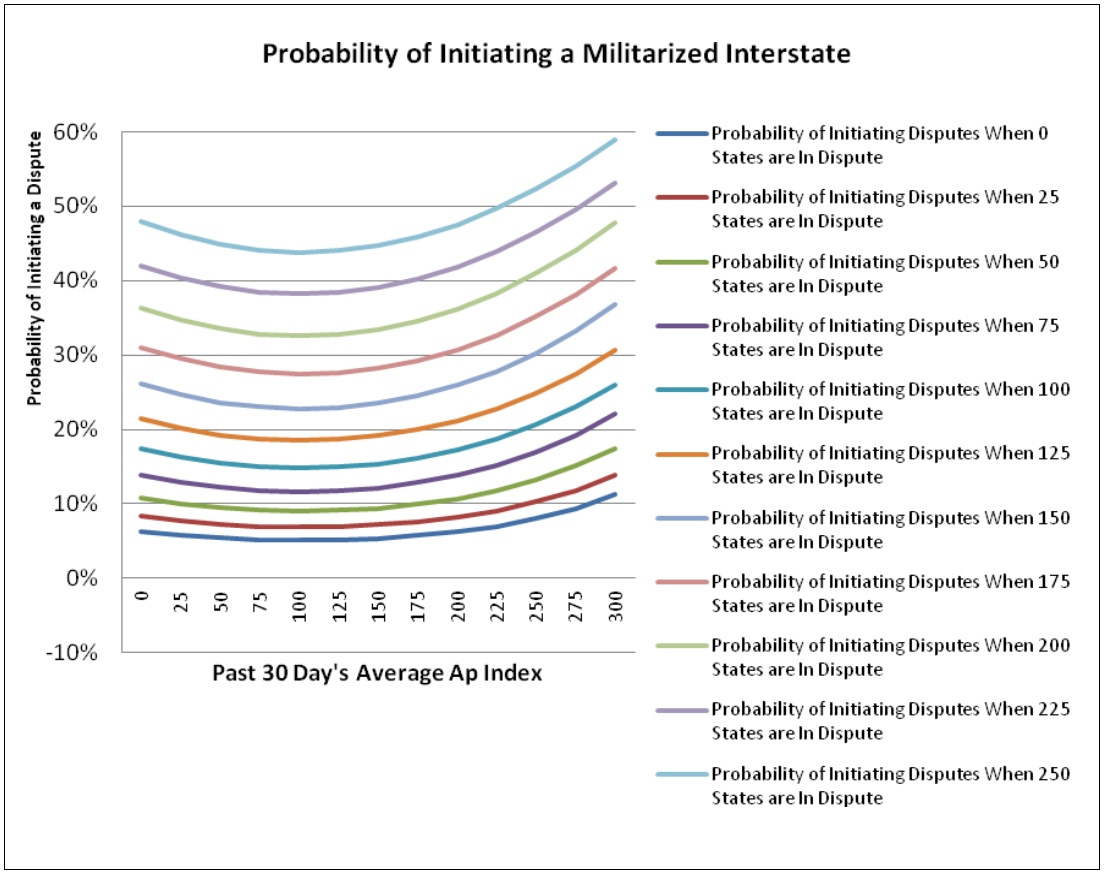
* P<.1 ** P<.05 *** P<.01

As the measure of the magnetic field changes from low- to mid-range values, the general trend is toward lower probabilities of war initiation. As the values increase from mid-range to higher, the probability increases. In this sample, disputes become significantly more likely when geomagnetic fields approach extreme values, whether especially low or especially high. The graph also shows that when fewer states are involved in disputes, the effect of the earth's magnetic field moving from lower to mid-level values is estimated to be much shallower than the condition of higher numbers of states involved in disputes. At the lower number of states the reduction in probability looks to be around 3%. At the higher number of states involved in disputes the reduction in probability looks to be around 7%, or more than twice conditions of few states involved in disputes. Progressing from the mid-level values to the upper values, the outcome resulting from the number of states involved in conflict and the earth magnetic field value demonstrates a greater probability of a state initiating a new dispute. This change is a rapid transition and rises well beyond the decline from the lower value to the mid-values. However, the chart lacks references for the 95% confidence intervals for each estimate. Therefore possible outcomes and estimates may make the clear distinction among the graphed estimates much murkier. However, in this sample, expected estimates show distinct separation.

Another relationship in this sample for analysts to note is when lower numbers of states are involved in disputes, the effect of higher values of the earth's magnetic field is much less than the effect when more states are involved in disputes. If, in fact, the earth's magnetic field is working as the model suggests, then it uncovers that states pursue militarized solutions to disputes under conditions of high conflict in the international system. Under conditions of low conflict in the international system, as defined by the number of states involved in disputes, states shy away from using military force to resolve disputes. However, as the magnetic field value increases it can overcome the general trend and increase the probability of initiating a new dispute. For instance, when there are no states involved in a dispute the magnetic field can double the probability that a state will initiate a dispute. The effect of the magnetic field at its highest sample value is the same as if 75 states are involved in militarized disputes but the magnetic field is at its lowest. Essentially, the effect of transitioning the international system from no militarized disputes to seventy-five disputes on the likelihood of an additional militarized dispute being initiated on any given day is the same as moving the magnetic activity of the earth from its lowest to highest values of the sample. This description of the graphic estimates of the relationship between magnetic field, the number of states participating in militarized disputes, and the likelihood that a new dispute is initiated is not generalizable. It reflects the covariance discovered in the sample, the temporal relationship among the variables, and the application of the theory of magnetic field influence on behavior. It is very likely that the a priori theoretical model influenced the post-simulation analysis.

As the system becomes less stable, as defined by the number of states involved in disputes, the probability of an actor starting a *new* dispute increases. Magnetic fields seem to magnify this trend. Theories of international relations that are based on measures of system stability, amount of conflict, or amount of conflict resolution should take into consideration the influence of magnetic fields. The findings of this model demonstrate that fields influence the chance of system instability as reflected in the probability of new disputes within the sample.

Figure 8 Simulated probability of Initiating a Militarized Interstate Dispute



A similar analysis, not shown, broke apart the probability that states would join a MID on behalf of the initiator versus the probability they would join on behalf of the target. In both cases, the raw variable for magnetic field had a positive coefficient, whereas the quadratic term had a negative coefficient – so, more or less, the probability of jumping into a militarized dispute climbed as magnetic fields approached high or low extremes. As before, the effect of very high geomagnetic levels overpowered the effect of very low levels within the sample. About the only remarkable distinction between the initiator coding and the target coding is that the U-shaped relationship was much more pronounced with regard to the decision whether to join a dispute on behalf of a targeted state. Low magnetic levels did not correspond to particularly high probabilities that states would unite with an initiator.

These findings highlight a problem with International Relations theory's view on the processes of band-wagoning and balancing. When these findings are applied to what we would expect to see under different views of the international system, it is apparent within this sample that magnetic field effects result in confusing the relationship between actor decisions related to joining attacker or targets and whether the international system facilitates cooperation or conflict.

A new model, therefore, looks at the 684 (target side)/984 (initiator side) cases in which a state joined a dispute on either the target or initiator's side. A new dependent variable codes actors that join initiators as 1 and actors that join targets as 0, thus predicting when a new belligerent will join up with the attacked rather than the defender. The model includes the presence or absence of declared war, the maximum level of Hostility reached by the dispute, and a new variable: the cumulative duration of the dispute, in days, at the point when the state joined the conflict. Finally, the model contains the Ap Index value (and its square) on the day the join occurred. The modeled and simulated sample indicates that when states join disputes, the chance they will join the attacker climbs to the highest levels when Ap values approach their peak. As the disputes go on in time, states are less likely to join initiators and more likely to join targets. States are also more likely to come to the aid of targets when the dispute slips into war. Finally, at higher hostility levels, the chances of joining the initiator increases. In fact, a one-unit increase in hostility can offset war's effect on which side states will join in disputes.

Again, in the sample analyzed and using simulation software to estimate dependent variable values, the magnetic field seems to be influencing the trend toward band-wagoning and balancing in both conditions of war and peace. It also seems to be affecting the probability of cooperation, conflict, and how cooperation plays out. For instance, it seems that balancing when war is ongoing seems to be the more-likely decision of joiners. When war is ongoing, actors are two to three times as likely to balance versus bandwagon when the magnetic field is a low value. As the magnetic field increases in value, the chance that an actor will band wagon increases in relation to balancing up to a probability that actors will band wagon of nearly 100% within the sample.

Table 15 Probability of joining the initiator rather than target when joining a dispute

	Model Type: Probit	
	Observations = 984	Pseudo R2 = .0598
Variables	Coefficient and Standard Deviation	Significance
War	**-0.3190**	0.051 *
	(0.1637)	
High Hostility Level By Initiator	**0.3727**	0.000 ***
	(0.0733)	
Ap Index at start of the dispute	**-0.0434**	0.000 ***
	(0.0107)	
Ap Index Squared at the start of a dispute	**0.0006**	0.000 ***
	(0.0001)	
Cumulative Duration	**-0.0002**	0.010 **
	(0.0001)	
Constant	**-1.045**	0.000 ***
	(0.256)	

* P<.1 ** P<.05 *** P<.01

4.4.3 Concluding a dispute through initiator victory

Geomagnetic levels may influence behavior in the international system by destabilizing decision-making and producing what appears to be irrational outcomes. Perhaps the best example of a mistake, in conflict studies, would be when a state initiates war in error and ultimately cannot achieve victory. The next model shows the sample probability that initiators win a dispute.

Differences in available power and alliance structures are two obvious influences on whether initiators prove victorious in a conflict. Other possible explanations of dispute outcome could be the observed fatality level (because it signals commitment on both sides), whether a dispute is reciprocal (because lack of reciprocity means one state may not consider the dispute as a national interest), or difference in escalation among initiator or target (because faster escalation may indicate greater concern on one participant's part). The results of such a model, including Ap and its quadratic term as measures of the earth's magnetic field, confirm previous findings on interstate disputes, and aligns with hypotheses from both realist and liberal literatures.

As shown, reciprocal disputes are significantly more likely to result in the target winning a dispute within the sample. It seems that for most of the dataset, the power of the defense over the offense was generally accepted. The fatality level of the conflict also influences the probability that the initiator will win the dispute. As the fatality level increases in the sample, so do does the probability that the initiator wins. However, if initiators escalate disputes disproportionately compared to their target(s), the probability of initiators winning falls in the sample. Initiators who race escalation higher covary with other states to seek balance by joining disputes on the side of targets, increasing the likelihood that the target wins.

The point of the model is to see how geomagnetic fields perform when included in a multiple regression modeling conflict and what we see here is consistent with just about every model introduced in this chapter: The probabilities associated with this dependent variable do indeed vary with the magnetic field measurements within the sample. Specifically, initiators are more likely to prove victorious at extreme geomagnetic levels, the conditions under which cooperation is least likely and outside parties least likely to enter a conflict on behalf of the targeted state within the sample. At middling geomagnetic levels, on the other hand, the initiator is much less likely to win after attacking.

Those targets win when the magnetic field is in middling values, and especially on the lower end in the sample, should not be a surprise. It is at these levels that balancing tends to occur and actors join disputes on the side of the target in the sample. The dynamic nature of the magnetic fields provides evidence for each of the many evolutions of both realism and liberalism.

Table 16 Probability that initiators win disputes

Model Type: Probit

Observations = 3,300   Pseudo R2 = .1091

Variables	Coefficient and Standard Deviation	Significance
Previous 30 Days' Average Ap	**-0.0430** *(0.0011)*	0.042 **
Previous 30 Days' Average Ap Squared	**0.0011** *(0.0005)*	0.028 **
Dispute is Reciprocal	**-0.8730** *(0.1114)*	0.000 ***
Fatality Level of Dispute	**0.1950** *(0.0220)*	0.000 ***
Difference in Escalation in a Dispute Attacker-Target	**-0.0436** *(0.0065)*	0.000 ***
Constant	**-0.859** *(0.205)*	0.000 ***

* P<.1 ** P<.05 *** P<.01

Running several different simulations through the model in yields several interesting graph-plots of the relationship between the magnetic field variable and the probability of the initiator winning a dispute. The simulations show the probability of the initiator winning when the dispute is reciprocal and when it's not. Initiators generally are less likely to win in a reciprocal conflict (except when extrapolated out to very high geomagnetic levels), even if the target escalates significantly more than the initiator in the sample.

Using the same model and re-running the simulations with differing levels of fatalities results in Figure 12. This chart demonstrates that when simulating based on the sample that increasing levels of fatalities increase the probability that the initiator wins a dispute within the sample. The effect of increased fatalities and increased Ap values results in greater-than-additive increases in the chance that the initiator wins the dispute when not taking escalation into account in the sample analyzed.

Figure 9 Simulated probability of initiator winning

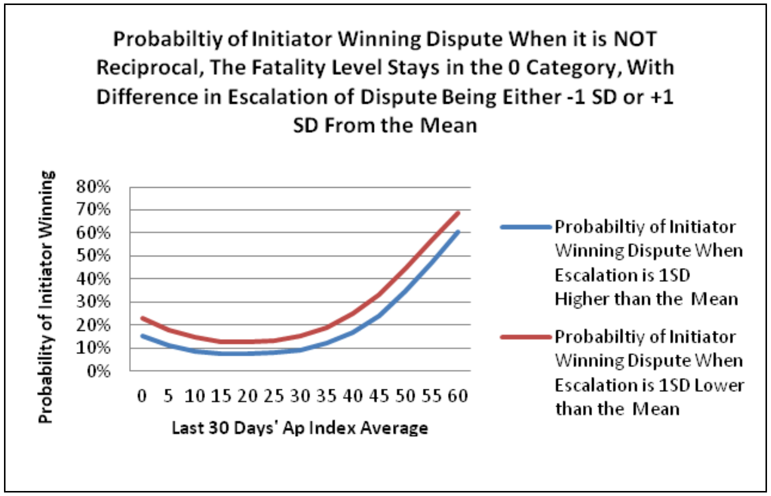


Figure 10 Simulated probability of initiator winning

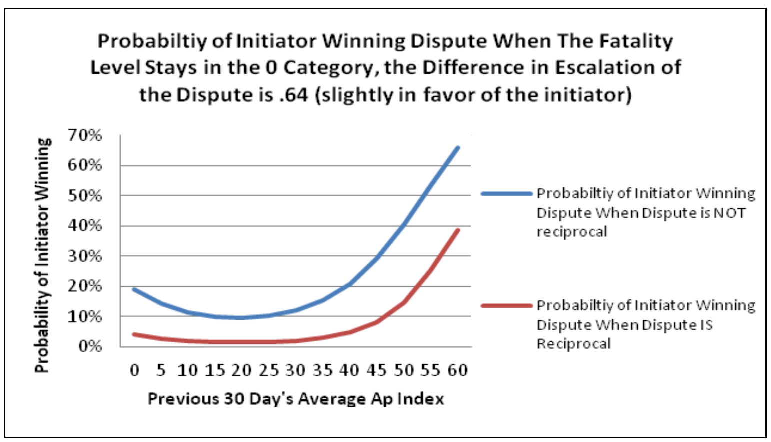


Figure 11 Simulated probability of initiator winning

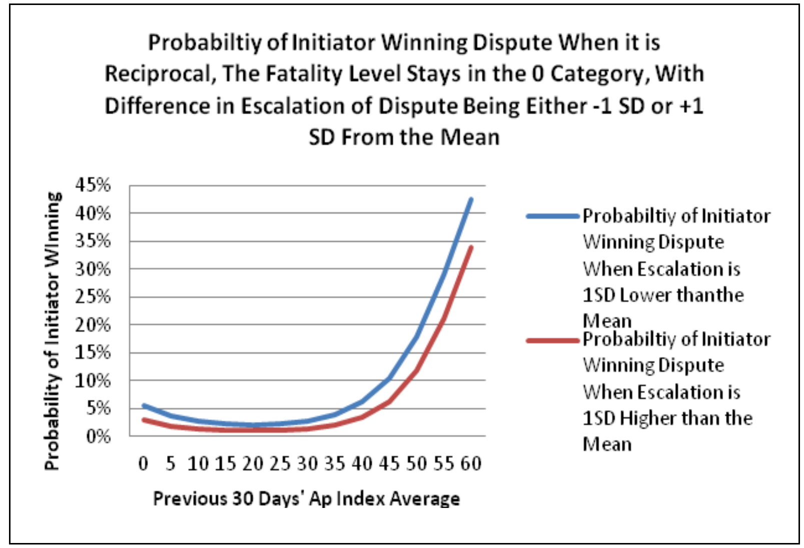
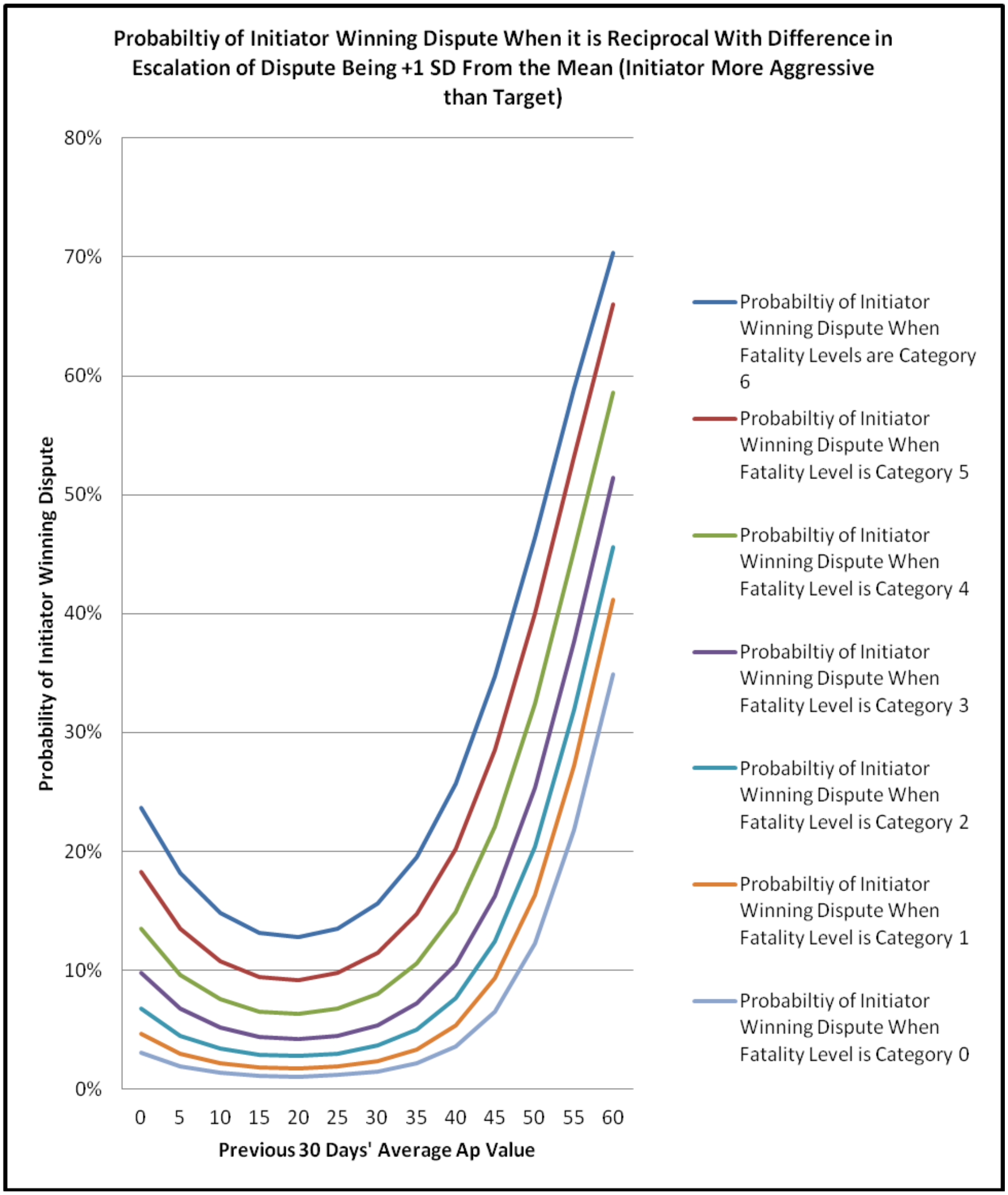


Figure 12 Simulated probability that initiator wins



The dynamics illustrated by the above model and simulations encourage several conclusions about the international system and the relations among nations. Absent any other information, and taking the patterns in these models at face value, the behavior of the international system seems to accord with a complex tangle of competing world views in International Relations Theory. If the sample reflects the population of militarized interstate disputes and their covariation with the Earth's magnetic field several observations are possible. First, it seems that at lower levels of Ap, the international system reacts to disputes by siding with targets more than initiators, and creating conditions by which targets can repel invaders. However, at higher levels of Ap, stitching together these defensive coalitions appears to be less likely; if anything, members of the international system pile on with the initiators of disputes, all the more so when targets show disproportionate aggressiveness.

In reference to the international system theories discussed earlier, this evidence supports arguments of both realism and liberalism. The analysis indicates that targets are better off counterstrikeing after attacked, meeting escalation with proportional self-defense. Not responding sufficiently to militarized threats results in targets having increased chances of their losing the dispute. Realists argue this is because targets have demonstrated a definitive lack of power, and in a self-help system this results in bandwagon on behalf of the attacker. Liberalism would not be able to explain these outcomes. International institutions, alliance frameworks, and international norms should have brought other actors into the dispute on the side of the target in order to deny hostile states rewards for violating international norms. Liberalism would argue that the actors in the system would view initiators with hostility and create structures to punish them and deny them victory.

However, once targets escalate beyond that of initiators, they risk a backlash on the part of the international system. This takes the form of states joining initiators and attempting to end the dispute on terms unfavorable to the target. This outcome makes little sense from a realist perspective. Realists would argue that the best thing for a target to do would be to escalate disputes, demonstrate power, and resolve to defeat an initiator. Other actors in the system would recognize the strength of the target and work with the target to defeat initiators and return the international system to the status quo. Realists would also be surprised that balancing did not occur when initiators initiated disputes and escalated threats well beyond what targets reciprocate. The system reacts more as liberal theories would anticipate.

When targets respond to initiators with overwhelming escalation, liberalism would argue that the international system would work to de-escalate and manage the "crisis." Institutions and norms would kick-in; actors would begin to seek leverage against both initiator and targets to maintain control of an escalating situation, and impose peace even if it means attackers will get away with the provocation and/or keep some of their gains. That being said, this outcome cuts against some of the values-based perspective seen in liberalism, which would be unable to explain why hostile initiators would be allowed to win militarized disputes they started. It is possible that liberals could argue that institutions punish targets because their escalations violate some set of norms associated with proportional response.

Incongruities among outcomes in the sample and international relations theory are accounted for by the inclusion of magnetic variables. The inclusion of the magnetic variable when analyzing the sample provided information to understand deviations among established theories and sample outcomes.

4.5 The United States at War

The next step in the analysis is to determine if the model provide information on an individual state's behavior. For this analysis, the United States is the focus of determining if the earth's magnetic field may affect individual state behavior. Looking at a specific country allows the movement away from the system variables used up to this point and permits the use of local geomagnetic fields. The first model looks at the United States' overseas troop deployments. The dependent variable is troops deployed, less those aboard ship and stationed in Europe, and it is measured annually.

The model includes one important control variable: annual defense spending. Not surprisingly, this spending is significant and goes up with the greater deployment of troops. Beyond this basic relationship, though, the magnetic fields measurements correlate significantly with observed troop deployments. The field measurements are significant, demonstrating that the influence is not zero. As the system measure of the magnetic field increases, the number of U.S. troops deployed overseas increases. Within the sample, higher values correlate with higher probability of war. This inexplicable pattern of military action correlating with the system-level geomagnetic predictors, as well as with individual field components is compelling. The magnetic field coefficients of influences are significant, so unlikely to be zero.

Much has been made of the influence of the military-industrial complex (Pursell, 1972) (Eisenhower, 1960) and defense spending related to threat perceptions (Page & Shapiro, 1992) (Mogg, Matthews, Bird, & Macgregor-Morris, 1990) (Gordon & Arian, 2001) and even defense spending as driven by psychological and institutional variables (Brader, 2002) (Beer, Healy, Sinclair, & Bourne, 1987). Thus, it is not surprising that a similar model predicting defense spending produced comparable results: On balance, spending was higher with high geomagnetic levels than at lower levels. However, the small number of cases, which results in a deceptively high R^2, and a confusing pattern of coefficients similar to that seen in the last table, makes the table less interesting than most.

Table 17 Number of U.S. Soldiers deployed less Europe and aboard ship

Model Type: Regression

Observations = 31   Pseudo R2 = .5

Variables	Coefficient and Standard Deviation	Significance	
Annual Average Ap	**.1763**	0.000	***
	(0.0032)		
V Component	**-.0138**	0.000	***
	(0.0003)		
N Component	**.0116**	0.000	***
	(0.0005)		
I Component	**.0503**	0.000	***
	(0.0009)		
D Component	**.0721**	0.000	***
	(0.0008)		
E Component	**-.1167**	0.000	***
	(0.0013)		
Annual Defense Spending (Billions of $)	**.0033**	0.000	***
	(0.0001)		
Constant	**.130**	0.000	***
	(0.013)		

* P<.1 ** P<.05 *** P<.01

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Chapter 5 Intra-State Conflict

Realism lacks a well-developed framework for discussing intra-state conflict. Liberalism does provide some space to think about internal dynamics. Most of the discussions in liberalism deal with how internal dynamics generate economic systems. However, the internal stability within a country will influence how the state generates power and how that power is exercised in the international system. The magnetic influence on internal dynamics therefore could affect how states interact in the international system.

The study of intra-state conflict covers a lot of ground. It includes domestic political instability all the way to a general break-down of civil society resulting in civil war. The following analysis will evaluate how using the earth's magnetic field could be beneficial in models of intra-state conflict. Specifically, outbreak of civil war, severity of civil war, and coup occurrence is reviewed. Some will build upon existing models to determine how the inclusion of a system variable representing the earth's magnetic field affects the explanatory power of the model and the significance of other variables of interest. Other models will attempt to motivate a new approach to analysis.

5.1 Recurrence of Civil Wars

Barbara F. Walter's "Does Conflict Beget Conflict?" provides a perfect opportunity to see how including a magnetic field variable in a fully analyzed and rigorous model may affect its power and relevancy (Walter, 2004). The model presented by Walter falls squarely into the Neo-liberal school of international relations. Walter's model shows that conditions of low quality of life and high barriers to political, economic, and social participation are valuable predictors of which states will experience continued civil conflict and which will not.

The phenomenon that has come to be termed the "Arab Spring" represents a spectrum of civil wars. These conflicts also represent a spectrum of possible paths, means, and outcomes of civil war. It will be interesting to see if the occurrence of civil war will follow the trends of historical civil wars from 1945 to 1996. During this time, 36% of civil wars followed closely behind a civil war. However, this only represents 22 of 58 cases of civil war (Walter, 2004). The occurrence and recurrence of civil war led Collier and Sambanis to coin the term "conflict trap" (Collier & Sambanis, 2002).

Before Walter, the literature on civil war recurrence focused primarily on the characteristics of the previous war to explain why some break out again and others do not (Licklider, 1995) and (Doyle & Sambanis, 2000). This earlier analysis argued that recurrence of civil war was a result of characteristics of the previous civil conflict and attributes of how the conflict ended. Walter argues that none of the previous explanatory factors is sufficient without the presence of strong economic and political incentives for the average citizen to fight (Walter, 2004). Walter's analysis of every country experiencing civil war from 1945 to 1996 suggests that the primary variable in prediction of recurrence of the civil war are basic living conditions and ability to participate in the political processes of the state. She also found that conflict duration and the willingness of a government to partition territory had significant effect on recurrence, but only in certain types of renewed war.

Explanations of why civil wars recur begin with why they start. Conflicts started based on ethnic and identity group conflict (Gurr, 2000) have unique intensity and scarring that tend to drive these civil wars to flare up again over time (Rothchild & Groth, 1995). Explanations of recurring civil wars also include descriptions of how parties fought the civil war. Civil wars that have high costs on those involved could drive desires of personal vengeance and result in recurring conflicts. This dynamic is probably restricted to the "minority" group and not the state. Wars costly to the state would suppress the tendency for civil war recurrence, as it would lack the will and resources to execute such a conflict if the previous one was particularly devastating (Rosen, 1972). Duration of the civil conflict also could influence the probability of a recurrence. Long wars are packed with information that leaves little doubt as to the "balance of power" among participants. Short wars may leave one or both sides wondering what the real balance may be and with uncertainty could enable another outbreak to occur (Walter, 2004). Finally, how the war ended may have an impact on recurrence. The majority of research and support goes to showing that the victorious party, experiencing a decisive victory, consolidates power and increases the costs of renewed fighting (Wagner R. H., 1993) and (Wagner R. H., 1994).

Walter argues that what drive the ability of groups to restart or initiate new civil wars following the ending of old ones are the conditions that motivate a re-mobilization of citizens. She believes that two conditions drive mobilization. First, the status quo needs to be perceived as worse than death. Second, there can be no non-violent means of changing this status quo (Walter, 2004). She presents a compelling argument concerning the quality of life that potential soldiers fighting a civil war have versus their willingness to re-enlist in an army to fight another civil war. She also acknowledges that other issues complicate the calculus, such as collective action problems; availability of resources, supplies, *etc*. Risk acceptance among the population also should matter. Her intent, though, is to show that citizen participation is an understudied dynamic in the recurrence of civil conflict.

Her focus on individual incentive and evaluating the outcome because of aggregate individual decision-making makes her theory a perfect candidate to test the relevance and impact of the earth's magnetic field within an established as well articulated model. She looked at every state in the international system that had experienced civil war between 1945 and 1996 based on the Correlates of War project coding. She used annual observations of each state as the unit of analysis. It resulted in 1,151 country-year observations representing 58 conflicts (states).

She created three dependent variables with the correlates of war data available. First, was a coding for *Subsequent War*, 1 if a subsequent war occurred in a given year, and 0 if it did not. To distinguish between cases where old factors caused the subsequent civil war and when new factors did, Walter created two other dependent variables, *Repeat War* and *New War*. A conflict was coded 1 for repeat war if it was fought by the same parties over the same issues as the initial civil war. A conflict was coded 1 for new war if it involved new combatants. There were 14 repeat and 8 new wars out of the 58 cases of civil war covering more than 1,100 country years.

Walter measured several groups of independent variables. The first group dealt with the characteristic of the civil war and was a determination if the civil war was an *Ethnic Civil War*. This group also included a classification variable of the demands of the rebels as either being in total control of the government or something less: *Total Goals* vs. *Non-Total Goals.*

The second group of independent variables used is *War-Related Deaths*, *Duration of War* in months, and the number of *Displaced People*. These three variables were log transformed. Walter claims that identical analysis with these variables not log transformed were the same. These variables were to measure the costs associated with renewed war. The third group of independent variables captures the factors associated with the resolution of the previous civil war. *Grievances Settled*, whether a side experienced a *Decisive Victory,* or if a *Partition* occurred could each point to a different likelihood of renewed conflict. Each, if true should reduce the likelihood of renewed civil war.

The final group of independent variables she evaluated measures of economic and political conditions of the population. They included *Infant Mortality Rate* (deaths per 1,000 births), *Life Expectancy at Birth*, *Adult Illiteracy*, and *Real GDP Per Capita.* These variables were highly correlated and not included in the model at the same time. In this group Walter included a measure of political openness to measure the non-violent tools available to a population unhappy with its plights. She used the *Democracy/Autocracy* scale from the Polity III dataset.

Finally, Walter included a group of control variables. First, included was a measure of *ethic heterogeneity*. This was to control for differences in racial, religious, and linguistic divisions. Second, the addition of the year under observation addressed evidence that the number of civil wars per year was increasing over time. Finally, a set of variables to measure the number of years between original and recurrence of civil war, identified as *Peace Years,* and a set of natural cubic spline variables of *Peace Years* to determine how war recurrence relates to duration of peace after the end of a civil war.

She found that in modeling subsequent war using logit regression that both *partition* in the previous civil war and the *number of years of peace* were significant at the .05 level. Partition increased the probability of recurrence, while increases in peace years decreased the likelihood of recurrence. The variable of interest, *Infant Mortality* (lagged one year), and the *duration* of the previous war were significant at the .01 level. None of the other variables measuring the characteristics of the previous civil war was significant (Walter, 2004). However, it is worth noting that both *total goals* are significant at the .1 level. This somewhat reduces the strength of her findings and creates a more balanced argument that both quality of life and the characteristics of the previous conflict are important. In fact at the .1 level a conflict focused on the total replacement of the government would be equal to roughly 76.66 infant deaths per 1,000 births.

As a start, evaluating the effect of Ap or C9 alone on the probability of a civil war recurring indicates that Ap is not very useful in prediction or explanation While the preponderance of the 95% confidence interval is positive and the expected effect is a meaningful value of .07 (with an Ap range of between 1 and 23), such results could appear by chance even if the true relationship was zero. C9, however, is significant at the .1 level. C9 could have a mitigating effect on recurrence and that mitigation effect would increase as C9 increases.

However, the inclusion of Ap and C9 in a fully developed model results in findings that are more compelling. The inclusion of magnetic field variables Ap and C9 in Walter's model don't drastically change the overall outcome of the model. Inclusion of Ap only subtly changed the effect of partition, increasing its coefficient by about 6%. Both Ap and C9 are significant in the model; Ap at the .1 and C9 at the .05 level. Within the estimated values of the model for Walter's sample a one standard deviation for the Ap index is 4 units, while one standard deviation for infant mortality is 48 units. It takes a 6.33 unit increase in the rate of infant deaths per 1,000 births to equal a 1 unit increase in the Ap Index. If the Ap index is at its max value, infant mortality would have to be as high as 145.5 per 1,000 to have equal influence on the recurrent of civil war based on the sample and model analysis. The impact of maxing out the Ap value has the same absolute impact that a 5-year increase in duration of a previous civil. The Ap increases the likelihood and duration decreases the likelihood. So, 5 years of civil war will reduce the likelihood and offset the effect of a max Ap value.

The measure of magnetic influence results in a more drastic impact on the base model. Total Goal collapses from a significance level of .071 to .150. The sample estimates show the influence of C9 in the model is 8 times as great as the influence of Ap. While the model finds the influence of infant mortality to be slightly greater it now takes an increase of 39 units in infant mortality to equal a 1 unit increase in C9. Indeed, the 2% of instances in which the C9 index is as high or higher than 4 units, infant mortality would have to be as high as 158-per-1,000 to be as influential in the recurrence of civil war as the C9 index. However, it would only take 1.5 years of civil war to cancel out the effects of either a C9 index score of 4 or an infant mortality rate of 158 per 1,000. It would only take three years of civil war to cancel out the effects of both.

Walter re-runs her analysis, substituting other measures of individual well-being for infant mortality. These variables are life expectancy and illiteracy. These models with Ap and C9 included end in roughly the same results as the base model using infant mortality. In the case of modeling with life expectancy, Ap is significant at the .1 level and C9 is significant at the .05 level. Their expected effect on the probability of recurring civil war are roughly the same as well. Modeling with illiteracy as a variable of interest results in a model of duration significant at the .01 level. Illiteracy is significant at the .1 level. Adding AP (P = .014) to the model results in illiteracy being significant at the .05 level, strengthening the results, but much of the rest of the model remains largely unchanged. Using C9 (P = .011) has much the same effects as AP in the model. In none of these models did partition rise to the .1 or better significance level.

The magnetic field measurements were solidly significant in the models. Of course, this is but a small subset of the population of intrastate and inter-state conflicts. Indeed, this analysis is based on only 58 civil war outbreaks, of which 22 suffered some type of recurrence. The 58 civil wars represent 5% of the evaluated country-years. The 22 recurrences are only 2% of the evaluated country-years. One must be cautious about asserting that the findings of either significance or impact on the base model (sample estimates) can be generalized to the larger set of international conflicts (population). But, it is another instance validating the inclusion of magnetic field information in models of international relations outcomes. There is no indication of temporal autocorrelation after conducting a preliminary set of diagnostic tests.

5.2 Severity of Civil Wars

Civil wars may represent microcosms of the international system and offer a warning to adherents of liberalism regarding the limits of institutions in maintaining orderly relations among people. The magnetic field's influence on the relations among groups within a state may offer insights into relations among states within the international system.

Bethany Lacina points out that all but three of the wars that occurred from 1990 to 2002 were civil wars, and that civil wars accounted for 90% of the civilian and combatant deaths experienced during that period (Lacina, 2006). While Walter's data set ends in 1996 and seemed to indicate that civil wars and their recurrence were few in number, Lacina points out that even when they occur rarely, such wars may have disproportionate impact on civilians and combatants. She also cites work on poverty (Bayer & Rupert, 2001), (Collier, Elliot, Hegre, Hoeffler, Reynal-Querol, & Sambanis, 2003) and (Murdoch & Sandler, 2002), poor public health (Ghobarah, Huth, & Russett, 2003) and (Krug, Dahlberg, Mercy, Zwi, & Lozano, 2002), and child mortality rates (Black, Morris, & Bryce, 2003) to provide strong evidence that civil wars were responsible for these social ailments. The depth and breadth of these social ills are most likely determined by the severity of any civil war that had occurred in the state.

Lacina proposes a set of hypotheses and regression analysis that identifies factors to explain variation in civil war battle deaths. Her findings are contrary to the analysis of civil war onset and duration that asserts that measures of state strength were *the* significant explanatory variables for these models. Lucina found in her models that political variables outperform the measures of state strength.

Lacina makes a satisfactory case for using the battle deaths suffered during a civil war as a measure of the war's severity. She acknowledges that the measure of battle deaths is not the same as measuring the total humanitarian cost associated with a civil war, but it does provide a satisfactory measure of the scale of combat associated with a civil war. The determinants of that scale fall into one of two camps: opportunity or motivation. The determinants of outbreak are likely to be so ubiquitous that they are unlikely to provide much explanatory power as to the variance in severity of civil wars.

Lacina develops a series of hypotheses grounded within three different categories of variables. The first are measures of state strength and include gross domestic product, outside assistance in the civil war, geography of the state and its population density. The second involve measures of regime type. The third category is that of ethnicity and religion (Lacina, 2006).

Lacina conducts analysis on each of these three categories using severity of battle violence as the dependent variable. She measures severity of battle violence as the natural log of the total count of battle deaths. She controls for both duration and population within the regression analysis. For state strength, Lacina uses the measure of military quality, which is defined as military expenditures divided by the number of military personnel, lagged one year and logged (Bennett & Stam, 1996), the per capita GDP that is adjusted for purchasing power parity and inflation (logged), a dummy variable for possible external support that is coded 1 if the war occurred during the cold war, and the percent of the country experiencing civil war that is "rough" (logged). The measure of regime characteristic is a dummy variable that codes a state with a composite score of 6 or higher on a combined Polity scale of regime type as a democracy (1) (Marshall & Jaggers, 2003).

The analytical findings were that duration, intervention, regime type, and ethnic polarization were significant in modeling battle deaths from civil wars. Lacina's base model explained 40% (R^2 of .40) of variance in battle deaths. The less restrictive model, using only the variables that are significant in the base model, explains 3% more of the variance (R^2 of .43) but is more parsimonious with little change in the coefficients of each variable.

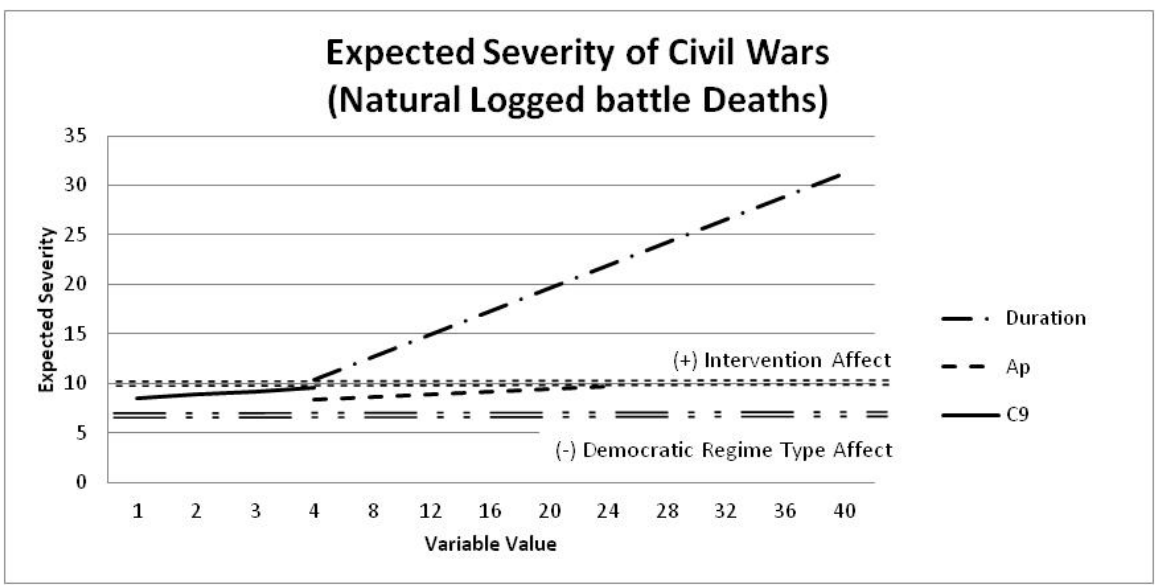
Looking at the possible value of the magnetic field alone in modeling battle deaths results in neither Ap nor C9 as being significant. In fact, the model indicates there is a good chance that in the least restrictive model of battle deaths with magnetic fields as the only explanatory variable that the likely effect of the variable is 0, or so very near to 0 as to be the same. This makes the findings of the value of the magnetic variables in the more restrictive model used by Lacina more intriguing and surprising.

Merging Lacina's dataset with the Ap and C9 dataset used to model the influence of the earth's magnetic field results in fewer cases, as some of Lacina's data points were outside of the available Ap and C9 data. Rerunning her model with only the 88 cases that match the available magnetic variable data resulted in the same significant variables. Shrinking the base model's cases to match the number of observations in the C9 and Ap models did no harm to Lacina's conclusions.

Including C9 or Ap in the model find both significant with the former at the .1 level and the later at .05 level. A trend to note is the movement of the significance of ethnic and religious polarity. With either Ap or C9 in the model, neither of the polarity variables is significant. The possible significance level of ethnic polarity increases, or moves away from an acceptable significance level, while that of religious polarity decreases, or moves toward an acceptable significance level.

If the hypothesis of the earth's magnetic field influencing human behavioral and aggregate behavioral outcomes is true, then this model of Lucina's sample indicates that the magnetic variable has an importance of at least that of some "traditional" explanatory variables used in the discipline, such as intervention and regime type. Under certain circumstances (low duration and/or high magnetic value) the magnetic field variables may be an important explanatory variable in determining civil war severity and duration. While one cannot make confident generalizations about the population effect of Ap and C9, one can be confident that if the sample is representative that the influence of the magnetic has a very small likelihood of being zero..

Figure 13 Simulated expected Severity of Civil Wars



5.3 Coups

Much like civil war, discussion space in this thesis for coups, insurgency, and terrorism is limited. In Realism, these dynamics are ancillary issues as long as they only threaten governments but not the existence of states. Liberalism provides increased space to discuss these dynamics. However, this space is full of discussions about how regime type and institutions can overcome power relationships, risk, and security concerns. The analysis here shows that the system variables could be as important as human institutions.

Some of the most serious intra-state armed conflicts include coups, terrorism, and ethnic wars. For coups, the model below estimates the probability of a coup in a given country, explained as a function of the time between and since the last coup in that country as well as the time since a coup was last attempted within the region. The Ap index score is my addition to the package of explanatory variables. The regions in which a coup could occur is a set of dummy variables. Dummy variables for whether the United States of America is involved in a "hot war", a "cold war", or at peace is included as well.

The Ap index is significant at the .1 level. Generally, as the Ap score increases in value the probability of a coup occurring in a county increases. As the time between coups in a country increases, the probability of a coup occurring in the same country increases. However, as the time between coups in a region increases, the probability of a coup occurring generally decreases. Compared to European countries, the baseline region, and the region least likely to experience a coup is the Pacific, followed by South America. As the Ap Index increases, the probability of a coup occurring in a region increases.

Figure 14 and Figure 15 show expected value of the dependent variable, probability of coup, when simulating from the sample and the U.S. is not in a "hot war," and holding the time since the last coup in the country and region at their sample means, controlling for no other influences on coups. When the Ap Index is near "0" given the other variables in the model, their sample mean is 3%. The expected probability of coups in a country of a region in a given day doubles to 6% when the Ap Index ranges between 130 and 160 units. The expected probability of coups increase to a range of 11% to 12% when the Ap Index is 280 units or greater. The absence of involvement by the United States in a war results in a shift of expected probabilities of coups by an average of 1%

Table 18 Likelihood of a coup on any given day

	Probability of A Coup On a Given Day Model Type: Probit Observations = 15,395	Pseudo R2 = .0181
Variables	Coefficient and Standard Deviation	Significance
Ap Score	**.0021** *(0.0012)*	0.092 *
Days Since Last Country Coup Attempt	**.0100** *(0.0016)*	0.000 ***
Days Since Last Coup Attempt in the Region	**-.0031** *(0.0014)*	0.027 **
Central Asia and Caucasus Region	**.2344** *(0.1255)*	0.062 *
Sub-Saharan Region	**.2628** *(0.1011)*	0.009 ***

Table 18 Continued			
South America	**.2189** *(0.1092)*	.045	**
Middle East	**.2308** *(0.1126)*	.040	**
Asia	**.2797** *(0.1190)*	.046	**
Pacific	**-.7037** *(0.2912)*	.016	**
United States in “Hot War”	**-.0950** *(0.0414)*	.022	**
Cold War Period	**.0351** *(0.0440)*	.426	-
Constant	**-2.266** *(0.1111)*	0.000	***

* P<.1 ** P<.05 *** P<.01

The Pacific region probability of coup is sufficiently different from the other regions to require its own chart. The expected probabilities of the Pacific region range from near “0” to around 2% as the Ap Index values range from “0” to more than 280 units.

The change in expected probability of coup for a country in a given day is small. However, when we average expected probabilities for the regions (less the Pacific) and we graph the percentage change from U.S. involved in a “hot” war to the U.S. being at peace, the impact of the condition change on the probability becomes noticeable. Figure 16 shows that in simulations of the sample and for non-pacific regions, when the Ap Index is near “0” in the sample the simulation shows a nearly 25% change in expected probability of coups occurring when the system changes from one in which the United States is in a “hot” war to one where it is at peace. When the Ap Index is at its sample high, the percent change in expected probability of coups under the previous condition change is only roughly 17%. For the Pacific region, the changes are nearly 35% (Ap near 0) and 27% (Ap near 280).

Figure 14 Simulated likelihood of a coup

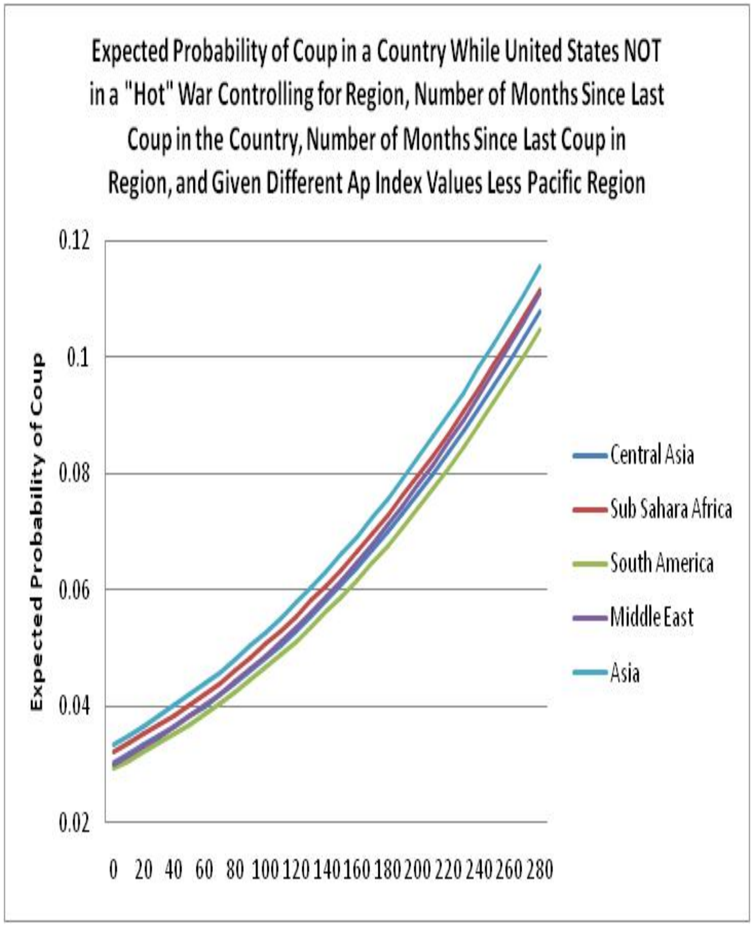


Figure 15 Simulated likelihood of a coup

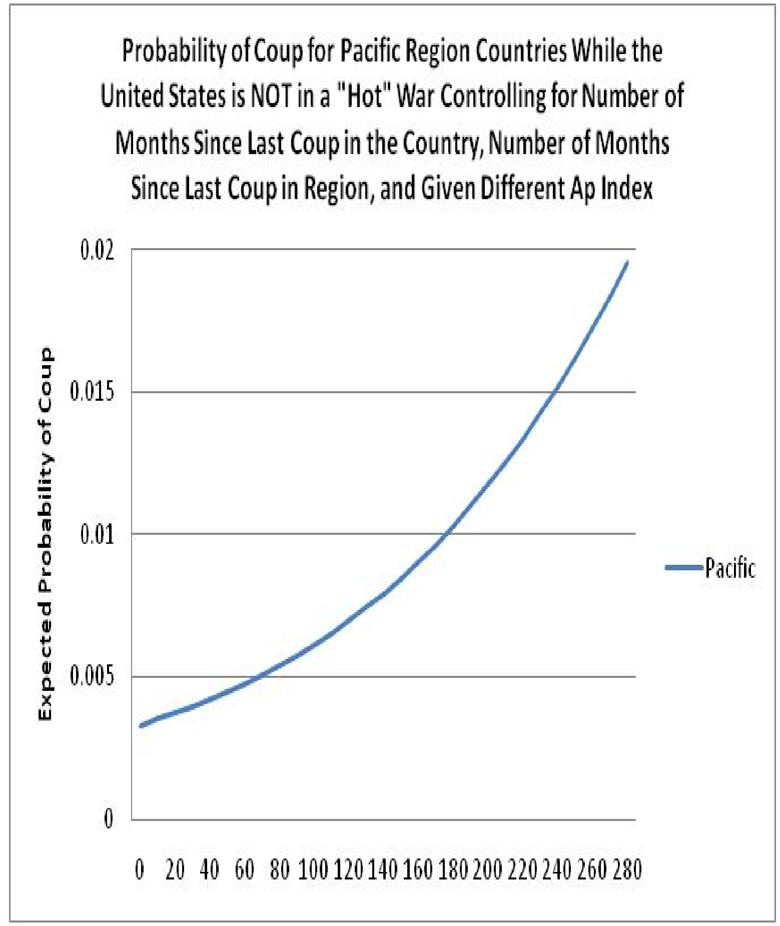
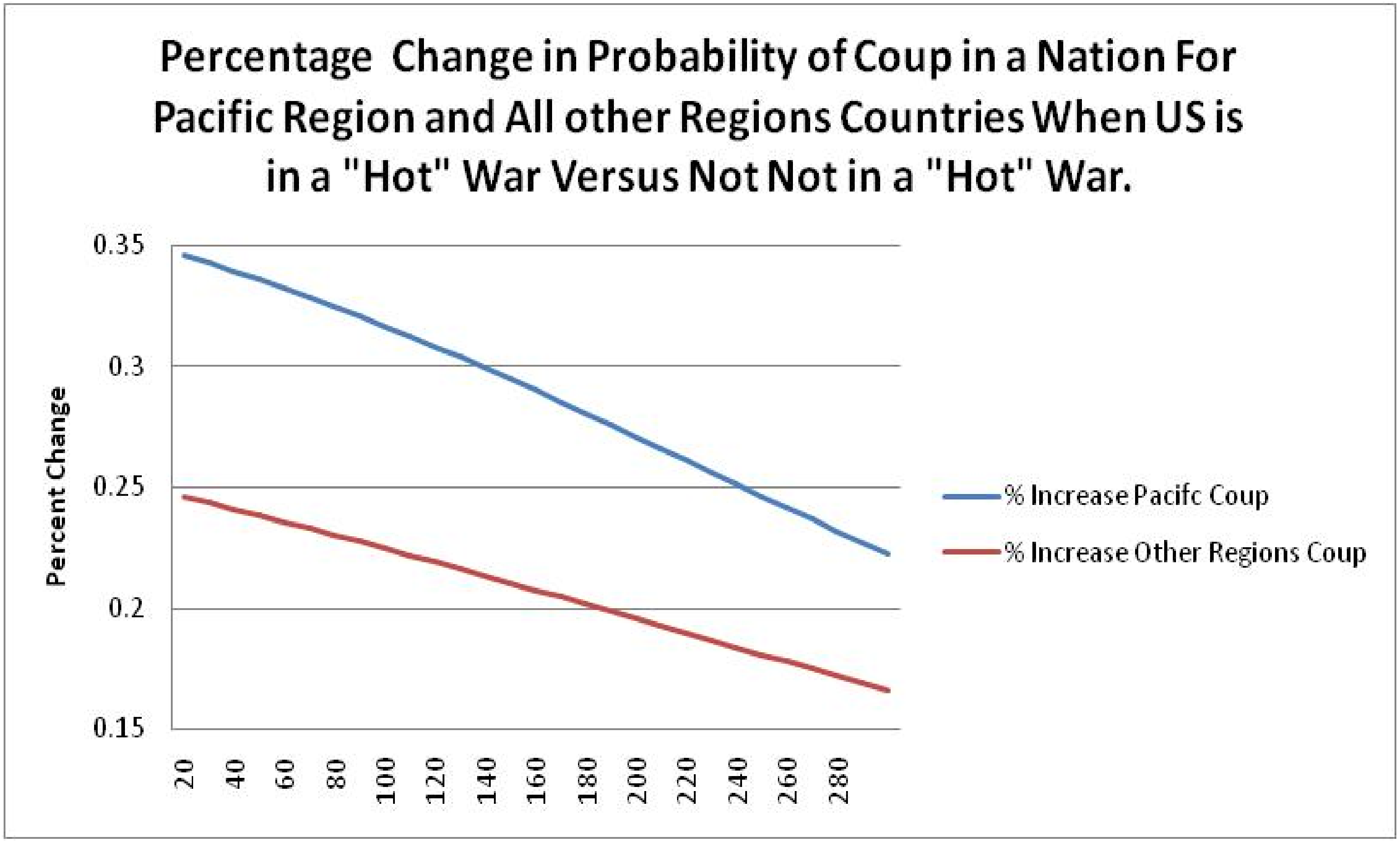


Figure 16 Simulated percentage change in the probability of a coup occurring



5.4 Insurgencies

Next is analysis of the model of insurgency in Iraq. The dependent variable in this analysis is the number of occupiers killed in insurgent attacks in Iraq from 2003 to 2010. The model controls for past casualties, past terrorism, and the duration of the occupation.

Table 19 Expected number of occupier troops killed in insurgent/terrorist attacks

Number of Occupiers Killed in Attacks

Model Type: Poisson

Observations = 51 Pseudo R2 = .1839

Variables	Coefficient and Standard Deviation	Significance
Cp Score	**.4939** *(0.1300)*	0.000 ***
Duration of Occupation	**.0132** *(0.0044)*	0.003 ***
Deaths Inflicted Last Month	**-.0019** *(0.0010)*	0.049 *
Wounded Inflicted Last Month	**.0007** *(0.0001)*	.000 ***
Terrorist Attacks Last Month	**.0001** *(0.0012)*	0.943 -
Constant	**3.323** *(0.136)*	0.000 ***

* P<.1 ** P<.05 *** P<.01

For this sample, geomagnetic fields correlate with the outcome of interest. Specifically, as levels increase, other things equal, the number of occupier deaths that we can expect will rise. The other variables also help predict deaths: They increase with longer occupations and in the aftermath of terrorist attacks. Whereas wounds might encourage additional insurgent activities, deaths of insurgents suppress insurgent activity in the following month – but these two variables matter less as individual explanations and more as a package of predictors, given that they correlate with each other.

5.5 Terrorism

The previous analysis for intra-state conflict has looked at some characteristics of insurgency and ethnic conflict at the local or state level. Incidents of terrorism occur all over the world, as a system process. The primary data used to conduct analysis of terrorist attacks comes from the Global Terrorism Database, retrieved from the Center of Excellence of the U.S. Department of Homeland Security, based at the University of Maryland. The database is in two portions, the first from 1970 to 1997, and the second from 1997 to 2007. The data provides information on incidents that are intentional, entail some level of violence, executed by a subnational perpetrator, and meet two of three, pertinent criteria. (1) Whether the act intended to attain a political, economic, religious, or social goal. (2) Whether evidence of an intention to coerce exists.(3) Whether the action took place outside the context of legitimate warfare (Security, 2007). First, let us look at how much additional information the AP score provides when attempting to predict the likelihood of a terrorist attack occurring in a given day somewhere in the world.

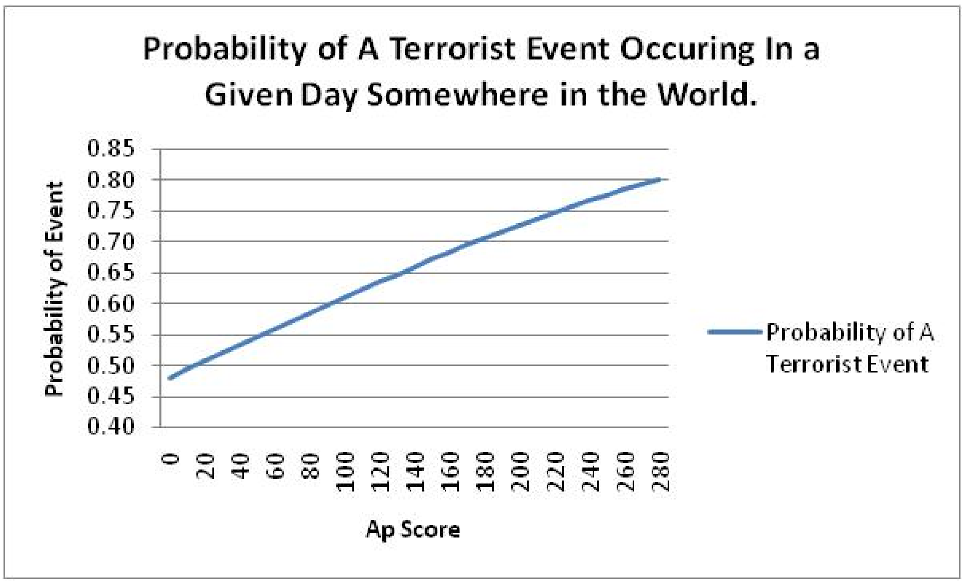
Table 20 Probability of a Terrorist Attack in a Given Day

	Probability of a Terrorist Attack in a Day	
	Model Type: Logit	
	Observations = 48,249	Pseudo R2 = .0014
Variables	Coefficient & Std Dev	Significance
Ap Score	**.0053**	0.000 ***
	(0.0006)	
Constant	**-.077**	0.000 ***
	(0.012)	

P<.1 ** P<.05 *** P<.01

The geomagnetic measurements covary with probability of a terrorist attack in a given day. The coefficient is significant at the .01 level and is unlikely to be zero. Figure 17 shows the sample based simulation that produce probabilities of an attack occurring over the range of magnetic field values. It shows that the probability is generally small regardless of the geomagnetic level, always falling below one percent; the estimated increase in probability does show in the figure.

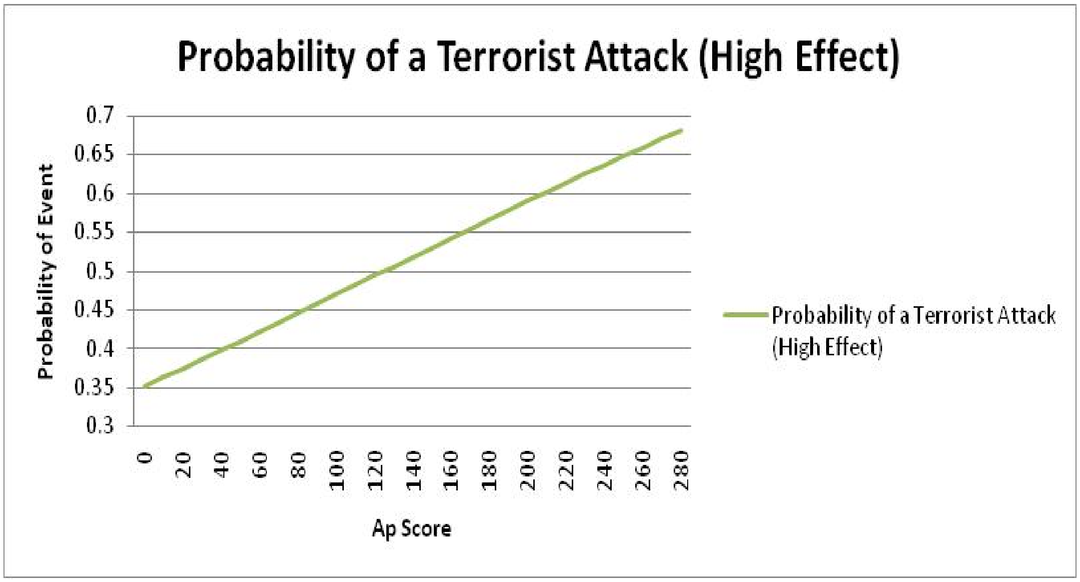
Figure 17 Simulated probability of a terrorist attack in any given day



When the predicted values for the probability for a terrorist attack occurring somewhere in the world on a given day is plotted against the Ap scores in the data sample, the probability of an event hovers between .45 percent and .50 percent when the Ap score is low, and then increases to .8 when the Ap score is 280 units. This sample includes all terrorist events, ranging from mobilizing a mass demonstration to detonating a powerful bomb. A full change from a low Ap score to a high score in the sample almost doubles the likelihood of a terrorist attack occurring somewhere in the world on any given day.

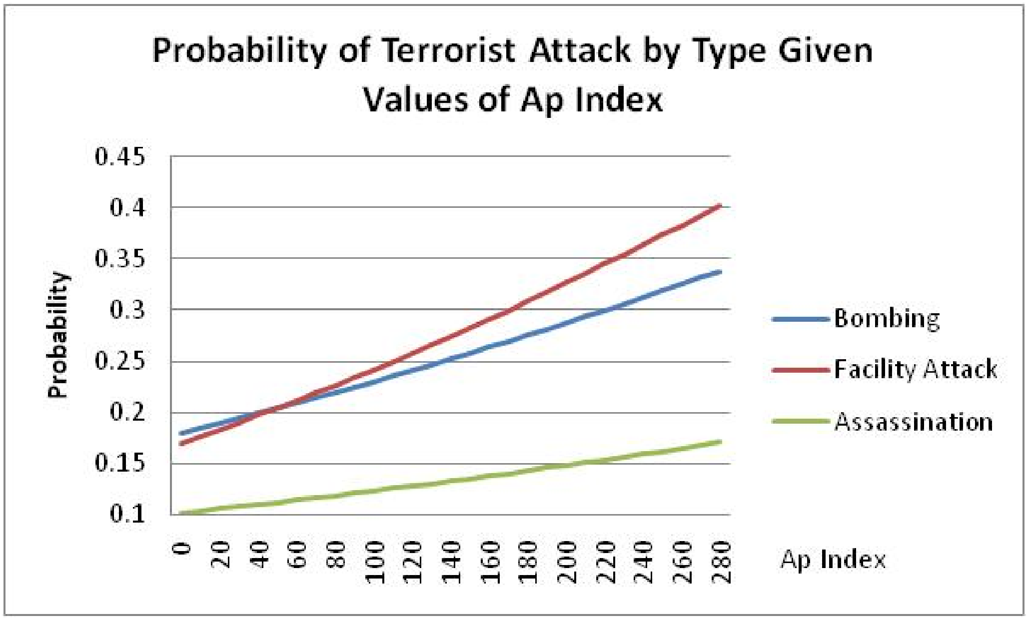
5.5.1 Probability of High Terrorism on any Given Day

Figure 18 Simulated probability of a terrorist attack



This chart shows that when using the sample and simulation that as the Ap score goes from 0 to 280 units the probability of a "high effect" terrorist event such as a bombing or facility attack on any given day goes from .35% to .70%. The probabilities more than double over the range from 0 to 280 for bombing and facility attack events to occur in a given day. For assassins the expected probabilities increase around 50% over the range of Ap values in the sample.

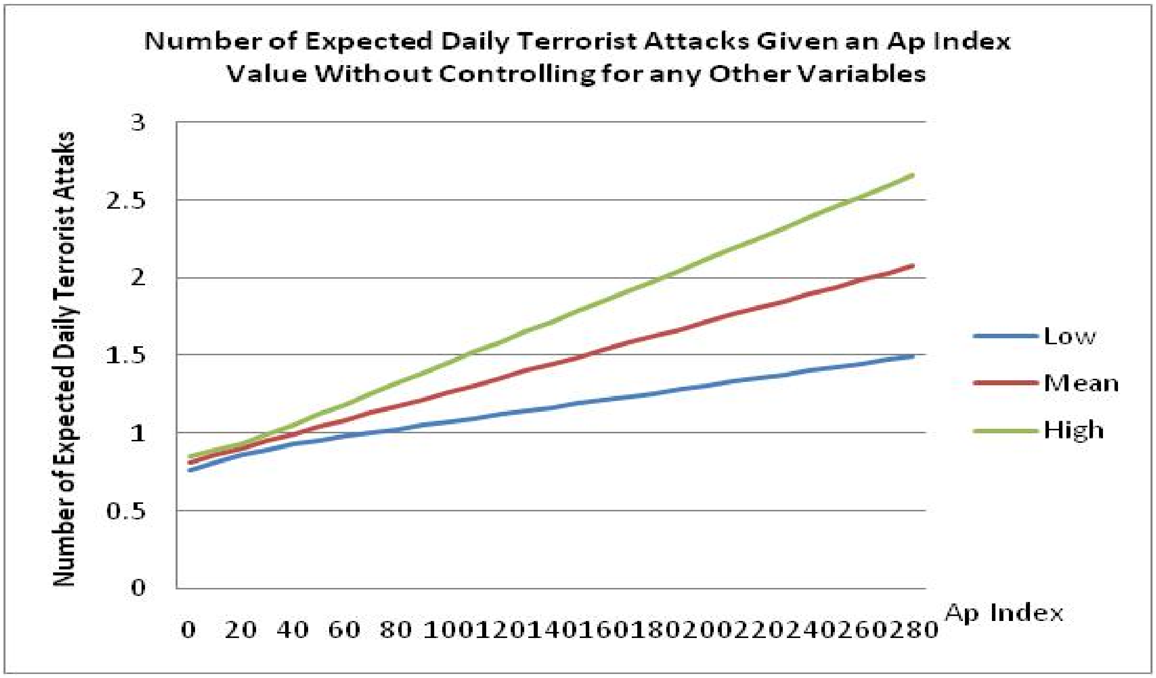
Figure 19 Simulated relationship between daily attacks and the Ap score



5.5.2 Probability of Terrorist Attacks

The Ap Index covaries with the count of daily terrorist attacks as well as the number of successful and failed attacks in any given day. Figure 20 shows that as the magnetic field increases, the expected number of expected daily terrorist attacks does as well within the sample.

Figure 20 Simulated expected number of daily terrorist attacks



Within the sample and using simulations, the model results indicate that as the Ap Index increases from 0 to 280 units the expected number of daily terrorist attacks increases from about .75 to a little over 2 per day somewhere in the world. The expected 95% confidence interval of the model and simulation is between 1.5 and 2.5 counts per day. Increasing Ap Index values is correlated with increased terrorist attacks.

5.5.3 Successful Terrorist Attacks

When terrorist attacks do occur somewhere in the world in the sample, the Ap index correlates with the number that are successful. Table 21 shows that the magnetic field measurement is significant in modeling the number of successful terrorist attacks if not controlling for any other variables.

Table 21 Expected number of successful terrorist attacks in a given day

Number of Successful Terrorist Attacks

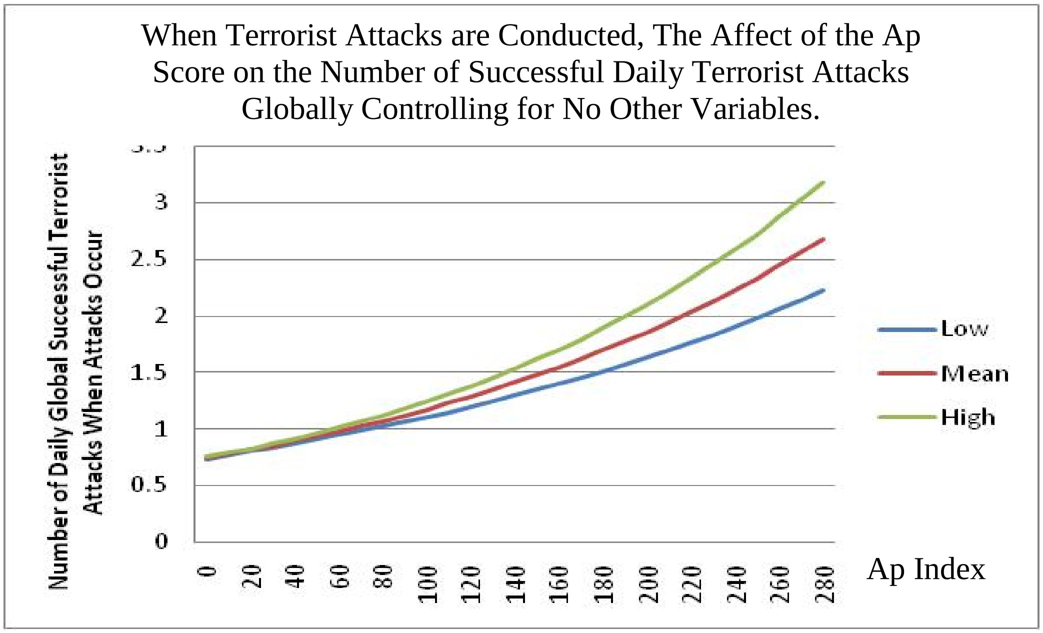
Model Type: Poisson

Observations = 27,606 Pseudo R2 = .0013

Variables	Coefficient and Standard Deviation	Significance
Ap Score	**.0045** *(0.0003)*	0.000 ***
Constant	**-.292** *(0.009)*	0.000 ***

* P<.1 ** P<.05 *** P<.01

Figure 21 Simulated expected number of successful daily terrorist attacks



There are likely to be fewer successful attacks in the sample on a day with lower Ap values than on days with higher Ap values. In fact the expected number of terrorist attacks in the sample in a day increases from around .75 on average at a 0 Ap value to an expected average of over 2.5 average attacks per day, or a 300% increase in expected daily terrorist attacks.

Let's look at the percentage of attacks in a given day that are successful. This time, the analysis will use a linear regression model versus a poison count model. The Ap Score is significant at .1 so is unlikely to be zero. However, the variable explains almost no variance in the number of successful terrorist attacks in any given day.

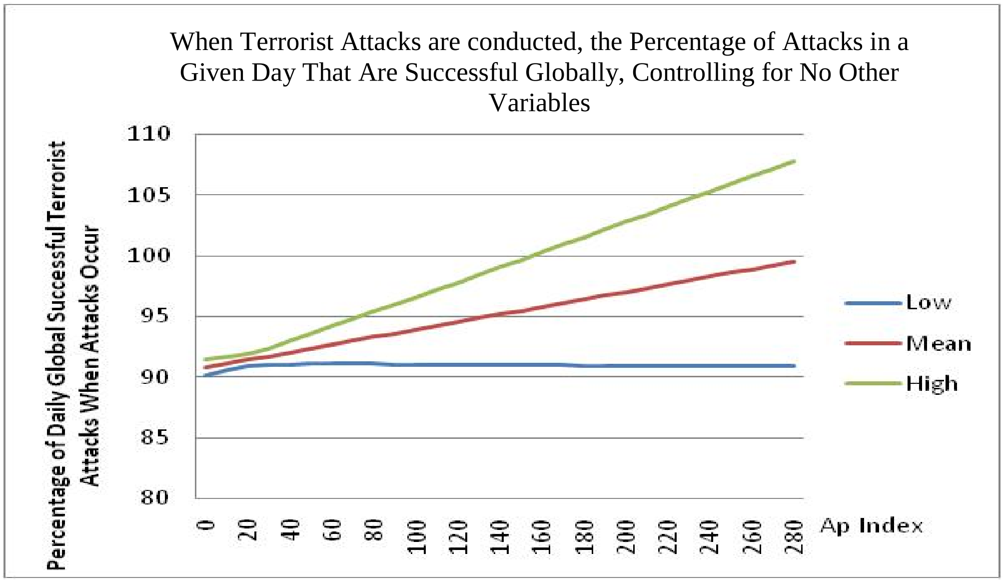
Table 22 Expected percent of terrorist attacks that are successful

	Percent of Terrorist Attacks Successful in a Day		
	Model Type: Regress		
	Observations = 3516	Pseudo R2 = .0007	
Variables	Coefficient and Standard Deviation	Significance	
Ap Score	**.0304** *(00166)*	0.066	*
Constant	**90.839** *(0.361)*	0.000	***

* P<.1 ** P<.05 *** P<.01

However, the confidence interval and simulating the possible outcome of this model indicates that it is possible that the Ap score has little to no effect. Let us look at the possible range of impacts that the Ap index has without controlling for other variables. Note that we have moved away from a direct count of successful attacks to an analysis of the *percentage* of attacks that are successful.

Figure 22 Simulated expected percentage of attacks successful



The sample has a high proportion of successful attacks. The Ap index in simulations based on the sample covaries with the percent of successful terrorist attacks each day. Looking at Figure 22 simulation based on the sample, it can be inferred, there are examples when no attempted terrorist attacks are successful; there are 35 of them. Yet, the sheer number of days in which all (not just some) attempted terrorist attacks were successful, 2,118 or over 60%, indicates that most attacks are successful and that the model, without controlling for other variables, cannot explain the failures very well. In fact, of all the days that had terrorist attacks occur only 3.75% of them had 50% or more failures. Likewise, based on ARIMA analysis there is a low confidence that temporal autocorrelation occurs in these models.

5.6 Conclusions and Caveats

Although realism and liberalism have shied away from defining characteristics of the space in which the international system operates, there may be justification for integrating at least one characteristic into their analysis. When looking at internal dynamics of actors in the international system, magnetic fields consistently correlate with state behavior as well as indications of state strength and stability. Furthermore, the ways that the expression of magnetic fields in the international system has a direct effect on how the international system operates. Any international relations theory that asserts its ability to explain why states behave the way they do should consider taking into account the influence of magnetic fields.

The study and analysis of interstate conflict encompasses quite a few subcategories, and generally, each possesses its own preferred control variables. For the occurrence of war there are many. Distance between states (Quakenbush 2006), regime types of states in a dyad (Schultz 2001) is a control variable when evaluating risks of war within the international system (Bennett and Stam 2000). Some other standard controls are historical interactions, wealth and power relations, per capita income, military spending, technological metrics, domestic regime characteristics, strategies of the parties involved, the state of the offense-defense relationships, terrain, among many others. Regime type, distance, power relationships, and previous disputes have recently been a common package in dispute analysis (Werner 2004). Analysts model military strategy as both an explanatory and a control variable in various models (Reiter 1999)

Theorists use explanations of why wars occur as controls when attempting to isolate important contributing factors to war occurrence, initiation, and termination. A few include system polarity (Levy 1985), the distribution of power in the international system (Singer, Bremer and Stuckey 1972), the percentage of power concentrated in the two largest powers (Wayman 1984) and the presence of transitions from bipolar to multi-polar system (Midlarksy 1988). Along with these, a valid control variable for this work would be a measure of the relative strength of satisfied and unsatisfied powers in the international system (Stoll and Chapion 1985) or the presence of an arms race (Mayer 1986). If rivalries are enduring or transitory (Goertz and Diehl 1995)

Other research has focused on the occurrence of war relating to other variables of interest. Jeremy Black's Why Wars Happen (Black 2005) summarized the revival of cultural war explanations. Black evaluates the literature of cultural war and highlights aggressiveness in societies, diplomatic breakdowns, and the internal character of states as explanatory variables to explain war occurrence. Therefore, a reasonable control variable could be diplomatic breakdowns or a metric of the internal character of the states involved in disputes.

Another set of appropriate controls would be information on alliances and alliance structure. Similarity of foreign policy positions among states (Signorino 1999) (Signorino and Ritter 1999) is a control as well as an explanatory variable. Theorists use regime type and the resulting presence or absence of electoral uncertainty as both an explanatory variable and a control variable (Garnkel 2010). Likewise, the characteristics of international institutions has been used as a control variable in the expectation that international institutions can make dispute outbreak and resolution easier or more difficult (Boehmke 2004)

Methodologists recommend use of a control variable when time series data suffers from time dependence. A spline used in some international relations quantitative analysis helps account for and control for dependence within dyads and time dependence (Beck, Johnathan and Tucker, Beyond Ordinary Logit 198).

For statistical analysis of states joining existing disputes the control variables include alliance structure (A. Smith 1995), alliance reliability, and regime type (Kegley and Raymond 1982), how loose or tight alliance commitments are (Kim 1991), characteristics of alliance agreements (Leeds 2003). Conflict expansion research rests on alliance structure, regime type, distance, interests, and institution controls (Wayman and Diehl n.d.)

Aside from formal alliance structures, the structures and institutions of trade are control variables when modeling the outbreak, occurrence, and termination of disputes (Mansfield and Pevehouse 2000). The normal controls for modeling war duration include strategy, terrain, capabilities, and regime type (Bennett and Stam 1996). Many of the previous variables are also widely used in models of war initiation and war outcome (Reiter and Stam, Democracy, War Initiation, and Victory 1998).

The standard control variables for military spending are previous year’s spending (Baek 1991), the threat perceptions (Ostrom and Marra 1986), domestic political considerations (Higgs and Kilduff 1993), regime type, alliance structure, international institutions, technology, ability to finance costs (Schneider 1988), and the balance or distribution of power in the international system (Eloranta 2010). Public opinion (Kriesberg and Klein 1980) of defense spending has also been a useful control in models of defense spending that focus on institutional explanations (Hartley and Russett 1992).

Developing fully specified models incorporating these many control variables falls beyond this scope of this research. It would not be possible with such a large battery of dependent variables. However, the exclusion need not rely entirely on practical considerations. Omitted variable bias is the methodological boogeyman in such a decision, and we can have a high level of confidence that such bias is not present except rarely and by chance. Why? The nature of the explanatory variable makes it difficult to argue that any other control variables would be causally prior, necessitating the capture of omitted variables.

In the spirit of the 2005 Special Issue of *Conflict management and Peace Science* (Kadera and Mitchell 2005), this analysis focuses on a single category of explanatory variable supported by a strong theoretical framework as to why it is causally prior and is not influenced by other possible independent variables. This negates the concern for omitted variable bias that likely drives up the number of control variables in dispute models. Further, as demonstrated in the analysis presented in the appendices to Chapter Three, it is likely that the geomagnetic variable has an influence on the other control variables as well in any model. It is possible that the presence of other control variables masks the influence of geomagnetic variables

Likewise, growing criticism of the inconsistent and weak explanatory power of the traditional explanatory variables has pointed out the poor return for the investment in large datasets with multiple controls and explanatory variables (Beck, King and Zeng, Improving Quantitative Studies of International Conflict: A Conjecture 2000). One of the strongest criticisms is theory assumptions that explanatory variable effects are the same in all cases. The geomagnetic field variable may not be able to avoid this problem, but leaving out all the controls should increase confidence that even small relationships are real correlations and set the conditions for further, deeper analysis. Avoiding over fitting models is a byproduct of the decision to leave out many of the second-order control variables. The intent is to demonstrate consistently that the explanatory variable of interest has near-universal applicability and over fitting would put this goal at risk.

The exceptions to this are the sections on recurrence of civil wars and the severity of civil wars. The intent of these two sections is to demonstrate the benefits of inclusion of the geomagnetic data into a fully specified model. The absence of the system variable may cause omitted variable bias as discussed in previous chapters. However, far from demonstrating any such dynamic, these sections provide evidence that there can be benefits from including the variable in models. For instance, Barbara Walter's "Does Conflict Beget Conflict? Explaining Recurring Civil War," (Walter 2004) demonstrates that adding the variable has little impact on the model outputs. In most cases, the coefficient of effect for magnetic fields is unlikely zero.

Bethany Lacina's (Lacina 2006) work "Explaining Severity of Civil Wars." is the basis for the section on severity of civil wars. Like the results of the recurrence of civil war analysis, using the geomagnetic field by itself to explain civil war severity proved of little value. Magnetic fields' coefficient of effect had a reasonable chance of being zero and therefore has no effect on the dependent variable in the sample. However, adding it to the specified model resulted in some quantifiable benefits. First, Lacina's model explains 50% of the variance in severity with the geomagnetic variable versus 40% without. Thus, geomagnetic fields show a consistent relevance that speaks to their value in International Relations research.

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Chapter 6 Crime

In this chapter, we move from conflict between one state and another, or perhaps one intrastate group and another, to the individual level and look at criminal behavior. Dependent variables in International Relations have the benefit of being interesting to political scientists. However, they the models often contain idiosyncratic system-level and national-level variables. This chapter therefore turns to low-level behavior that may be influenced by geomagnetic fields but that are subject to a completely different body of theory and to unrelated predictive models. The hope is that by using such diverse data, the research triangulates in on a series of consistent findings that cannot be explained away because of a specific model specification.

6.1 Theories of Crime

This chapter will attempt to link the search for a structured model of crime with an understanding of the effects of geomagnetic activity on humans. Research and cultural *stories* indicate a relationship among seemingly irrational behavior and solar and geographical magnetic fields. An attempt is made to explain the count of crimes in an econometric model. The intent is to tie the magnetic field impact to the opportunity and motivation to commit violent crimes. Unemployment, poverty, or per capita income, and the interactions among the magnetic fields, are independent variables in count models that explain the number of crime events. Specifically, magnetic fields that may affect decisions to *carry out a desire to commit a criminal act* are evaluated.

The criminological research program dates back to formative pieces in 1916 by Bonger (Bonger, 1916) and continues to the formative criminological research arguments spurred by Cantor and Land's seminal 1985 piece (Cantor & Land, 1985). This research can be divided into three categories of explanation: the *Strain Theories* (Cloward & Ohlin, 1960) (Cohen A. , Delinquent Boys, 1955) (Cohen A. , 1965) and (Merton R. K., 1938), *Utilitarian* or *Rational Choice Theory* (Becker, 1968) (Block & Heineke, 1975), and the *Conflict* or *Marxist Theory* (Bonger, 1916) (Hughes & Carter, 1981).

The Strain Theories define crime as structurally induced frustrations resulting from a disjuncture between what an individual expects, or aspires to attain, and what the structures of society will allow. Utilitarian Theory posits explanations of crime as a cost-benefit analysis conducted by individuals who determine that the benefits of crime far outweigh the costs of a crime. Conflict Theory puts forth explanations on the discrepancies between what a society produces and what a society, through labor and wage conditions, allows classes of its citizens to consume.

The criminological debate revolves around an implicit unification of each of these theories into what I will call the *Unemployment-Crime Motivation and Opportunity Theory*. The need for such a theory came about from the untidy tendency of the primary explanatory variable of interest being unstable in sign, significance, and size of effect from theory to theory as well as among models within theories. Postulated by Cantor and

Land in 1985 (Cantor & Land, 1985), the Motivation and Opportunity model resulted in the dedication of an entire issue of the *Journal of Quantitative Criminology* (2001) to its defenders and detractors. This article proved to be a seminal building block for the quantitative analysis of crime as a consequence of individuals' (as represented by an aggregate crime rate) motivation, which is a unification of conflict and utilitarian theory, and opportunity, which is a unification of conflict and strain theory. Changes in motivation and opportunity come about from the business cycle, the systematic expansions, and contractions of the economy as represented by unemployment. This theory rests upon a fundamental rational-actor hypothesis, and while the model holds for property crimes, it collapses under the strain of explaining violent crimes (Cantor & Land, 1985) (Cook & Zarkin, 1985).

The debate in the *Journal of Quantitative Criminology* (December 2001) agreed on little about the relationship between crime and unemployment as a proxy for the business cycle, but did come to a general consensus that criminological study had reached a pinnacle that could only be surpassed by looking beyond the national systemic level of analysis and digging into lower levels of analysis (Levitt & Miles, 2007) (Paternoster & Bushway, 2001). While not explicit, a general criticism of linear regression also evolved out of the debate (Levit, 2001). The primary explanatory of interest has been limited, due to data availability, to employment or the lack thereof and its effect on crime rates (Phillips, Votey, & Maxwell, 1972) (Linsky, Bachman, & Straus, 1995) (Lester & Yang, 1994) (Lester & Yang, 1997).

Studies of violent crime generally refrain from using this variable. Its inability to explain murder, rape, and assault has largely gone ignored in this debate. A status of employment is a proxy for opportunity; people working have less opportunity to commit crimes. For motivation, either poverty rate or the per capita income is an appropriate measure. The greater the need represented by high poverty or low per capita income, the greater the motivation to commit crime.

Rape is the only category of violent crime that has attracted a distinct research project and an audience. This is probably because of the increasing influence of females in the discipline, the cultural view of rape in our society, and the low count of crimes such as murder. This research program has looked to specific individual variables to explain the occurrence of the crime of rape. Male dominance behavior, female precipitation, societal pressure, male sexuality, and pathology are explanatory variables. The strongest explanations are psychological and tied to a man's desire for power and domination (White & Humphrey, 1997).

An alternate theory behind crime could unite an adjusted opportunity and motivation model with the magnetic research project as an explanation. The geomagnetic research program has much to offer a model for explaining crime. One possible explanation for the failure of the opportunity-motivation model and other theories to explain violent crime is that these models rest on rationality. Violent crime is inherently irrational. Society will expend only a few of its limited resources to solve or prosecute property crimes, hence the power of rational and economic models to explain these types of crimes. However, society will redirect resources to solve and prosecute perpetrators of violent crime. The “rational” explanation and related models are further discredited because people the victims know and can identify (Justice, 2008) perpetrate a great deal of violent crime.

Research in the field shows some sort of relationship between the magnetic fields and events that result from a breakdown in behavior and decision-making. Studies show that traffic accidents in two Indian cities correlate with periods of magnetic field disturbances, with 83% of magnetically quiet days having no traffic accidents while 81% of the magnetically disturbed days had traffic accidents (Dubrov A. , 1978). Additionally, studies indicate a relationship between magnetic fields and the number of accidents in the workplace (Dubrov A. , 1978). Each of these examples supports a possible relationship between magnetic fields and an ability of an individual to make decisions. If magnetic fields can affect the “simple” process of cost-benefit analysis for how fast to drive, what machinery to use, when to accelerate or decelerate at a lighted intersection, or where to put one’s limb in relation to a piece of machinery, imagine the effect it could have on the “complex” cost-benefit analysis that would be conducted to decide to commit a crime. The magnetic field could be affecting the *perception of opportunity* and would have an important influence on the outcome of models.

A.P. Dubrov continued his study of magnetic field effects on individuals by looking at the number of schizophrenia cases reported in Moscow in the 1970s (Dubrov A. , The Geomagnetic Field and Life. Geomagnetobiology, 1978). His research showed a correlation between .7 and .9 connecting the increase in reported schizophrenia to magnetic field measurements (Dubrov A. , 1978). Thirty years later, M.A. Persinger found a strong negative relationship between an individual’s sense of pleasantness and the earth’s magnetic field (Persinger M. , 2004). Within this study, he hypothesized and supported that magnetic fields influenced neuropsychological processes to generate hedonistic effects/emotions/mental processes that correlate with multiple types of “negative behavior.” Persinger explained that the period of reduced pleasantness and increased hedonistic “desires” result in an increased irritability, diminished vigilance, and attenuated inhibition. To complicate these effects, Dmitrieva *et al*. found in subject experiments that field-human interactions also resulted in a physiological response similar to a “normal” human stress response (Dmitrieva, Obridko, Ragoulskaia, & Reznikov, 2000). Magnetic fields induced “stress” that differed significantly from “normal stress” in that it resulted in a “hyper-function” that lasted several hours, followed by an extended (several day) period of depression . The period of “hyper function” results in feelings of strength, actual physical strength, agility, and constitution, and a false sense of increased cognitive capability. The period of “extended depression” results in a feelings of decreasing value, hope, and “normality.” “Normal stress” de-escalates relatively quickly and has no extended mood impacts.

Criminology and demography have shared several characteristics that allowed the stressing of a linkage between population dynamics and deviant behavior (Short, 1971).

Generally, the two fields have emphasized spatial variations, used aggregate trends, embraced biological and physiological explanations, and based their research on the life-course perspective. Further, both fields generally favor quantitative over qualitative approaches (South & Messner, 2000).

Age, sex, and race are among the most powerful and robust individual-level factors for deviancy and victimization. Young people, males, and disadvantages racial groups are consistently at the greatest risk of deviancy, both as perpetrators and victims (Messner & Rosenfeld, 1997). In fact, most theorizing concerning crime in sociology and criminology is concerned with explaining these relationships (Braithwaite, 1989, pp. 44-53). One of the debates exploring these relationships concerns age as related to deviance and victimization. Hirschi & Gottfredson argues that the social factors cannot account for crime because the age-crime relationship is invariant. They argue that the reason crime falls off with age occurs because of the aging process (Gottfredson & Hirschi, 1983) (Gottredson & T., 1990). The lack of variation between age and crime implies that longitudinal research studies are unnecessary, that a mere panel model should capture all the variation if the age-crime relationship is constant.

Some vigorous challenges to the assertion that age-crime relationships are constant have arisen. However, most of these challenges rest on increasing the complexity of models or in reducing the applicability of crime models to limited sub-sets of the population under specific, environmental conditions. For instance, one response is that age and crime are actually not invariant, but only manifest differently for different offenses and that the relationships change over time (D., Allen, Harer, & Streifel, 1989) (Greenberg, 1985). Another challenge of the invariance between age and crime is that the aggregate does not adequately capture the relationship between these two factors and the entire population. For instance, a series of studies indicate that researchers can distinguish among different groups or categories of offenders based on their distinctive offending “trajectories” (D'under, Land, McCall, & Nagin, 1998) (Laub & Nagin, 1998) (Nagin & Land, 1993).

Further debate revolves around the persistence of deviant behavior over the lifespan of the individual. An established finding in the literature is that deviancy in childhood is a powerful predictor of adult criminality (Krohn, Thornberry, & Rivera, 1999) (Sampson & Laub, 1993). Two explanations of this relationship are the latent-trait perspective and the life-course perspective (Moffitt, 1997) (Simons, Johnson, Conger, & Elder, 1998). The latent-trait perspective asserts that the propensity to commit deviant acts develops at a young age and remains stable throughout life. If this is true, deviant behavior reflects stable differences in propensities across individuals. The life-course perspective, on the other hand, rests on developmental processes. Young-age deviancy leads to feedback, events, and learning that tend to generate behavioral stability. Under this model, the correlation between early and later behavior is imperfect. Life events and transitions can result in redirected and altered behavioral trajectories. Research is developing that supports both perspectives (Simons, Johnson, Conger, & Elder, 1998) (Paternoster & Brame, 1998) (Bartusch, Lynam, Moffitt, & Silva, Criminology).

Like age, sex has a generally identifiable pattern. Males are disproportionally involved in crime as both victims and offenders. This is especially true for serious and violent crimes. Again, an ongoing debate concerns the stability or change in the "gender gap." The continuing stability of rates of gender incarceration in the face of increasing gender equality in economic, education, and other sociological characteristics has been a mystery. However, in practice the effect of gender equality on relative levels of male and female deviancy remains an open question in the literature. The primary theory that addresses these relationships is the "power-control theory of delinquency" (Hagan, Gillis, & Simpson, 1987) (Hagan, Gillis, & Simpson, 1990). This theory holds that greater equality of genders in authority relations result in more egalitarian familial relations. This in turn would lead to similar socialization of boys and girls, leading to similar risk profiles and reduced differences in delinquency between the genders.

The power-control theory has had to deal with several critiques (Akers, 1997) but others have provided support for the approach (Grasmick, Blackwell, & Bursik, 1993) (Grasmick, Hagan, Blackwell, & Ameklev, 1996). However, one of the most compelling arguments against the theoretical model of power-control theory is one that uses basic assumptions concerning crime against the theory. Gender inequality should lead the disadvantaged group to participate in crime because of that disadvantage, as asserted by conventional theories on the causes of crime (D. & Allan, 1996).

Gender and victimization is another point of contention in the literature. Theoretically, gender equality should equate to legal equality in quality of representation for women leading to increased cost to commit violence against them. The increased cost should result in a decline in violence against women as gender equality increases (Bailey & Peterson, 1995). The research is clear that at an aggregate level, and looking only at victimization and gender, such a relationship does not exist (Bailey & Peterson, 1995). However, after controlling for "standards of structural determinants" the relationship is small but exists (Brewer & Smith, 1995). Generally, though, research has determined that for minor deviancy the variables important in predicting and explaining crime, while different in the how women and men are involved in deviancy and how they perpetrate crimes, are not different for males and females (Steffensmeier & Allan, 1996) (Mazerolle, 1998) (Triplett & Myers, 1995) (Miller, 1998) (Alarid, Marquart, Burton, Cullen, & Cuvelier, 1996).

The issue of race is one that stirs much controversy. Minorities, specifically African Americans, are over-represented in the criminal system as offenders. Some have argued that this is the result of the structure of the justice system. However, there is general agreement that behavioral differences exist among races that influence offender and victim propensities (Sampson & Lauritsen, 1994) (Sampson & Lauritsen, 1996). Explanations of the race and crime relationship have traditionally come down to a combination of cultural and structural models (Wolfgang, 1967) (Curtis, 1975) (Blau & Blau, 1982) (Blau P. S., 1984) (Messner & Rosenfeld, 1999) (Parker, McCall, & Land, 1999). However, no set of research definitively settles the question, and several conflicting findings are quite compelling, if not convincing (Messner & Sampson, 1991).

One such set of intriguing studies asserts that the black and white populations are actually two different populations, that the structural context in which each lives are so different, on average, that “the worst urban context of white communities are better off than the average black communities” (Sampson R. J., 1997). If this is true then controls for race in these models actually do reflect the structural context of the samples. One such study demonstrates that, when we control for structural conditions, we find no significant difference between deviancies among black and white boys (Peeples & Loeber, 1994). Of course, other work depicts a complex relationship between race in crime, made more complicated by the fact that crime rates within racial groups vary considerably across places and in comparison with other groups (Hawkins, 1999).

One of the implications of these dynamics and concerns in the literature is that of “compositional effects.” If people with different characteristics show more or less probability of being a deviant or victim, then some variation in crime taken together must occur due to the group quantities that compose the aggregate, such as differences in relative size or density of the group relative to others. A popular way to control for this is to use information on how groups get involved in criminal activity to create rates that reflect what would be expected if all groups that made up the collective had the same propensity to commit crimes as the whole (Deane, 1987) (Phillips J. , 1997).

The standard method for controlling for the structure of the aggregate population and its effect on the crime dynamic is to include these types of control variables in statistical models (LaFree, 1999) (Neopolitan, 1997). The relationships are of a manner that allows generalization across the population and generally tends to seem more complex than the standard prediction that low age predicts crime and high age predicts victim, or that “medium age male” and “low age female” predict crime, and so forth. The inclusion of these control variables is further problematical as, especially in the case of race controls, multicollinearity is generally present (Messner & Sampson, 1991) (Land, McCall, & Cohen, 1990).

6.1.1 Linking Crime to the Aggregate Level

A few of the theories that link crime to the population structure are (1) social disorganization theory, (2) sub-culture of violence theory, and (3) relative cohort resource availability theory. Generally, these theories attempt to explain crime in terms of the impact of socialization. The general theme in these studies is that people who exist in a social environment that lacks the mechanism for “vaccinating” individuals against the mind-set of committing crime, or in an environment that does not build a social norm for protecting “classes” of people, will have a higher tendency either to commit crime or be victimized by it.

Social disorganization theory is based on change in local communities, such as population turnover and migration, along with group heterogeneity and measures of demographic change at the higher levels of analysis. This theory uses these measures to determine the ability of communities to impose informal community norms on residents.

A community's ability to inculcate norms results in a high (or low) propensity of crime; the greater the ability, the lower the crime rate (Bursik, 1988) (Crutchfield, Geerken, & Grove, 1982) (LaFree, 1999) (Neopolitan, 1997) (Parker, McCall, & Land, 1999).

The sub-culture of violence theories argue that communities, as characterized by contextual variables affecting crime, create dynamics that propagate a culture of crime and violence. Research indicates that the density, segregation, social isolation, and poverty of populations all represent important variables in the theories of sub-culture of violence. Members of groups influenced by these contextual variables socialize into or out of the culture of crime and violence (Shihadeh & Flynn, 1996) (Sampson R. , 1987) (Sampson R. , 1985) (Peterson & Krivo, 1993) (Phillips J. , 1997).

Relative cohort resource availability theories generally argue that a lack of resources for social control and social normalizing, as well as a community's ability to accept risk in a sub-group, is what leads to crime. This follows the logic of "strain" and "control" theories. First, larger cohorts trend towards fewer resources per individual, such as larger student-teacher ratios or lower rates of law enforcement per person in a community, providing less social control. Second, large cohorts lead to reduced economic, social, and security opportunities. Large cohorts have to compete for a finite set of economic opportunities. Economic growth and dynamism might absorb more of a cohort, but those that are significantly larger than previous cohorts will face problems. Third, cohort characteristics may point to different differences in resource availability and propensity to crime. Cohorts high in members from single-family homes or from families that have parents who are absent from the home for long periods will lack the "positive" socializing influences that exposure to adults brings. The tendency of these cohorts to spend more time with their peers, who are themselves lacking in positive socializing influences, results in the cultivation of deviant behavior. Finally, certain sub-group demographics may lack community resources because of their economic, social, or other characteristics relative to other sub-groups. The less available these resources, the more protection that the society affords these resources, thereby protecting them from crime or creating conditions that negate that groups need for committing crime (O'Brian, Stockard, & Isaacson, 1999) (Pampel & Gartner, 1995) (Steggensmeier, Streifel, & Shihadeh, 1992).

A large area of the literature dealing with crime suggests that criminal behavior is a result of perpetrators' broadly (relative) rational choices and decisions (Clarke & Cornish, 1985). This area moves away from the determinism that dominated the literature prior to the 1990s. Scholars see socio-economic status, stress, or the community as proving a compelling impetus moving individuals in a criminal direction. Culture need not cut against this force: The relativity of deviant behavior, versus acceptable behavior, as well as the effects of social control and political and economic resources within communities, could frame individual choices, predisposing an individual to accept deviancy. People make choices within framed spaces. Rationalizing choices through techniques of neutralization, ("Everyone else I know is doing it") and reconciling morality and justifications ("they have it better than me; I deserve it" or "That rule is for other people; it is not wrong for me to do it") take place within the defined sociological context. The communal nature of crime is complementary and grows within families and communities (Kockars, 1974) (Prus & Irini, 1980) (Maguire, 1982).

The explanations for crime have assisted in educating policy makers and allowed them to make decisions; yet, often times the delay and distance between the theory and the policy result in problematic outcomes. These outcomes lead to a sense in communities that "nothing works" (Glaser D. , 1979). In turn, this despair leads to a sense that the only thing to do is to incarcerate and punish in order to reduce recidivism. While this punitive approach may work to a degree, it grossly overtaxes the ability of society to deal with the consequences of such policies.

Criminological research attempts to recommend policy that will influence the circumstances around an offense, and it necessarily involve itself with the rewards, opportunities, and normalization of crime. Some research indicates that as criminals' age, they tend towards less deviant criminal behavior (Petersilia, 1980) (Donald, 1982) (Petersilia, 1980). Further research along these lines indicates that criminals make rational choices concerning risk, suitability of targets, opportunity for escape, or the resources required to travel to the target (Brantingham & Brantingham, 1975) (Downes, 1966). Additional research focused on "opportunity structure" for crime shows that the supply of available opportunity drives crime. Note that geomagnetic disruptions in the reasoning process could affect any of these processes.

Psychologists also contribute to the criminological literature, starting with the "social learning" research agenda in the late 1960s and early 1970s. Social learning theories argue that learning mechanisms influence an individual analysis to the point of determining whether someone commits crime. This theory asserts that an individual's cognitive abilities predicts tendency towards deviant behavior (Mischel, 1973) (Mischel, 1979). This leads to process tracing, or studying decision making as it naturally occurs, by interviewing people – and later studies that looked at rules of thumb and decision making or choice heuristics leading to the concept of "bounded rationality" (Gigerenzer & Selten, 2002). Again, geomagnetic fields could intervene.

6.1.2 Theoretical Model

Taken as a whole, criminological studies show a strong need to include a variable that affects *motivation*. Magnetic fields may influence motivation. From an increase in the hedonistic desires of individuals to the tendency to have "vivid" or "paranormal" memories, may encourage motivation to commit a violent crime. Magnetic research indicates that the fields not only affect the perpetration of violence indirectly through the motivation and opportunity mediums but it may have a direct effect on violence itself. St. Pierre, *et al*. found that certain magnetic fields directly influence the rate of aggressive biting in rats during experiments (St-Pierre, Persinger, & Koren, 1998). Magnetic fields represent a variable of interest that affects opportunity and motivation.

6.1.3 Methodology of Analysis

Analysis of crime counts will use the Poisson distribution as a model of event counts. I will use poverty and per capita income as proxies for the motivation component and unemployment as a proxy for the opportunity portion of Cantor and Land's model. Models will control for the population of the unit of analysis in consideration. These models assume that observations are independent, and *not affected* by events in any previous observation period. Counts of crime *cannot be negative* but lack a theoretical upper bound. The Poisson also implicitly assumes that the probability of more than one event occurring at exactly the *same instant* is zero.

6.1.4 The Data

I will analyze crime at the state, county and city level. Previous literature focused on national and state annual crime since the end of the WWII. One may argue that analysis of crime at the state level is generally a highly localized phenomenon and is of limited utility; this analysis goes two steps further and analyzes violent crime at the county and city level. In this chapter, the analysis will start at the lowest level and work the analysis higher. The discussion will start with an evaluation of magnetic field effects on crime in cities in Kentucky in 1978. It will transition to a short discussion of the aggregate city data applied to the entire county during the same period. An analysis of the entire state transitions the discussion to a nation-wide analysis of crime counts. At each level, I use measures of the magnetic field affecting the level and the times.

The dependent variables used in each of the modeled datasets represent violent crime counts and come from the Kentucky State Police annual publication, *Crime in Kentucky* (Police, 1978). The crime variables are annual counts, with periods bounded by the first and last day of the year, and as monthly counts, with periods bounded by the first and last day of the month. The models use annual counts for the City 1978, County 1978-1980, and Annual Kentucky crime models. The Monthly Kentucky 1973-2000 crime model use monthly counts of crime. The different crimes modeled include murder, rape, assault, robbery, and a count of total violent crimes for the period.

Murder is a dependent variable in each of the geographic and temporal models. Rape and Assault is also a dependent variable in each of the geographic and temporal models. However, these two variables are more suspect as they may suffer from reporting bias from two dimensions. First, people may not choose to report such events. Second, communities may have an interest in underreporting events for one of two reasons; cultural or economic. Each of the geographic and temporal models *except* for the City 1978 model use total counts of violent crimes.

The variable of interest is the measurement of the geomagnetic field. Three different data "groups" Capture the measure of magnetic fields. The first is a set of three values that represent the three dimensions of the full field. These dimensions are the Horizontal Field, the Declination Angle, and the Vertical Field. These measures are daily values. In order to match the period of the dependent variables they were each averaged for a given month and then for the year. This produced a monthly and yearly (from 1960 to 2008) average horizontal, declination angle, and vertical field. The dataset analyzing annual violent crime counts in Kentucky from 1970 to 2008 and monthly violent crime counts in Kentucky from 1973 to 2008 use this data set.[1]

The second data group is a measure of the total intensity of the geomagnetic field that I depict as the total effect of the three components. This measurement came from an aeromagnetic map of the state of Kentucky built in 1978. The map represents a graphical depiction of the total field intensity at 1000 feet above ground level for the entire state. It transforms continuous data into ordinal data. The measures are "smoothed" and represented by colored bands that represent a range of 20 gammas of field intensity.[2] I will use this Gamma measurement in two different data sets. The first is a city data set that looks geographically at the minimum and maximum field strength overlaying each city represented on the map. The second set uses a county minimum and maximum magnetic field measurement. The second set of models averages the minimum magnetic field and maximum magnetic field associated with each city residing within the county borders.

The lack of available gamma-magnetic measurements make it necessary to use the Space Physics Interactive Resource site component measurements for all datasets looking for relationships outside the 1978 temporal domain.[3] Therefore, we require two different groups of models: one with Gamma magnetic field measurements and another with the component measurements. Both groups represent the *earth's geomagnetic influence* on violent crime counts, just using different available data. While the measure

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[1] We define the horizontal field as the measure of electromagnetic field intensity relative to true north. The vertical field is the measure of the electromagnetic field intensity from the northern pole of the earth's field to the equator. The vertical field produces a 0-degree angle in a dip needle at the equator and a 90 degree dip angle at the magnetic north and south poles. Both the horizontal and vertical fields are measured in nano-tesla, which represents 100,000 gauss. Generally, the horizontal and vertical fields are referred to as the horizontal and vertical component of the total field and are not defined as separate and distinct concepts or entities. This analysis breaks with that tradition and will look at the effect of each and the interaction between them . The declination is a measurement of the angle between magnetic north and true north. Since the magnetic north of the Earth is in constant motion, this angle changes . This measure is in units of degrees.

[2] One gamma equals one nano-tesla. Maximum error due to contour smoothing in production of the map is 10 gammas. Further, establishment of recognizable ground points for each collection of data is accurate to within +/- 50 feet. The measures of intensity range from -300 to 2500 gamma (nano-tesla).

[3] The 1978 Aeromagnetic Map was produced as an aid to estimating the states' coal and oil reserves. Aeromagnetic measurements assist in identifying resource deposits. Since resource deposits, once mapped, do not move and extraction is closely monitored, these types of measurements are done rarely.

of the effect may be different, the presence or absence of an effect should remain constant.

The third variable group representing magnetic fields is the C9 index. This index is a somewhat complicated transformation and summation of the isolated effects of the sun on the earth's magnetic field.[4] This variable is measured daily and must be averaged the same as the horizontal, declination, and vertical fields. The result is an average daily C9 index for each month from 1970 to 2008 and each year from 1960 to 2008. Another variable that used is the Ap index. The Ap index is a measure of magnetic activity. The higher the Ap Index the greater the magnetic activity.

6.2 Kentucky City Crime in 1978

Kentucky city crime data set uses the 1979 aeromagnetic map produced to assist in locating coal and natural gas deposits in the state. The aeromagnetic map produces a generalized measure of the geomagnetic field every 10 km in a grid pattern across the state. An algorithm developed from modeling correlations between the aeromagnetic measurements taken 1,000 Above Ground Level versus surface measurements smoothed the measurements, creating a "Contour-like" effect. The field strength in which the cities were located is the field measurement (in gauss units) for that city.

I found the crime counts using the Kentucky State Police annual publication, *Crime in Kentucky* (Police, 1978). I use the census population counts from 1980 as a proxy for the actual population of the cities in 1978. While some cultural and economic dynamics may have resulted in large shifts of population between 1978 and 1980 I found no obvious ones or ones that could cause such a social upheaval that the population change would invalidate inferences from models using the 1980s numbers. The crime rates for the counties are also available from the *Crime in Kentucky* publication for that year. Finally, poverty values are available from the Kentucky state government for the counties as well as from the 1980 census. I use the 1980 poverty numbers. The magnetic field value for the county is the average of the magnetic field Contour measurements crossing through the county. I attempted to weight the average based on percentage of the county covered by each magnetic field value. In addition, I used the average of the magnetic field strength within each county to determine the average magnetic field for urban areas versus the average for the county. Ultimately, I found no significant difference among the three geomagnetic averages. Further, in Kentucky in 1978, more

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[4] These measurements are taken at three-hour intervals at 13 different observatories all over the world. These measurements are summed across a 24 hour period at each observatory and the arithmetic mean is computed for the thirteen stations. Finally the measurements are transformed into an ordinal scale from 0 to 9. The final outcome is a scale of solar effect on the magnetic field ranging from 0 to 9. This conversion and transformation process is done and reported on the Space Physics Interactive Data Resource for almost every day from 1932 to 2004.

people living in a county were rural than were urban. Therefore, the final average I used was a straight average of all magnetic field values existing within a county.

6.2.1 Murders

Using magnetic fields to model violent crime allows modeling at each level of analysis, from city to nation. Looking at 30 cities in the state of Kentucky in 1978 demonstrates the ability of magnetic field to offer modeling power. The number of murders in the 1978 Kentucky city dataset ranges from 0 to 66 with the average number of murders being 4. The mode is 1 murder per city (12 out of 30 cities) representing 40% of all cases. Cities with no murders account for another 23% of cases. There were 125 murders in 1978 in Kentucky.

Rather than present the statistical output, Figure 23 shows simulation based on the sample generating the expected number of murders in an average size Kentucky city in 1978 given a magnetic field measurement. For an average-sized city, the increase in the count of murders from the lowest to the highest magnetic field measurement ranges from an increase in murders from 1 murder to 2 (100%) at the lower range of the confidence interval, or from less than 4 up to 8 murders using the upper bound (200%).

Figure 23 Simulated expected number of murders; average size city

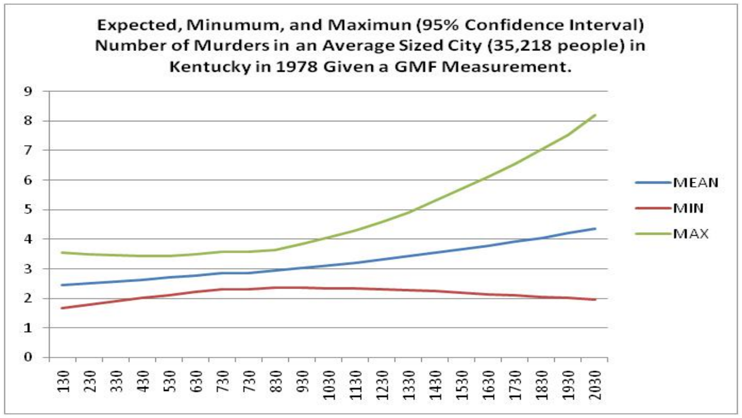


Figure 25 Simulated expected number of urban murders

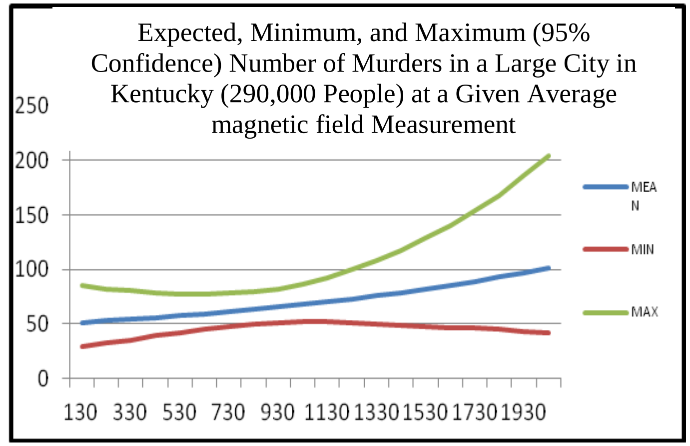


Figure 24 Simulated expected number of murders in a small city

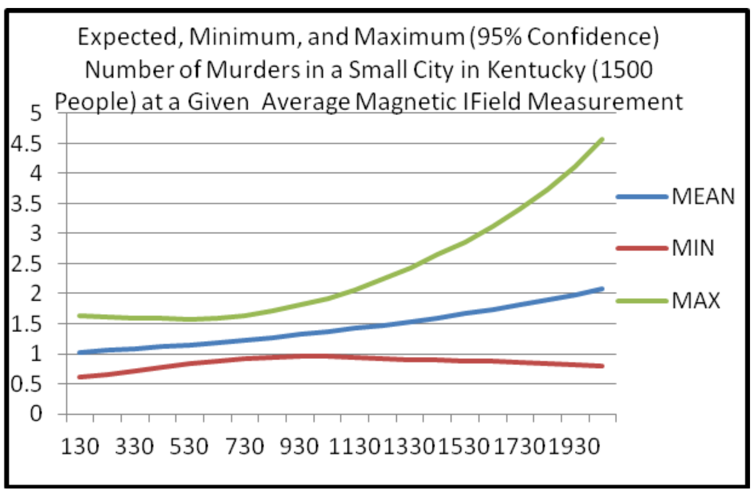
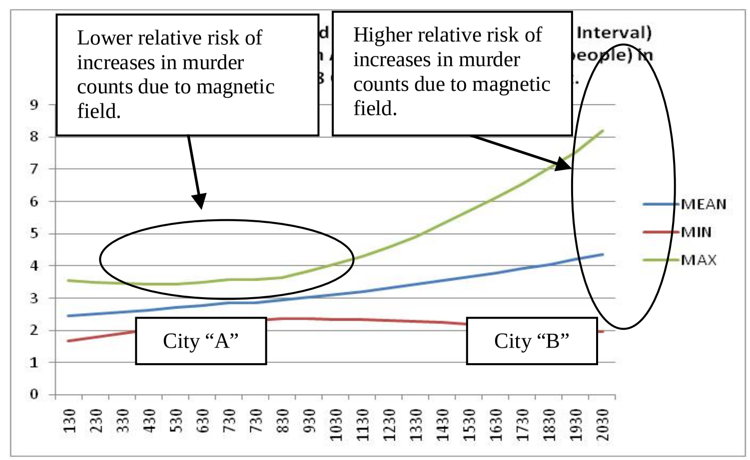


Figure 26 Simulated example of expected murders among Kentucky Cities, 1978



While we have greater information on communities experiencing lower field values and less for communities at higher field values, we are still confident that the affect of the geomagnetic field is not zero. There is little probability of getting these coefficients if there was actually no relationship between the crime counts and the magnetic field. Knowing the magnetic field that a city resides in may provide a great deal of information on how to divide limited resources.

The general methods of analyzing charts are to:

1. Compare the mean line among the magnetic field Fields to determine how changes in magnetic field affect the best prediction of the crime count.

2. Compare the Max and the Min lines. The Max line represents the upper bound of the 95% confidence interval. The Min line represents the lower bound of the 95% confidence interval.

Whether one is concerned about absolute count or percent increases and decreases, the models provide warnings and information that can frame decisions made relative to resource allocations, making those decisions more efficient. For instance two cities (all other things being equal) with the same population but with one experiencing magnetic field values towards the higher end of the measurements while the other is at the lower end, the one in the higher end has greater risk of experiencing more murders if the analyzed sample reflects the population. If additional resources are available and a political decision concerning the allocation of those resources made based on risk, then the city in the higher magnetic field measurement values should receive the resources. Figure 26 depicts this. In this example, City “B” should receive the additional resources (all other things being equal) if available because their magnetic fields field will result in more murders than City “A.”

6.2.2 Rapes

The model of murder counts in Kentucky cities in 1978 found that the magnetic field was not significant, although the best guess of the model is that the likelihood of this rare event increased along with geomagnetic levels. In the case of rape counts in Kentucky cities in 1978, the magnetic field measurement is statistically significant in the model. The Table 23 model includes a control variable for city population.

Table 23 Expected rape counts in Kentucky cities in 1978

	Rape Counts in Kentucky Cities in 1978	
	Poisson Model	
	Observations = 30	Pseudo R2 = .8619
Variables	Coefficient and Standard Deviation	Significance
City Population (1980) in 1,000s	**0.0154**	0.000 ***
	(0.0005)	
Average 1978 Magnetic Field Measure	**-.0009**	0.001 ***
	(0.0003)	
Constant	**1.529**	0.000 ***
	(0.1836)	

* P<.1 ** P<.05 *** P<.01

Looking at a sample simulated city with an "average" population (35,218 people) and affected by an "average" magnetic field (722 Gauss), all things equal, one would predict an average of 4 rapes. It is unlikely that the sample produces the expected values if there was no relationship.

Table 24 Simulated expected number of rapes

Estimated Rape Count	*Lower 95%*	*Upper 95%*	Population	Magnetic Field
4.068	3.377	4.893	MEAN	MEAN

An initial review may lead to the question of why higher magnetic field measurements would lead to more murders but fewer rapes. This pattern matches what we saw in the last chapter with regard to war being more likely, while militarized disputes if anything were less likely, at the highest geomagnetic levels. Therefore, it could be a dynamic of escalating violence. If the populations susceptible to committing rape and murder overlap, then higher magnetic fields may be escalating cases from the class of rape to the class of murders; reducing the numbers of rapes and moving them into the "murder" category. If that were true, we would expect the same pattern with Assault: A decline as the geomagnetic level increases. This does leave the question of where missing assaults and rapes went, given the number of rapes is small compared to assaults and murder counts are small compared to rapes.

6.2.3 Assault

Table 25 shows the general count model for assaults in Kentucky cities in 1978 controlling for their populations. When controlling for population, using the coefficient for the magnetic field of a city would yield valid predictions of assault counts in the model and would be the best measure of effect to use a significant proportion of the time.

Table 25 Expected assault counts in Kentucky cities in 1978

	Assault Counts in Kentucky Cities in 1978		
	Poisson Model		
	Observations = 30	Pseudo R2 = .6138	
Variables	Coefficient and Standard Deviation	Significance	
City Population (1980) in 1,000s	**0.01**	0.000	***
	(0.0002)		
Average 1978 Magnetic Field Measure	**-.0005**	0.000	***
	(0.0001)		
Constant	**4.423**	0.000	***
	(0.045)		

* P<.1 ** P<.05 *** P<.01

If one considers that murder, rape, and assault are all forms of violent crime, it may be useful to model the impact of magnetic fields on overall violent crime counts in

Kentucky cities in 1978. Combining all three crimes into one model may eliminate the problem of *escalation* that may occur under magnetic influence. Magnetic fields could drive what may have been at first only a simple assault, or rape, into the next level of violence.

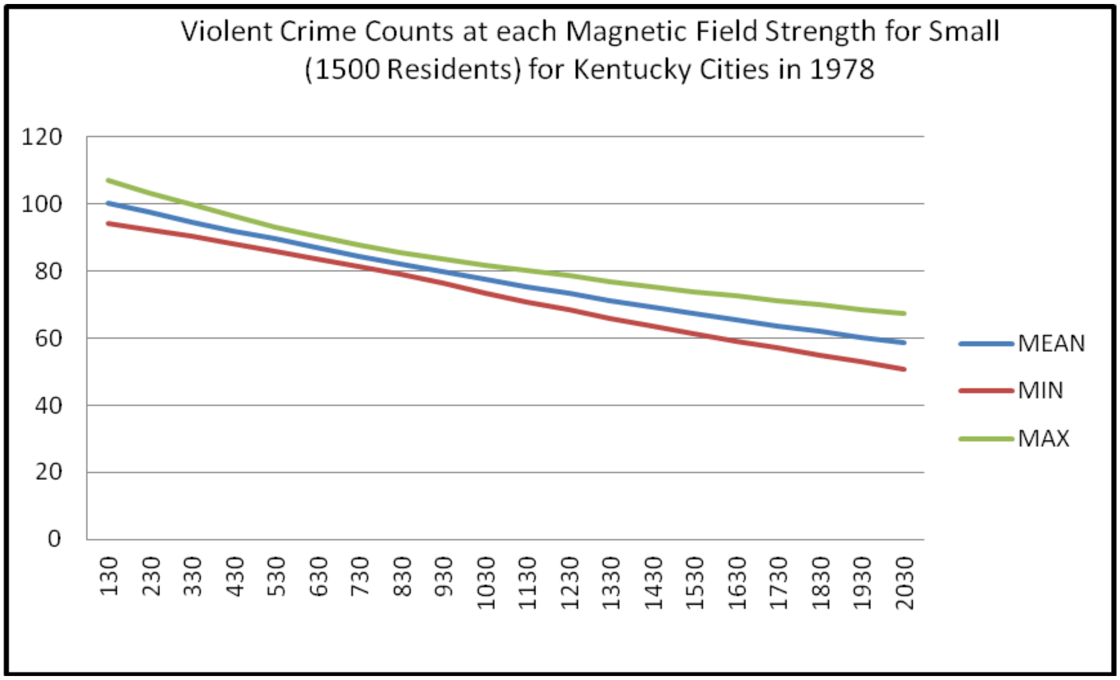
Table 26 shows that at least in cities in Kentucky in 1978, as the magnetic field value increase, the count of violent crimes decline. Further, the estimated value of the decline is the best estimate to use a significant amount of the time. Figure 27 depicts graphically a simulation based on the sample generating the impact of the different range of magnetic field values on a small city in Kentucky.

Table 26 Expected count of violent crimes in Kentucky cities in 1978

	Violent Crime Counts in Kentucky Cities in 1978	
	Poisson Model	
	Observations = 30	Pseudo R2 = .5346
Variables	Coefficient and Standard Deviation	Significance
City Population (1980) in 1,000s	**0.009**	0.000 ***
	0.0001	
Average 1978 Magnetic Field Measure	**-.0003**	0.000 ***
	0.0001	
Constant	**4.631**	0.000 ***
	0.005	

* P<.1 ** P<.05 *** P<.01

Figure 27 Simulated expected violent crime counts in small Kentucky cities in 1978



The pattern with Assault therefore matches that with Rape. Before accepting the escalation hypothesis, though, we should see if geomagnetics continue to perform in the same way with other data

6.2.4 Crime Counts in Kentucky Counties in 1978

One possible reason for the anomalous negative pattern with Rape and Assault is that I only used city data in the last analysis. Changing the level of analysis to the county should alleviate problems with how counties reported crime. County-level data also will allow the inclusion of new explanatory variables whose data was unavailable for the cities, moving us toward a more fully specified model. Because a third problem with the city analysis was that we were unable to include the other motivation and opportunity variables that Cantor and Land assert are important. We also can include some of the structural variables that the literature has identified as influencing motivation and opportunity. These variables include spending on police, education, welfare, and the number of people living below the poverty line.

Table 27 Expected murder counts in Kentucky cities in 1978

Variables	Murder Counts in Kentucky Counties in 1978 Poisson Model Observations = 119 Coef & Std Dev	Pseudo R2 = .6064 Significance
County Population (1980) in 1,000s	**0.0042** *(0.0003)*	0.000 ***
Average 1978 Magnetic Field Measure	**.0004** *(0.0001)*	0.000 ***
Percent Population Living Below Poverty 1978	**-.0997** *(0.1519)*	0.000 ***
Per Capita Spending on Police	**.0004** *(0.0019)*	0.822 -
Per Capita Spending on Education	**-.0014** *(0.0014)*	0.311 -
Per Capita Welfare Spending	**.0013** *(0.0169)*	0.940 -
County Unemployment Rate in 1978	**.0988** *(0.0331)*	0.003 ***
County Per Capita Personal Income	**.0004** *(0.0001)*	0.000 ***
Constant	**-1.854** *(0.597)*	0.002 ***

* P<.1 ** P<.05 *** P<.01

Table 27 shows the opportunity and motivation model for murder counts with the magnetic field included. The predictive model performs well. The socioeconomic and spending variables are a bit unruly, relative to how one might have expected them to behave as controls, but now the geomagnetic variable has a positive and significant value, as expected.

For rapes, both attempted and successful, the structural opportunity and motivation variables do much better than in the case of murder as far as the significance of their coefficients are concerned. The percent of the population living below the poverty line, the amount of money per capita spent on police, the per capita expenditure on education, unemployment rate, and per capita income are significant. However, the geomagnetic variable again fails to predict a significant increase in this behavior. Table 28 shows the statistical model for rape counts.

Table 28 Expected annual rape counts in Kentucky counties in 1978

	Rape Counts in Kentucky Counties in 1978	
	Poisson Model	
	Observations = 119	Pseudo R2 = .7963
Variables	Coefficient and Standard Deviation	Significance
County Population (1980) in 1,000s	**0.0034**	0.000 ***
	(0.0003)	
Average 1978 Magnetic Field Measure	**.0001**	0.005 ***
	(0.0002)	
Percent Population Living Below Poverty 1978	**-1.9203**	0.000 ***
	(0.3282)	
Per Capita Spending on Police	**.0180**	0.000 ***
	(0.0025)	
Per Capita Spending on Education	**-.0074**	0.000 ***
	(0.0014)	

Table 28 Continued			
Per Capita Welfare Spending	**.0062**	0.680	-
	(0.0151)		
County Unemployment Rate in 1978	**.1581**	0.000	***
	(0.0330)		
County Per Capita Personal Income	**.0004**	0.000	***
	(0.0001)		
Constant	**-.1758**	0.762	-
	(0.5805)		

* P<.1 ** P<.05 *** P<.01

All motivation and opportunity variables help explain Assault counts. In this case, all of them have expected impacts on assault counts that cannot be ignored, and the coefficients are unlikely greater than zero by chance. One again, however, the estimated effect of geomagnetic field is not statistically significant in the hypothesized direction.

Table 29 Expects annual counts of assaults in Kentucky counties 1978

	Assault Counts in Kentucky Counties in 1978	
	Poisson Model	
	Observations = 119	Pseudo R2 = .7496
Variables	Coef & Std Dev	Significance
County Population (1980) in 1,000s	**0.0010**	0.000 ***
	(0.0001)	
Average 1978 Magnetic Field Measure	**.0001**	0.000 ***
	(0.0001)	
Percent Population Living Below Poverty 1978	**-2.1511**	0.000 ***
	(0.0774)	
Per Capita Spending on Police	**.0186**	0.000 ***
	(0.0005)	
Per Capita Spending on Education	**-.0039**	0.000 ***
	(0.0034)	
Per Capita Welfare Spending	**.0284**	0.000 ***
	(0.0030)	
County Unemployment Rate in 1978	**.1562**	0.000 ***
	(0.0079)	
County Per Capita Personal Income	**.0004**	0.000 ***
	(0.0001)	
Constant	**1.529**	0.000 ***
	(0.139)	

* P<.1 ** P<.05 *** P<.01

6.3 Magnetic Fields and Murder

Despite the limited size of the coefficients on geomagnetic waves, however, they results are still substantively meaningful given the potential variation in those variables. The following charts, Figures 27 through 29, show the outcome of simulations based on statistical analysis of the sample. The effects on Murder of the geomagnetic field at varying strengths in small, average, and large counties on a range of crimes. I generate the figures by charting the results of first running the data in a Poisson count model and then simulating the expected outcomes for differing measures of the magnetic field using Clarify (King, Tomz, & Wittenberg, 2000) (Tomz, Wittenberg, & King, 2001). In each case, we keep all other explanatory variables at their average value for the dataset, although we are extrapolating out to high geomagnetic levels. The MEAN value on the chart, the “blue” line, provides the average predicted count of crimes given the magnetic field. The other lines represent the minimum and maximum bounds of the 95% confidence interval.

This model shows that, given information about the magnetic field environment of different size counties, policy makers could use it in resource-allocation decisions that might make responding to murders more efficient and maybe even more effective. Magnetic fields have an important relationship with violent crime counts in Kentucky counties in 1978, astonishing given the small amount of data. While the sample is relatively small, one year and only 119 counties in only one state, the models show that geomagnetic fields have significant explanatory and even predictive power.

Figure 28 Simulated expected murder counts; Kentucky counties

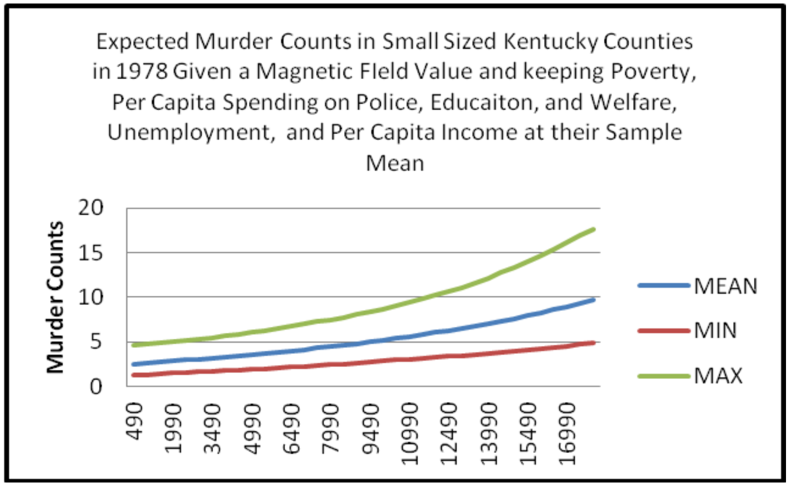


Figure 29 Simulated expected murder counts; Kentucky counties

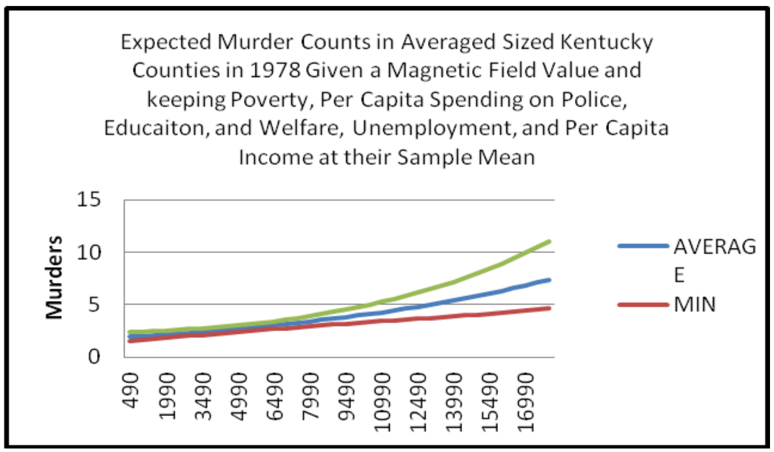
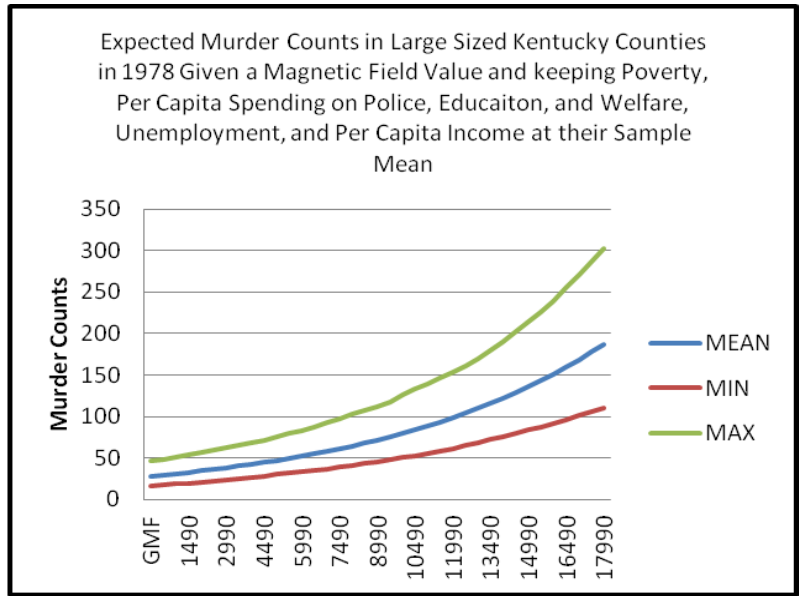


Figure 30 Simulated expected murder counts; Kentucky counties



6.4 Crime Counts in Kentucky from 1970 to 2005

The key points to be made with this analysis is that magnetic field influences decisions of individuals and groups, that magnetic field as a variable in models has strong explanatory and predictive power while being efficient in cost to collect, so it can be a critical tool in assisting in resource decisions at all levels of politics and government. Now to see if the analysis extends to the state level and if it remains powerful in explaining and predicting or modeling other types of crimes.

The first dependent variable is the Kentucky Criminal Index, which is a summation of all crime type counts and represents the “amount” of crime that the state experiences, and has data available for 36 years. This model, as well as the ones that follow it, include the state population and the opportunity and motivation variables of unemployment rate and per capita income. Because direct magnetic field ground measures become so complicated at the state level, and because the main source of interesting variation now comes across time rather than across space, the Ap Score will substitute for the magnetic field measure used at the state and county level.

This first model from the modern period supports the hypothesis that geomagnetic levels help predict crime. The Ap Score (magnetic field measurement) is significant and the directions of the opportunity and motivation variables are as predicted by the Cantor and Land hypotheses.

Table 30 Expected total crime counts in Kentucky

	Magnetic Field Effect on the Kentucky Total Crime Counts 1970-2005 (Poisson Model)	
	Observations = 36	Pseudo R2 = .5967
Variables	Coefficient and Standard Deviation	Significance
Kentucky Population in 1,000s	**0.0004**	0.000 ***
	(0.0001)	
Average Magnetic Field Measure	**.0009**	0.000 ***
	(0.0002)	
State Per Capita Income (1,000s)	**-.0019**	0.000 ***
	(0.0004)	
State Unemployment Rate	**.0292**	0.000 ***
	(0.0005)	
Constant	**9.9220**	0.000 ***
	(0.0397)	

* P<.1 ** P<.05 *** P<.01

Figure 31 Simulated expected total recorded crimes in Kentucky

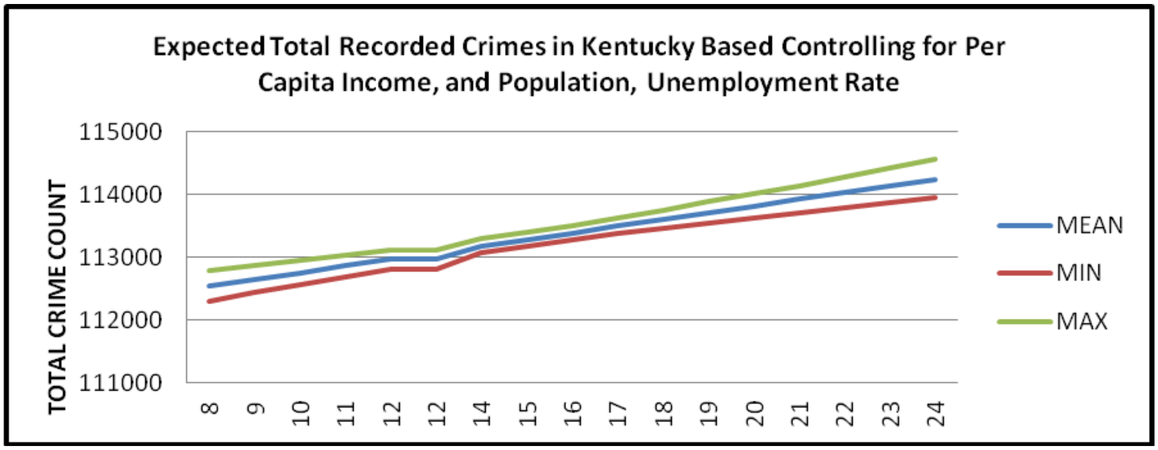


Figure 31 shows the relatively strong relationship between Ap scores and the estimated crime index in the simulation of that statistical analysis of the sample. In this model, on average, a one-unit increase in the Ap score yields about a 100-unit increase in the Crime Index.

6.4.1 Violent Crime

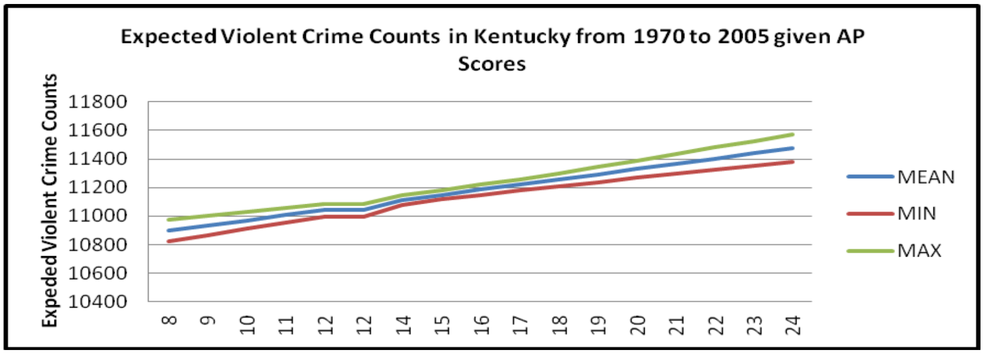
If we look at only violent crime in the index, and use as the dependent variable the count of violent crime in the state, the model and the graph of the effect of Ap Score looks like Table 31 and Figure 32.

Table 31 Expected violent crime counts in Kentucky

	Magnetic Field Effect on the Kentucky Violent Crime Count 1970-2005 (Poisson)	
	Observations = 36	Pseudo R2 = 0.5523
Variables	Coefficient and Standard Deviation	Significance
Kentucky Population in 1,000s	**0.0028**	0.000 ***
	(0.0001)	
Average Magnetic Field Measure	**.0032**	0.000 ***
	(0.0005)	
State Per Capita Income (1,000s)	**.0001**	0.000 ***
	(0.0001)	
State Unemployment Rate	**.1227**	0.000 ***
	(0.0015)	
Constant	**17.227**	0.000 ***
	(0.124)	

* P<.1 ** P<.05 *** P<.01

Figure 32 Simulated expected violent crime counts in Kentucky



In this simulation a one-unit, increase in the Ap Index results in an increase of violent crime counts by about 50. The 95% confidence interval has a distance that ranges from 50 to 200 violent crime counts. It is unlikely that the statistical analysis would generate coefficients or the 95% confidence interval if the actual relationship was zero. I also analyzed separate components of this violent-crime rate one at a time: Murder, Rape, and Assault (analysis not shown). In all three cases, the rate of violent crime increased as the Ap Index climbed. For Rape and Assault, the pattern was statistically significant.

6.4.2 Property Crime

Up to this point the primary emphasis of analysis has been on violent crimes such as murder, rape, and assault. Property crime also fits the expectations of my hypothesis that high levels of geomagnetic field scores will lead to higher crime rates, because they too bring the dangers of arrest and serious penalties. Below, a model of property crime using the Ap Score, with controls for the motivation and opportunity models, shows that magnetic field is also a useful variable for analyzing property crime risk and counts.

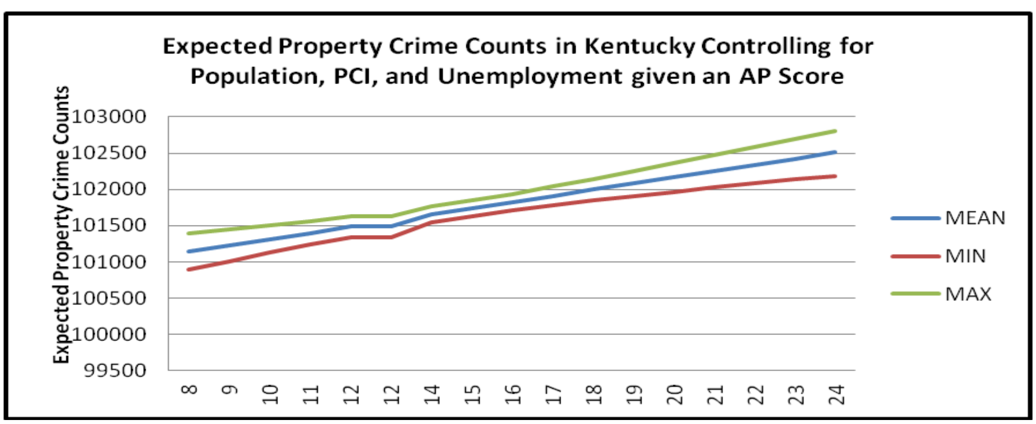
For the annual period of analysis for the state of Kentucky, the Ap index is significant in property crime models. Table 32 and Figure 33 (Simulated Expectations) show that the magnetic field effect on the count of property crimes is such that it should enter into decision-making and policy-making processes. The chart of the effect of Ap on property crimes, setting all the other model's variables to their average and depicting the 95% confidence interval, show the power of the index on indicating the risk of increases or the benefit of decreases in the counts of property crime.

Table 32 Expected count of property crimes in Kentucky

Variables	Magnetic Field Effect on the Kentucky Property Crime Counts 1970-2005 (Poisson Model)	
	Observations = 36	Pseudo R2 = .5756
	Coef & Std Dev	Significance
Kentucky Population in 1,000s	**0.0008**	0.000 ***
	(0.0001)	
Average Magnetic Field Measure	**.0008**	0.000 ***
	(0.0002)	
State Per Capita Income (1,000s)	**-.0157**	0.000 ***
	(0.0005)	
State Unemployment Rate	**.0182**	0.000 ***
	(0.0005)	
Constant	**8.716**	0.000 ***
	(0.0002)	

* P<.1 ** P<.05 *** P<.01

Figure 33 Simulated expected property crime counts in Kentucky, 1970 to 2005



The expected change in the number of property crimes when population, per capita income, and unemployment are set to their means and the AP Score increases one unit is approximately 200 counts. The simulation's total average impact of the AP Score moving from 8 to 24 is 1,300 property crimes. The maximum total predicted impact of the AP score moving from 8 to 24 in the simulation is approximately 1,800 counts of property crime.

6.4.3 Burglary

Burglary may not be as interesting as other violent crimes, but the sheer number, emotional and mental strain on victims, and the amount of resources committed to the problem of burglary is such that it is deserving of analysis. The Ap index is significant in the model that included unemployment, per capita income, and population. The magnetic field is positive and significant at the .01 level, as shown in Table 33.

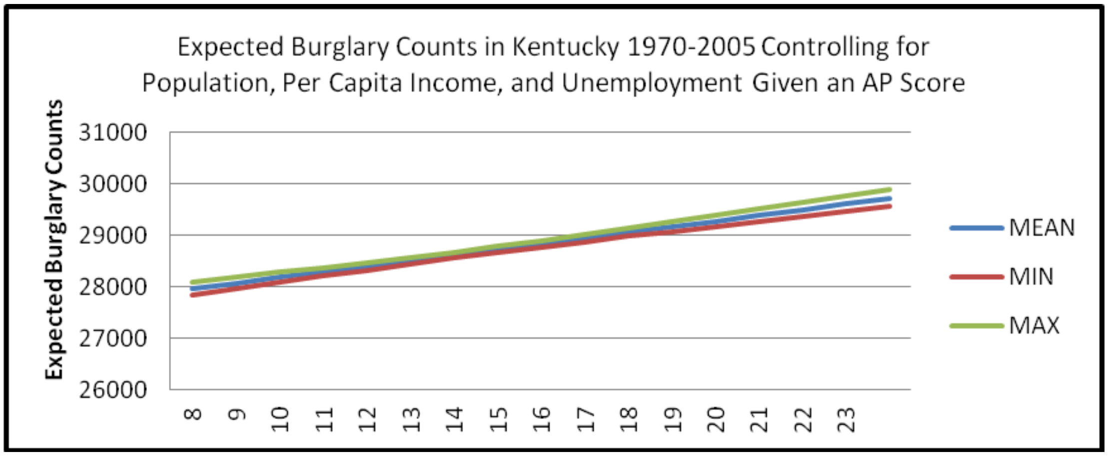
Keeping the population, unemployment, and per capita income at their average and looking how changes in Ap Score effects burglary counts provides yet more evidence that geomagnetic field variables have an important role to play in modeling, predicting, and mitigating burglary counts. The amount of change in burglary counts in the simulation as one goes from the lowest to the highest Ap scores for the data set is between 1,500 and 2,000 burglary counts. This represents about a 7% increase from lowest to highest Ap value.

Policy makers get unprecedented precision information from this model. Someone trying to determine where to put resources addressing burglary or when to commit it can look at the Ap index projected and make projections as to where will experience more or fewer burglaries based on the Ap. In the simulation, two towns with similar population, unemployment, and wealth but separated by 6 units on the Ap scale will experience a difference of between 850 and 1,150 burglaries.

Table 33 Expected burglary counts in Kentucky

Variables	Magnetic Field Effect on the Kentucky Burglary Counts 1970-2005 (Poisson Model)	
	Observations = 36	Pseudo R2 = 0.6530
	Coefficient and Standard Deviation	Significance
Kentucky Population in 1,000s	**0.0013** *(0.0003)*	0.000 ***
Average Magnetic Field Measure	**0.0038** *(0.0009)*	0.006 ***
State Per Capita Income (1,000s)	**-0.0466** *(0.0008)*	0.000 ***
State Unemployment Rate	**0.0140** *(0.0003)*	0.000 ***
Constant	**5.909** *(0.078)*	0.000 ***

Figure 34 Simulated expected burglary counts in Kentucky, 1970-2005



6.4.4 Larceny

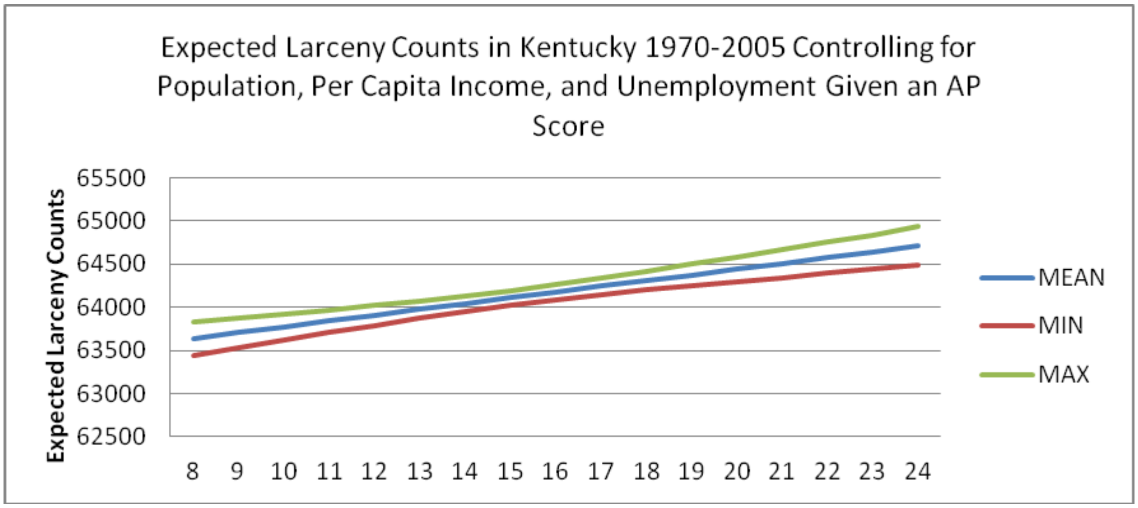
The same conditions and outcomes found when looking at the Ap index for Burglary holds for analysis of larceny. Ap is significant and the graphs of the effects show that the span of the distance between the lower 95% and upper 95% confidence interval is relatively small. Table 34 and Figure 35 (simulation) show the relationship between larceny counts and the magnetic field.

Table 34 Expected counts of larceny in Kentucky

	Magnetic Field Effect on the Kentucky Larceny Counts 1970-2005 (Poisson Model)	
	Observations = 36	Pseudo R2 = .6500
Variables	Coefficient and Standard Deviation	Significance
Kentucky Population in 1,000s	**0.0007**	0.000 ***
	(0.0002)	
Average Magnetic Field Measure	**0.0010**	0.000 ***
	(0.0002)	
State Per Capita Income (1,000s)	**-0.0057**	0.000 ***
	(0.0006)	
State Unemployment Rate	**0.0248**	0.000 ***
	(0.0006)	
Constant	**8.357**	0.000 ***
	(0.053)	

* P<.1 ** P<.05 *** P<.01

Figure 35 Simulated expected larceny counts in Kentucky, 1970 to 2005



6.4.5 Vehicle Theft

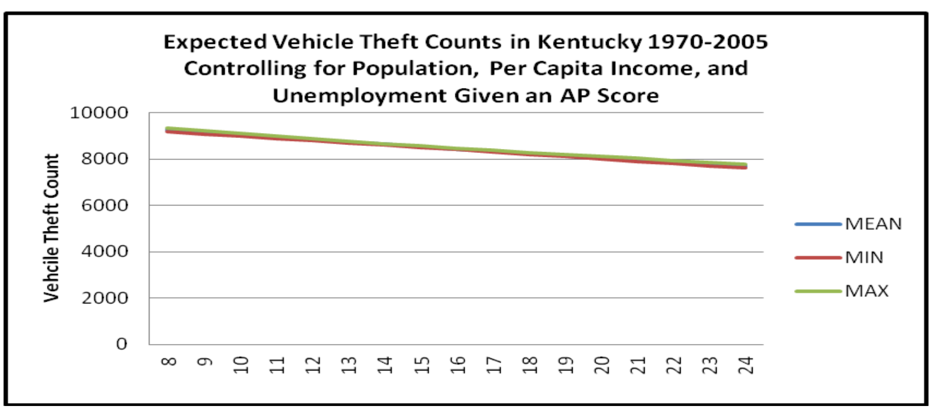
The magnetic field model of vehicle theft has a high level of confidence in the coefficient of effect for the Ap index. It is unlikely that the value of the magnetic field is zero. Ap is significant at better than .01 and indicate a negative relationship to the dependent variable. Again, the apparent decline in vehicle theft covaries with magnetic field influence. It could be that vehicle thefts become much more violent as Ap increases thereby falling into progressively higher violence categories of crime. Figure 36 shows the simulated expected number of vehicle thefts because of the magnetic field based on the sample.

Table 35 Expected vehicle theft counts in Kentucky

Variables	Coefficient and Standard Deviation	Significance	
	Magnetic Field Effect on the Kentucky Vehicle Theft Counts 1970-2005 (Poisson Model)		
	Observations = 36	Pseudo R2 = 0.3102	
Kentucky Population in 1,000s	**0.0005**	0.000	***
	(0.0005)		
Average Magnetic Field Measure	**-0.0115**	0.000	***
	(0.0005)		
State Per Capita Income (1,000s)	**0.0156**	0.000	***
	(0.002)		
State Unemployment Rate	**-0.0112**	0.000	***
	(0.0017)		
Constant	**10.892**	0.000	***
	(0.140)		

* P<.1 ** P<.05 *** P<.01

Figure 36 Simulated expected vehicle thefts in Kentucky, 1970 to 2005



6.5 Ground Magnetic Field and Crime in Kentucky

The Kentucky city and county analysis discussed earlier in this chapter demonstrated the power of a geomagnetic field variable at near ground level. The variable used was the Total-Field effect measured in Gauss. The statewide analysis used the measures of Solar Magnetic activity as an estimate for its effect on the ground level magnetic field. The next set of analysis breaks the total-geomagnetic measures down into some key component parts to determine which component may affect "rational decision making," deviant behavior, and risk taking.

A concern is that the component measures for Kentucky are not available as there are no detailed component measurement stations in the state. However, the city of Fredericksburg, Maryland, does have a detailed measuring station with some data for the period analyzed (25 out of 39 years). This is less of an issue for the index count as it uses a proxy (magnetic field component measures in Fredericksburg for the magnetic field Components in Kentucky) to explain an aggregate containing information on many different categories, and even classes, of crime counts. While one would be wise to take care when using the models to *predict,* they do offer tantalizing glimpses into the power of magnetic field Components as independent variables, when the data is available.

The opportunity and motivation model should support the model for general theft. However, the sign of the unemployment variable is opposite that expected, according to the Cantor and Land *et. al*. opportunity-motivation models. The expected sign is positive while it is actually negative in the model. The expectation is that as unemployment increases so, too, does the expected count of thefts in the period of analysis. However, the model shows a decline in cases of theft as unemployment increases. This could be capturing an interesting dynamic in deviancy. Much crime occurs locally and many criminals perpetrate crimes against those of a similar cultural and social group to themselves.

Transportation, risk, comfort, knowledge, focus, and orientation of security forces all argue against targeting groups outside one's "territory" and "cultural reference structure." Increased unemployment in communities decreases the available loot for thieves to target. This could lead to a decline in theft simply because there are fewer things to steal. For the graphical look at the impact on theft counts, two different charts are required.

Figure 37 Simulated expected thefts in Kentucky, 1970 to 2008

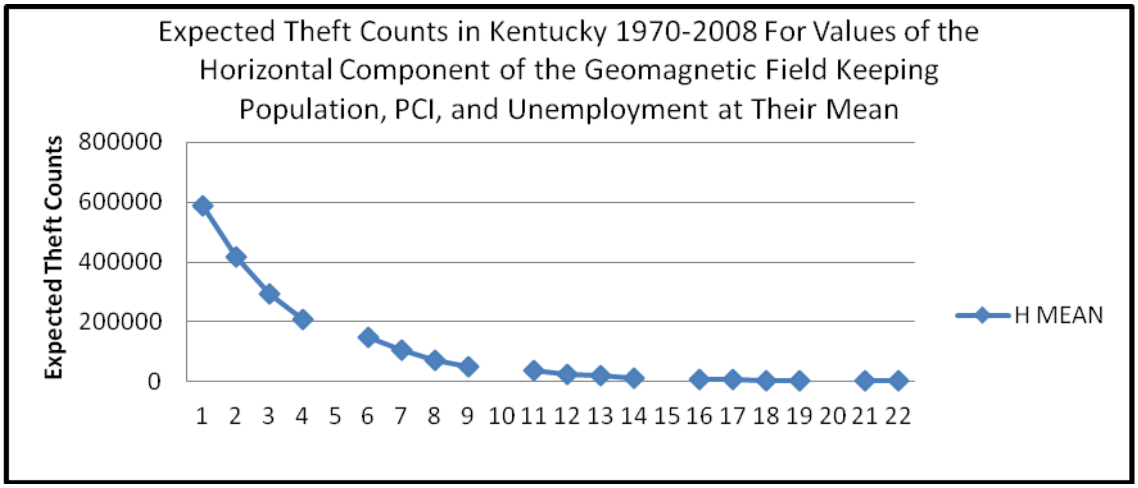
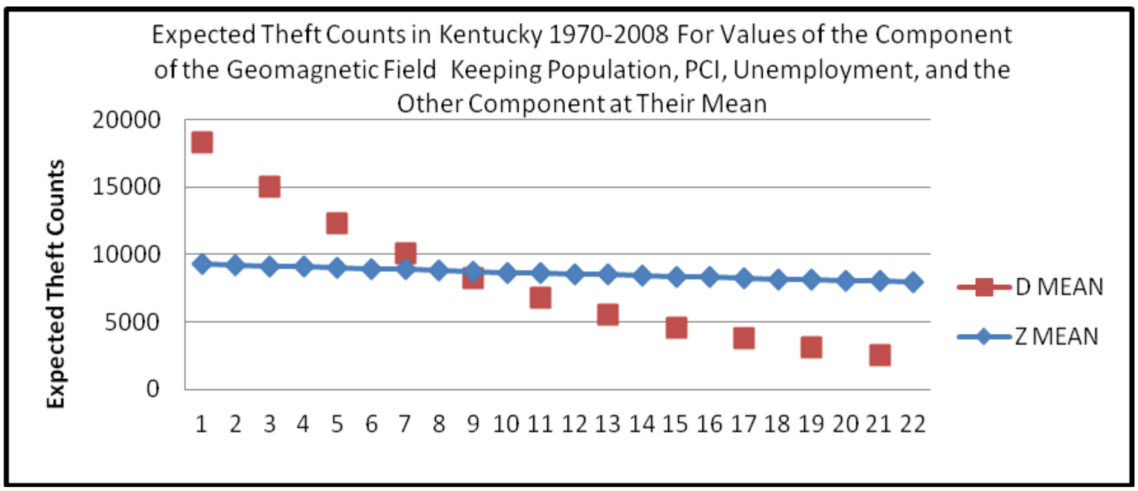


Figure 38 Simulated expected thefts in Kentucky, 1970 to 2008



Using three of the components of magnetic field in modeling different categories of crime counts proves that almost all cases are significant at least at the .05 level. In many models, the addition of magnetic field components or magnetic field made either or both motivation (per capita income) and opportunity (unemployment) insignificant at below the .1 level. The effect of magnetic field and/or its component covarys so that small changes in magnetic fields correlate with large changes in crime counts.

6.6 State Crime and Geomagnetic Fields

I have demonstrated that magnetic field measures have value in modeling crime at the city and county level in one state, Kentucky. They also have value in predicting crime in the state of Kentucky. Now we can look across states, and with an expanded time, to see if magnetic field remains a valid, and significant, independent variable to model crime counts. The expanded data set allows the use of additional control variables. The basic data set includes information for Alaska, Arizona, California, Colorado, Hawaii, Maryland, Mississippi, Texas, and Wisconsin. The data generally covers the period of 1960 to 2008. While some states may have data that is earlier and later, the majority of the data comes from this period. Two different data sets are produced and analyzed, one looking at annual data and a second looking at monthly data.

Data is available to include information related to the number of sworn full time officers available in the year at the federal, state, and local level as well as per capita spending on justice, police, judicial system, and corrections. However, a serious multicollinearity problem exists among the officers available at the different levels and the population of the state.

Table 36 Correlations among the number of sworn full time officers and populations

Correlation Among The Number of Sworn Offers

Variables	Local Sworn Officers	State Sworn Officers	Federal Sworn Officers	Population
Local Sworn Officers	1			
State Sworn Officers	0.9037	1		
Federal Sworn Officers	0.999	0.9216	1	
Population	0.9936	0.9326	0.9962	1

There is no such problem among the different per capita spending on law enforcement, legal system, and correctional systems and the population. However, there are, as could be expected, correlations among the three; law, legal, corrections that may cause problems. There is also a danger of a multicollinearity issue among these three measures and the per capita income of the state.

It is difficult to determine the relationship between the levels of crime, the size of a population, and the number of officers and amount of money spent on security. The theoretical problem is what comes first, high crime rates or a police force dictated by a population? This problem is more acute and troublesome for the counts of officers than the amount spent on them as well as the legal and correctional system. A polity may spend on a fixed ratio of police to population, especially in the absence of any other information to determine proper police force size (count). However, no polity would willingly spend resources on maintaining a large legal and correctional system in the absence of a clear requirement to do so. Therefore, it is more reasonable to argue for the inclusion of expenditures on these programs than it is to argue for the inclusion of counts of law enforcement officers or the money spent on them.

Table 37 Correlations among select independent variables of crime models

	Correlations Among Per Capita Security Spending					
Variables	Per Capita Spending On Justice	Per Capita Spending on Police	Per Capita Spending on Courts	Per Capita Spending on Corrections	Population	Per Capita Income
Per Capita Spending On Justice	1					
Per Capita Spending on Police	0.9757	1				
Per Capita Spending on Courts	0.9286	0.8648	1			
Per Capita Spending on Corrections	0.9604	0.9249	0.815	1		
Population	0.0965	0.1214	-0.0371	0.1738	1	
Per Capita Income	0.8316	0.8382	0.754	0.7881	0.1857	1

The value of including these variables is problematic, however as they really contribute very little to the improvement in model power, precision of estimates, or the effect that magnetic field components have on the crime counts being analyzed.

Table 38 Expected annual state murder counts

Magnetic Field Effect on State Murder Counts 1960-2008 (Poisson Model)

Observations = 115 Pseudo R2 = .9681

Variables	Coefficient and Standard Deviation	Significance	
D Component in 1,000s	**-0.0199** *(0.0047)*	0.000	***
H Component in 1,000s	**0.002** *(0.0006)*	0.003	***
State Unemployment Rate	**.0001** *(0.0001)*	0.507	-
State Per Capita Income (Squared)	**-0.076** *(0.0029)*	0.000	***
Number of State Sworn Full-Time Law Enforcement (100s)	**-0.0282** *(0.0008)*	0.000	***
Number of Local Full-Time Sworn Law Enforcement (100s)	**-0.0075** *(0.0003)*	0.000	***
Per Capita Spending on Police	**0.0010** *(0.0004)*	0.004	***
Per Capita Spending on Judiciary	**-0.0081** *(0.0004)*	0.000	***

Table 38 Continued			
Per Capita Spending on Corrections	**0.0024**	0.000	***
	(0.0002)		
Population in 1,000s	**0.0003**	0.000	***
	(0.0001)		
Constant	**7.159**	0.000	***
	(0.0548)		

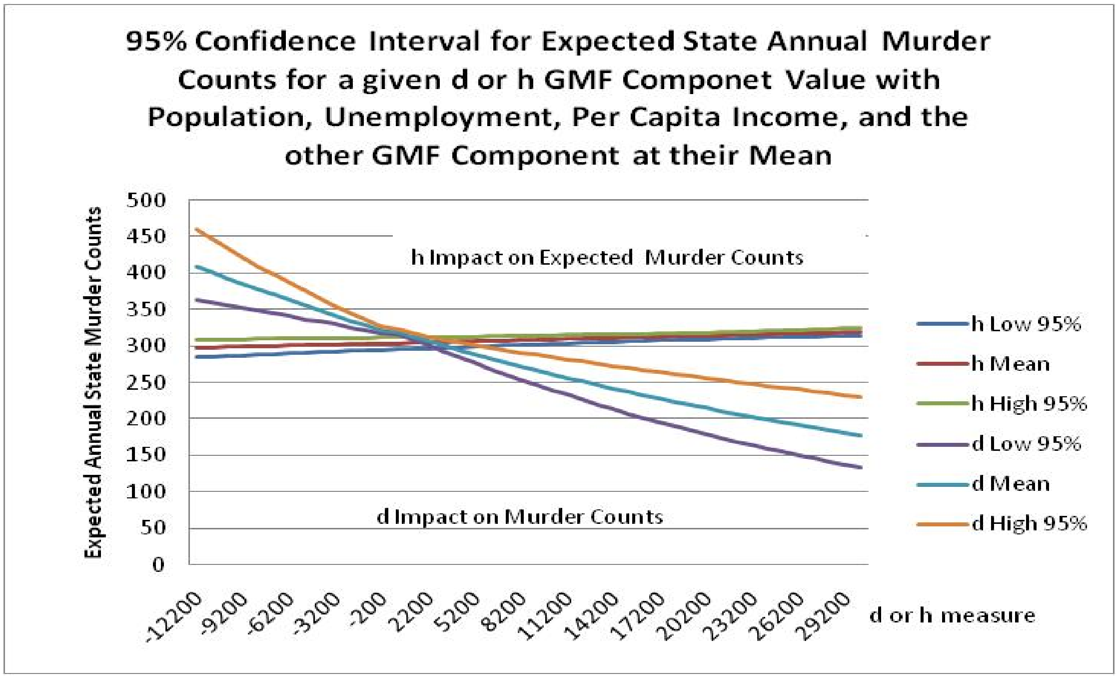
* P<.1 ** P<.05 *** P<.01

Graphing the impact on murder counts of the h and d components of the geomagnetic fields, while keeping the other independent variables set to their means, yields the following chart. The lines represent the average, highest, and lowest estimates defined by the 95% confidence interval for annual state murder counts when all but the specific magnetic field component is set its average value and the specific magnetic field component of interest changes.

Table 39 Summary statistics of the independent variables in the model of annual state murder counts with magnetic field components

Variable of Interest	Obs	Mean	Std. Dev.	Min	Max
Murder	490	542.2224	804.9552	11	4096
D Component	373	3406.796	5947.054	-12215	16907.16
H Component	349	22797.82	5705.324	2564.311	29252.04
Unemployment	299	249525.6	321428.6	12564	1605757
Per Capita Income	273	27064.76	7087.538	10947	41580
Number of State Full Time Sworn Officers	240	1403.658	1823.348	0	7924
Number of Local Full Time Sworn Officers	240	13792.22	16105.01	609	59402
Per Capita Spending on Police	220	153.9955	64.56185	41	412
Per Capita Spending on Judiciary	220	82.18636	53.28682	12	290
Per Capita Spending on Corrections	220	125.5955	67.07847	18	299
Population	490	6636297	8136127	226167	36800000

Figure 39 Simulated expected annual state murder counts



The same type of analysis applied to the entire spectrum of crime demonstrates how the components affect estimates.

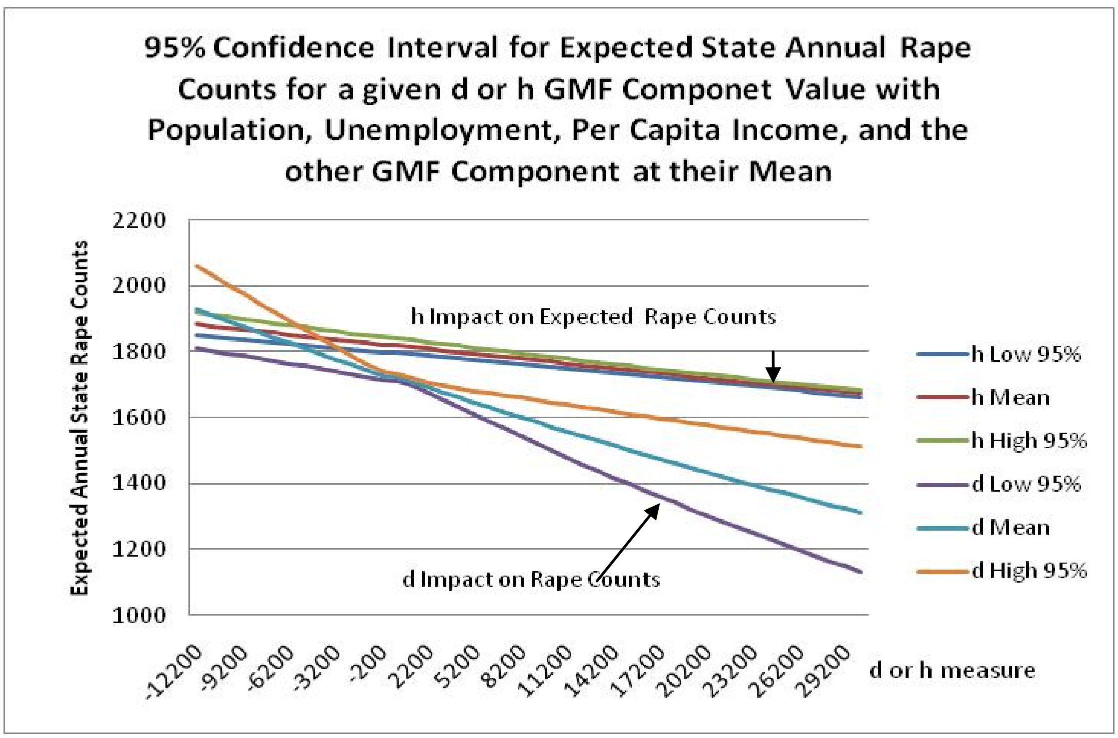
Table 40 Magnetic field effect on state rape counts

	Magnetic Field Effect on State Rape Counts 1960-2008 (Poisson Model)	
	Observations = 115	Pseudo R2 = 0.9660
Variables	Coefficient and Standard Deviation	Significance
D Component in 1,000s	**-0.0092**	0.000 ***
	0.0024	
H Component in 1,000s	**-0.0028**	0.000 ***
	0.0003	
State Unemployment Rate	**-0.0001**	0.000 ***
	0.0001	
State Per Capita Income (Squared)	**-0.0006**	0.560 -
	0.0010	
Number of State Sworn Full-Time Law Enforcement (100s)	**-0.0242**	0.000 ***
	0.0042	
Number of Local Full-Time Sworn Law Enforcement (100s)	**-0.0043**	0.468 -
	0.0002	
Per Capita Spending on Police	**-.0013**	0.000 ***
	0.0002	
Per Capita Spending on Judiciary	**-0.0086**	0.000 ***
	0.0001	

Table 40 Continued			
Per Capita Spending on Corrections	**0.0025** *0.0001*	0.000	***
Population in 1,000s	**0.0002** *0.0001*	0.000	***
Constant	**7.32** *0.024*	0.000	***

* P<.1 ** P<.05 *** P<.01

Figure 40 Simulated expected annual state count of rapes



6.6.1 Assaults

The previous charts depict the relationship of d and h components of the magnetic field on various crime counts. These variables are statistically significant at the .001 level in each of the statistical analysis. Further, d shows a consistent non-linear downward influence on crime counts as its value increases. The h component demonstrates an incremental downward linear influence on the value of crime counts as its value increases.

Table 41 Expected annual state counts of assaults

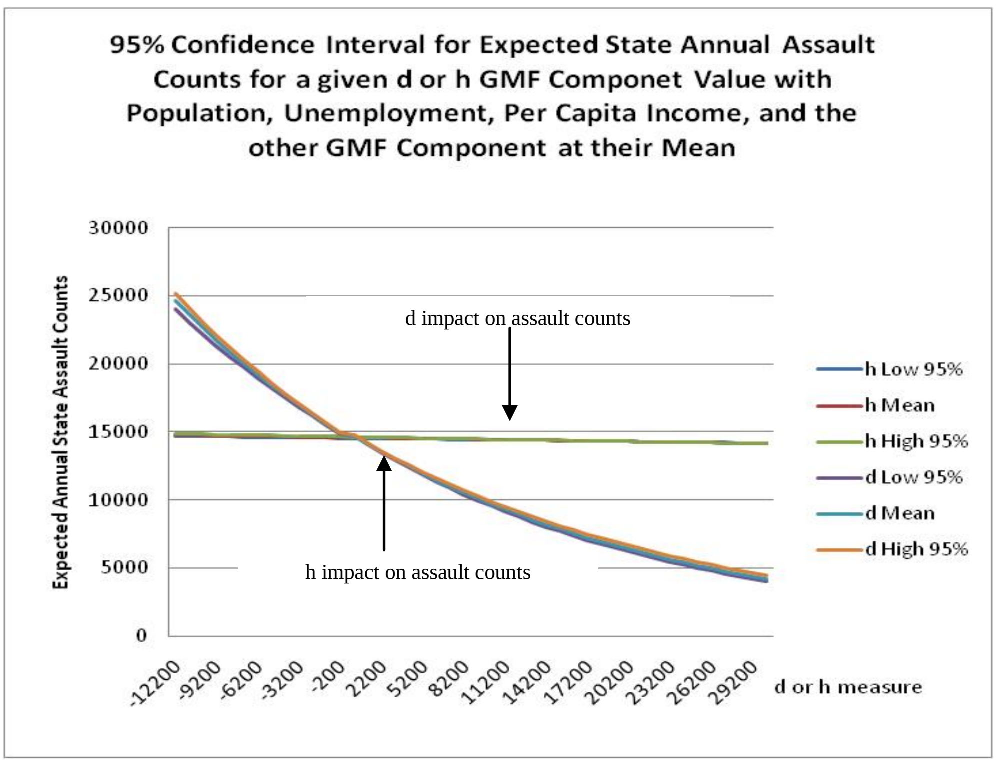
Magnetic Field Effect on State Assault Counts 1960-2008 (Poisson Model)

	Observations = 115	Pseudo R2 = .9684
Variables	Coefficient and Standard Deviation	Significance
D Component in 1,000s	**-0.0415** *(0.0009)*	0.000 ***
H Component in 1,000s	**-0.0010** *(0.0001)*	0.000 ***
State Unemployment Rate	**-0.0001** *(0.0001)*	0.000 ***
State Per Capita Income (Squared)	**-0.0457** *(0.0001)*	0.000 ***
Number of State Sworn Full-Time Law Enforcement (100s)	**-0.0107** *(0.0001)*	0.000 ***
Number of Local Full-Time Sworn Law Enforcement (100s)	**-0.0042** *(0.0001)*	0.000 ***
Per Capita Spending on Police	**0.0009** *(0.0001)*	0.000 ***
Per Capita Spending on Judiciary	**-0.0097** *(0.0001)*	0.000 ***

Table 41 Continued			
Per Capita Spending on Corrections	**0.0061**	0.000	***
	(0.0001)		
Population in 1,000s	**0.0002**	0.000	***
	(0.0001)		
Constant	**9.964**	0.000	***
	(0.0084)		

* P<.1 ** P<.05 *** P<.01

Figure 41 Simulated expected annual state counts of assaults



6.6.2 Victims by age

If these components can prove statistically significant as well as useful in modeling crime counts perhaps they have use modeling the demographic characteristics of the victims of the most violent of crimes; murder. Whereas the previous analysis looked at the impact of magnetic field components on the perpetrator of a crime this analysis looks at the impact of magnetic field on either the choice of a victim or of the tendency of members of a group to be victims. The age models and estimates presented in this section provide a sample of the significant relations that exist among the magnetic field, its components, and the age of victims. The findings indicate that the D component of the magnetic field and the number of homicide victims who are under 14 may have a direct relationship. In the model, the number of victims almost doubles over the range of sample D component values. For age groups from 15 to 17, the D component indirectly relates to the dependent variable.. Magnetic fields are significant in modeling the count of homicides in most age categories reported by the FBI.

Table 42 Expected count of state homicide victims under the age of 14

Magnetic Field Effect on Count of State Homicide Victims Under the Age of 14 (Poisson Model)

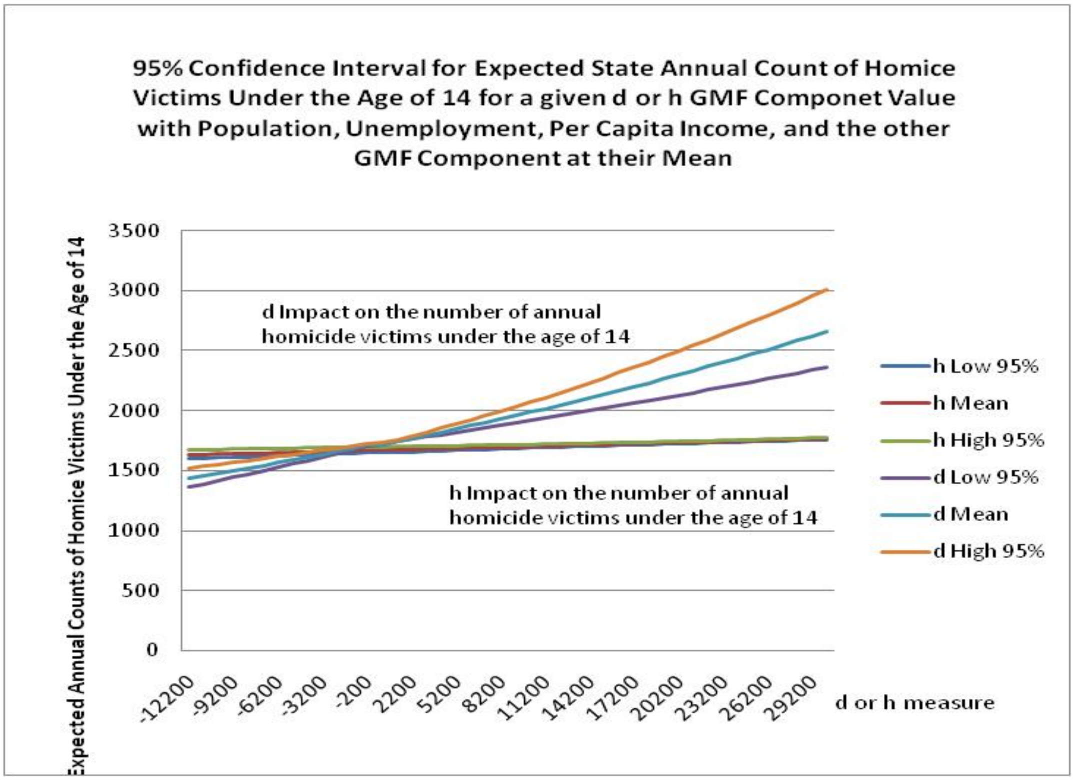
Observations = 115 Pseudo R2 = .9571

Variables	Coefficient and Standard Deviation	Significance
D Component in 1,000s	**0.0142** *(0.0022)*	0.000 ***
H Component in 1,000s	**0.0018** *(0.0001)*	0.000 ***
State Unemployment Rate	**-0.0001** *(0.0001)*	0.000 ***
State Per Capita Income (Squared)	**-0.0001** *(0.0001)*	0.000 ***
Number of State Sworn Full-Time Law Enforcement (100s)	**-0.0225** *(0.0001)*	0.000 ***
Number of Local Full-Time Sworn Law Enforcement (100s)	**-0.0055** *(0.0001)*	0.000 ***
Per Capita Spending on Police	**0.0052** *(0.0001)*	0.000 ***

Table 42 Continued			
Per Capita Spending on Judiciary	**-0.0118**	0.000	***
	(0.0002)		
Per Capita Spending on Corrections	**0.0019**	0.000	***
	(0.0001)		
Population in 1,000s	**0.0002**	0.000	***
	(0.0001)		
Constant	**7.522**	0.000	***
	(0.0238)		

* P<.1 ** P<.05 *** P<.01

Figure 42 Simulated expected count of homicide victims under 14



Likewise the model can be used for estimating the number of homicide victims in the age range of 15 to 17.

Table 43 Estimated annual state counts of homicide victims age 15 to 17

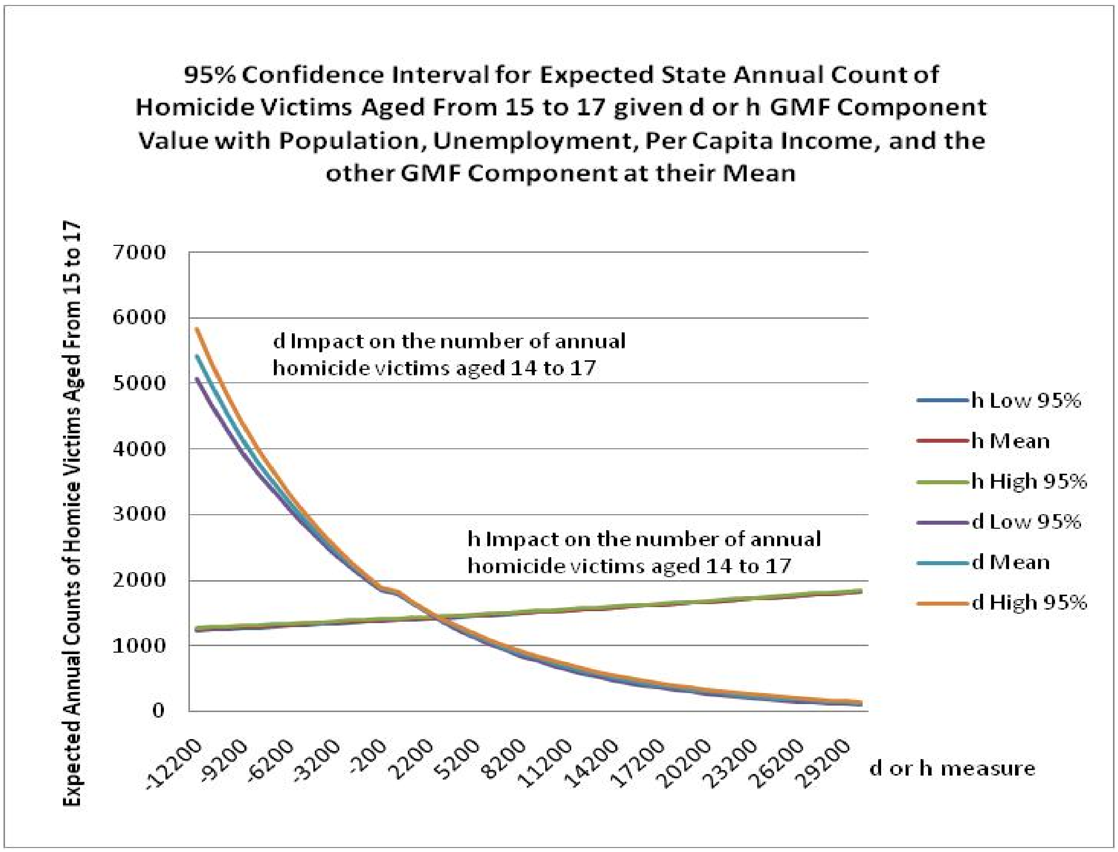
Magnetic Field Effect on Count of State Homicide Victims Aged 15 to 17 (Poisson Model)

	Observations = 115	Pseudo R2 = .9532	
	Coefficient and Standard Deviation	Significance	
D Component in 1,000s	**-0.0884**	0.000	***
	(0.0027)		
H Component in 1,000s	**0.0089**	0.000	***
	(0.0001)		
State Unemployment in 1,000s	**-0.0004**	0.000	***
	(0.0001)		
State Per Capita Income (Squared)	**-0.0001**	0.000	***
	(0.0001)		
Number of State Sworn Full-Time Law Enforcement (100s)	**-0.0147**	0.000	***
	(0.0001)		
Number of Local Full-Time Sworn Law Enforcement (100s)	**-0.0028**	0.000	***
	(0.0001)		
Per Capita Spending on Police	**0.0013**	0.000	***
	(0.0001)		
Per Capita Spending on Judiciary	**-0.0050**	0.000	***
	(0.0001)		
Per Capita Spending on Corrections	**0.0073**	0.000	***
	(0.0001)		

Table 43 Continued			
Population in 1,000s	**0.0002** *(0.0001)*	0.000	***
Constant	**8.742** *(0.0244)*	0.000	***

* P<.1 ** P<.05 *** P<.01

Figure 43 Simulated expected count of homicide victims 15 to 17



6.6.3 Victims by gender

The magnetic field components of interest have been particularly efficient and valuable in modeling victim counts below and above certain ages and within age ranges; especially the d component. Perhaps the components will be able to provide information to help estimate the counts of victims by gender, race, and gender-race combinations. The figures show various predicted relationships among gender and race and the magnetic field components D and H. In both male and female models, the D component is inversely proportional to the number of expected homicide victims by gender. The H component shows a direct relationship. Proportionally, the effect of the D component is much larger than the effect of the H component. Figure 44, Figure 45, and Table 44 depict the estimated effects of magnetic field component values on the count of victims by gender based on a series of simulations generated using the statistical analysis of the sample.

Figure 44 Simulated expected number of male homicide victims annualy

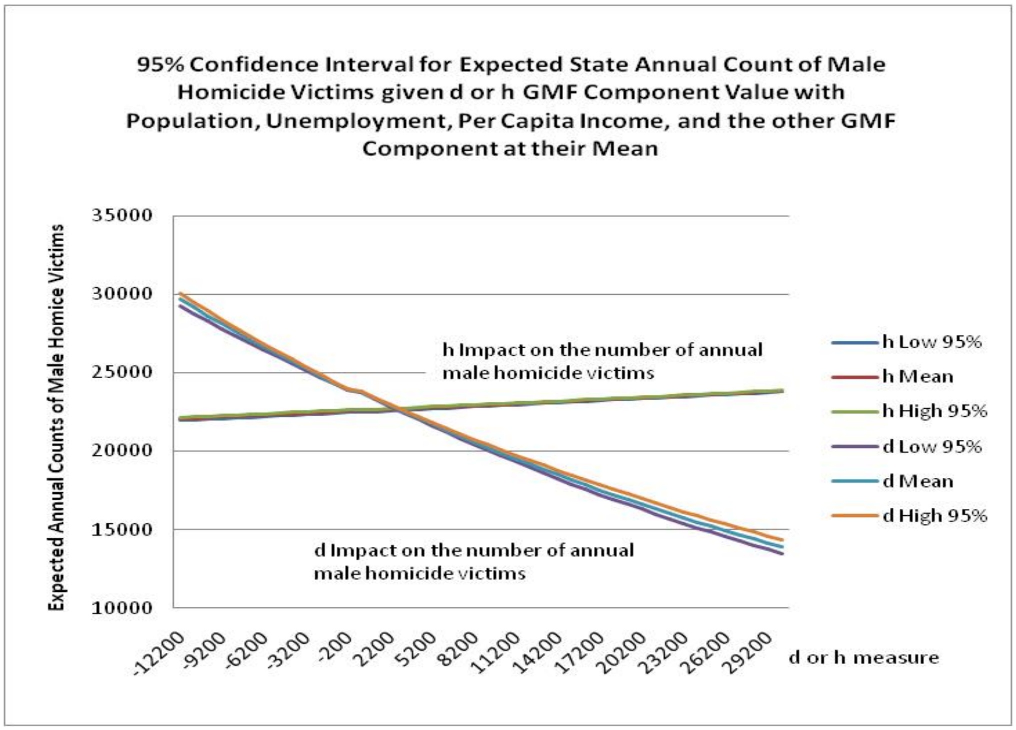


Figure 45 Simulated expected annual number of female homicide victims

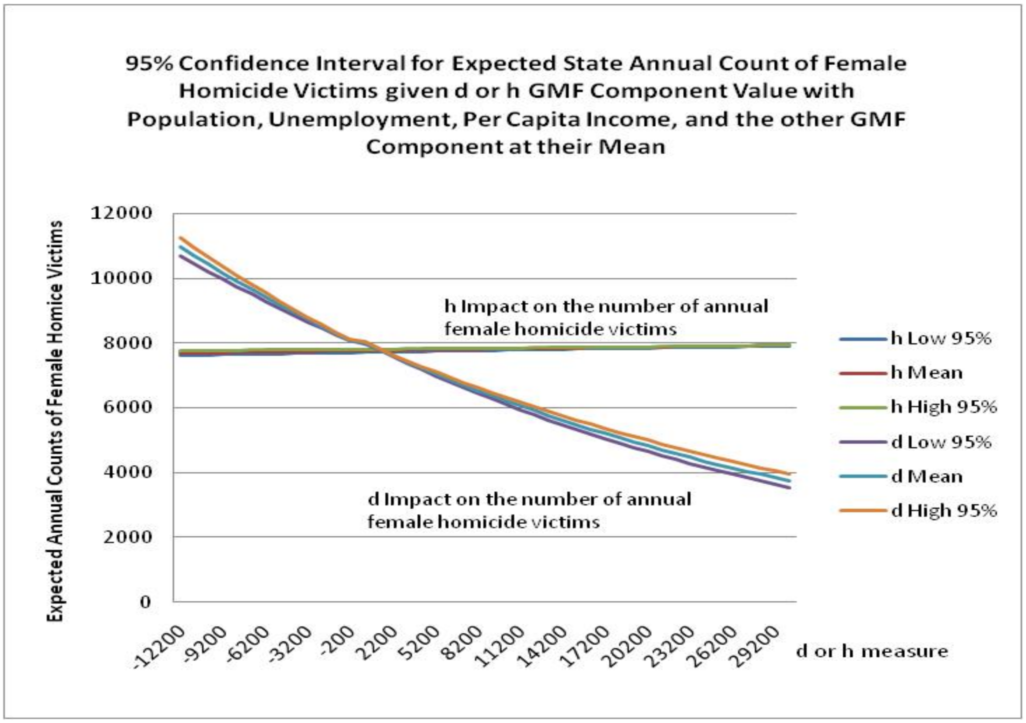


Table 44 Expected state counts of male and female homicide victim

Variables	Magnetic Field Effect on Count of Male Homicide Victims (Poisson Model)		Magnetic Field Effect on Count of Female Homicide Victims (Poisson Model)	
	Observations = 115	Pseudo R2 = .9729	Observations = 115	Pseudo R2 = 0.9680
	Coefficient and Standard Deviation	Significance	Coefficient and Standard Deviation	Significance
D Component in 1,000s	**-0.0179**	0.000 ***	**-0.0253**	0.000 ***
	(0.0005)		*(0.0009)*	
H Component in 1,000s	**0.0018**	0.000 ***	**0.0007**	0.000 ***
	(0.0001)		*(0.0001)*	
State Unemployment (1,000s)	**0.0001**	0.000 ***	**-0.0001**	0.000 ***
	(0.0001)		*(0.0001)*	

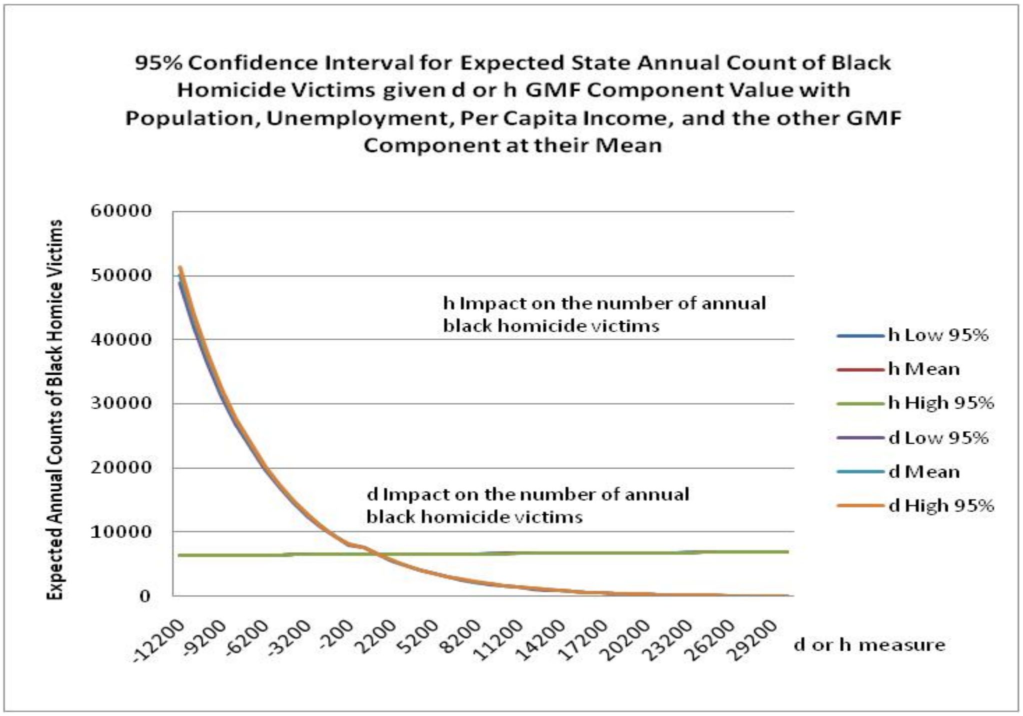
Table 44 Continued						
State Per Capita Income (Squared)	**-0.0001**	0.000	***	**-0.0001**	0.000	***
	(0.0001)			*(0.0001)*		
Number of State Sworn Full-Time Law Enforcement (100s)	**-0.0292**	0.000	***	**-0.0242**	0.000	***
	(0.0001)			*(0.0002)*		
Number of Local Full-Time Sworn Law Enforcement (100s)	**-0.0079**	0.000	***	**-0.0062**	0.000	***
	(0.0001)			*(0.0007)*		
Per Capita Spending on Police	**0.0010**	0.000	***	**0.0006**	0.000	***
	(0.0001)			*(0.0001)*		
Per Capita Spending on Judiciary	**-0.0076**	0.000	***	**-0.0094**	0.000	***
	(0.0001)			*(0.0001)*		
Per Capita Spending on Corrections	**0.0027**	0.000	***	**0.0015**	0.000	***
	(0.0001)			*(0.0001)*		
Population in 1,000s	**0.0003**	0.000	***	**0.0003**	0.000	***
	(0.0001)			*(0.0001)*		
Constant	**11.690**	0.000	***	**9.773**	0.000	***
	(0.006)			*(0.0109)*		

* P<.1 ** P<.05 *** P<.01

6.6.4 Homicide victims by race

The models of black and white homicide victims indicate that the D component of the magnetic field has a significant effect on the count of homicide victims by race. The simulations indicate that the D component is indirectly related to the count of black homicide victims but indirectly related to the count of white homicide victims. The H component relates directly to the count of both black and white homicide victim counts.

Figure 46 Simulated expected annual number of black homicide victims



The h component may not look very valuable at this scale. If separated out into its own estimate graph the impact of the component is much more clear and compelling.

Figure 47 Simualted expected annual count of black homicide victims

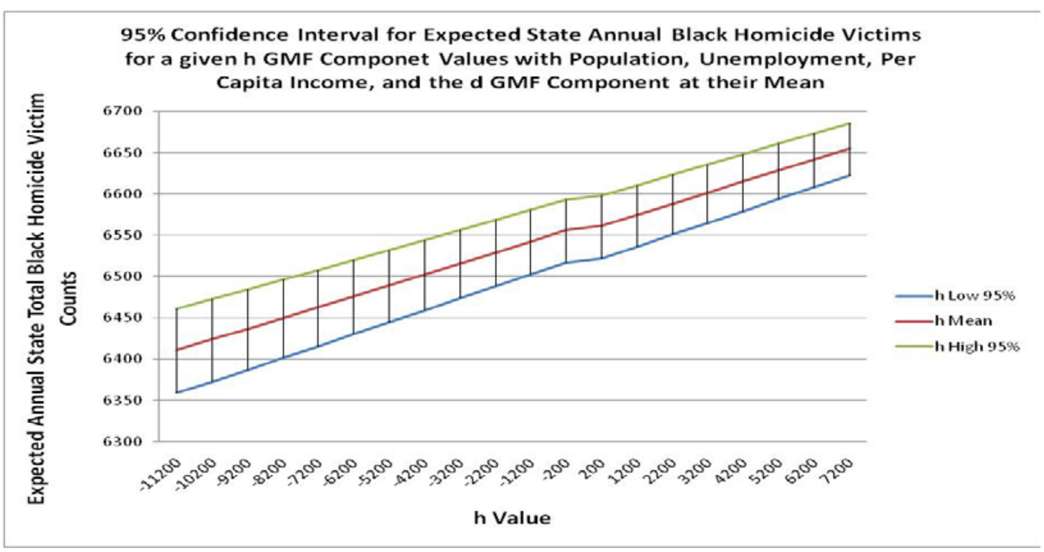


Table 45 Expected annual state count of black homicide victims

	Magnetic Field Effect on Count of Black Homicide Victims (Poisson Model)	
	Observations = 115	Pseudo R2 = .9380
Variables	Coefficient and Standard Deviation	Significance
D Component in 1,000s	**-0.1518**	0.000 ***
	(0.0001)	
H Component in 1,000s	**0.0020**	0.000 ***
	(0.0001)	
State Unemployment (1,000s)	**-0.0003**	0.000 ***
	(0.0001)	
State Per Capita Income (Squared)	**-0.0002**	0.000 ***
	(0.0001)	
Number of State Sworn Full-Time Law Enforcement (100s)	**-0.0211**	0.000 ***
	(0.0002)	
Number of Local Full-Time Sworn Law Enforcement (100s)	**-0.0066**	0.000 ***
	(0.0001)	
Per Capita Spending on Police	**0.0001**	0.000 ***
	(0.0001)	
Per Capita Spending on Judiciary	**-0.0095**	0.000 ***
	(0.0001)	
Per Capita Spending on Corrections	**0.0047**	0.000 ***
	(0.0001)	

Table 45 Continued			
Population in 1,000s	**0.0003**	0.000	***
	(0.0001)		
Constant	**12.870**	0.000	***
	(0.011)		

* P<.1 ** P<.05 *** P<.01

Table 46 Expected annual state count of homicide victims; white

	Magnetic Field Effect on Count of White Homicide Victims (Poisson Model)		
	Observations = 115	Pseudo R2 = 0.9468	
Variables	Coefficient and Standard Deviation	Significance	
D Component in 1,000s	**0.0242**	0.000	***
	(0.0006)		
H Component in 1,000s	**0.0019**	0.000	***
	(0.0001)		
State Unemployment (1,000s)	**-0.0001**	0.000	***
	(0.0001)		
State Per Capita Income (Squared)	**-0.0001**	0.000	***
	(0.0001)		
Number of State Sworn Full-Time Law Enforcement (100s)	**-0.0034**	0.000	***
	(0.0002)		

Table 46 Continued			
Number of Local Full-Time Sworn Law Enforcement (100s)	**-0.0089**	0.000	***
	(0.0004)		
Per Capita Spending on Police	**0.0038**	0.000	***
	(0.0001)		
Per Capita Spending on Judiciary	**-0.0116**	0.000	***
	(0.0001)		
Per Capita Spending on Corrections	**0.0018**	0.000	***
	(0.0001)		
Population in 1,000s	**0.0003**	0.000	***
	(0.0001)		
Constant	**10.532**	0.000	***
	(0.007)		

Figure 48 Simulated expected annual count of white homicide victims

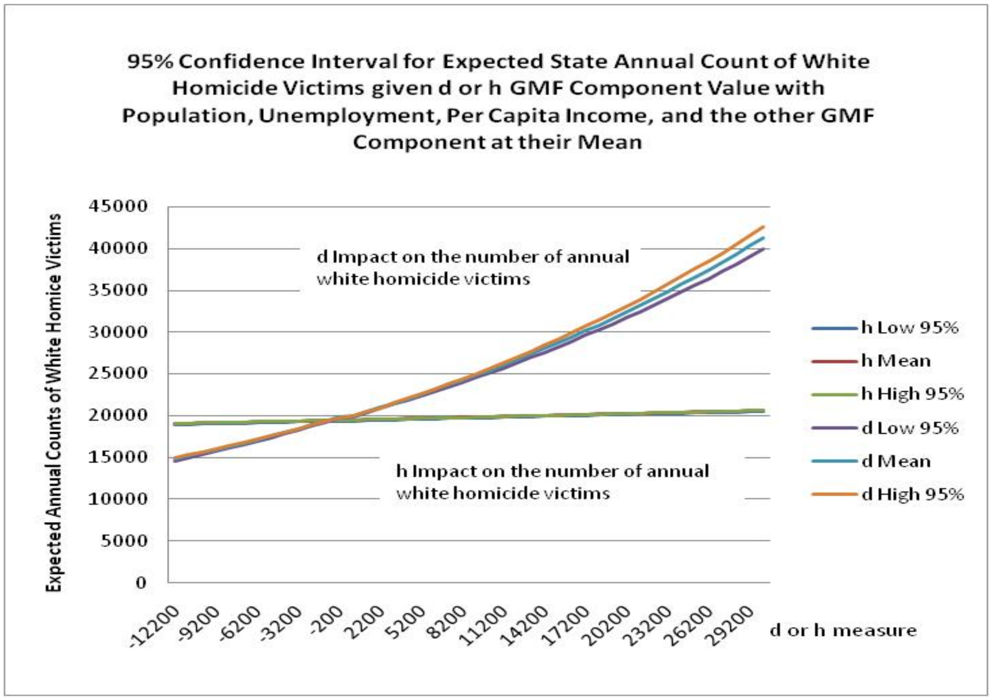


Figure 49 Simulated expected annual count of white homicide victims

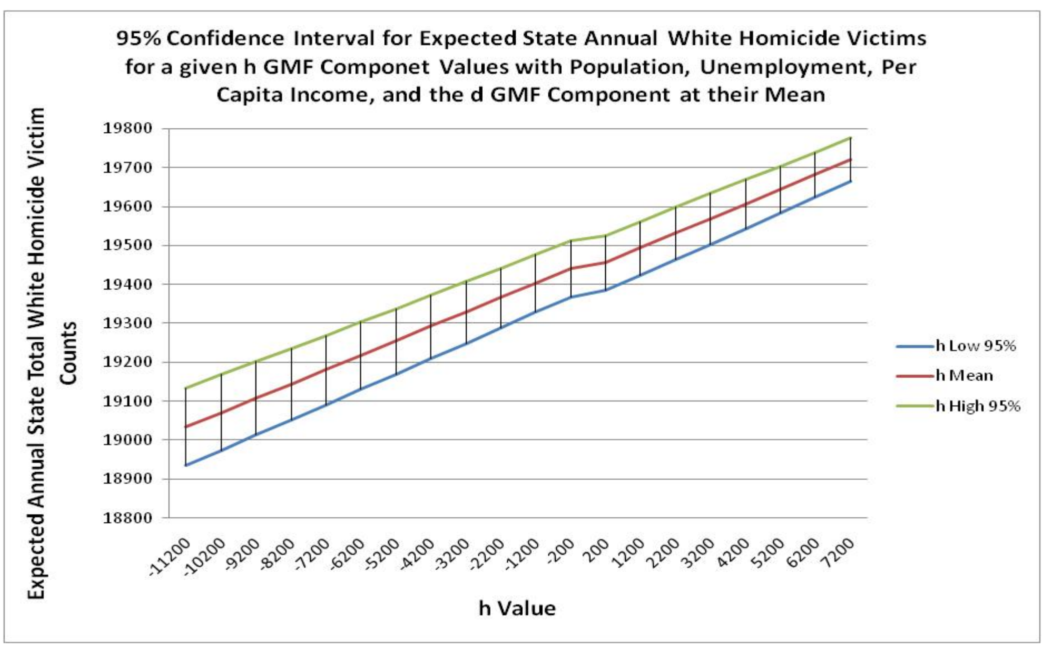


Table 47 Expected simulated annual state counts of black homicide victims

Variables	Coefficient and Standard Deviation	Significance	
	Magnetic Field Effect on Count of Black Male Homicide Victims (Poisson Model)		
	Observations = 115	Pseudo R2 = .9370	
D Component in 1,000s	**-0.1488**	0.000	***
	(0.0001)		
H Component in 1,000s	**0.0020**	0.000	***
	(0.0001)		
State Unemployment in 1,000s	**-0.0003**	0.000	***
	(0.0001)		
State Per Capita Income (Squared)	**-0.0002**	0.000	***
	(0.0001)		
Number of State Sworn Full-Time Law Enforcement (100s)	**-0.0207**	0.000	***
	(0.0002)		
Number of Local Full-Time Sworn Law Enforcement (100s)	**-0.0065**	0.000	***
	(0.0007)		
Per Capita Spending on Police	**0.0007**	0.000	***
	(0.0001)		
Per Capita Spending on Judiciary	**-0.0083**	0.000	***
	(0.0001)		
Per Capita Spending on Corrections	**0.0049**	0.000	***
	(0.0001)		

Table 47 Continued

Population in 1,000s	**0.0003** *(0.0001)*	0.000 ***
Constant	**12.774** *(0.012)*	0.000 ***

Table 48 Expected annual state counts of black homicide victims

	Magnetic Field Effect on Count of Black Female Homicide Victims (Poisson Model)	
	Observations = 115	Pseudo R2 = 0.9293
Variables	Coefficient and Standard Deviation	Significance
D Component in 1,000s	**-0.1636** *(0.0023)*	0.000 ***
H Component in 1,000s	**0.0038** *(0.0002)*	0.000 ***
State Unemployment in 1,000s	**-0.0004** *(0.0001)*	0.000 ***
State Per Capita Income (Squared)	**-0.0001** *(0.0001)*	0.000 ***
Number of State Sworn Full-Time Law Enforcement (100s)	**-0.0022** *(0.0003)*	0.000 ***

Table 48 Continued			
Number of Local Full-Time Sworn Law Enforcement (100s)	**-0.0070**	0.000	***
	(0.0001)		
Per Capita Spending on Police	**0.0025**	0.000	***
	(0.0002)		
Per Capita Spending on Judiciary	**-0.0146**	0.000	***
	(0.0002)		
Per Capita Spending on Corrections	**0.0039**	0.000	***
	(0.0001)		
Population in 1,000s	**0.0003**	0.000	***
	(0.0001)		
Constant	**10.758**	0.000	***
	(0.023)		

Figure 50 Simulated expected annual count of black male homicide victims

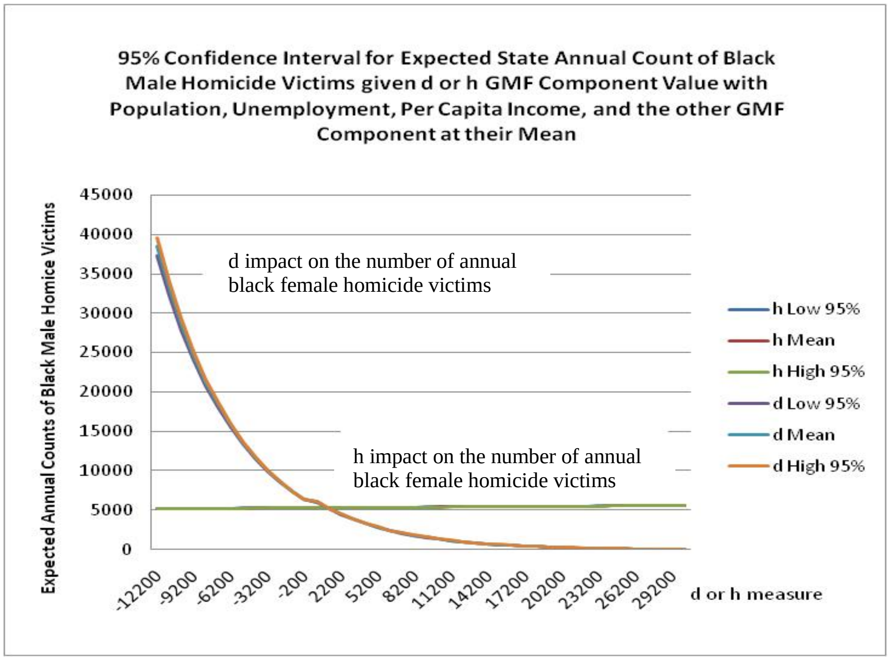
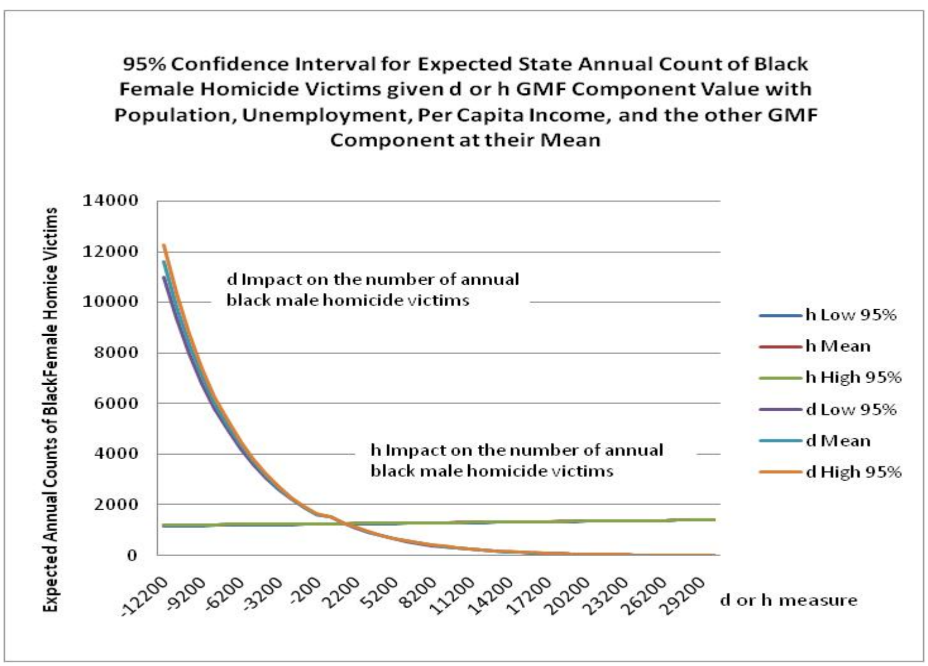


Figure 51 The expected simulated annual state count of black female homicide victims



The same models are useful for white homicide victims by gender.

Table 49 Expected state annual counts of white homicide victims

Variables	Magnetic Field Effect on Count of White Male Homicide Victims (Poisson Model)	
	Observations = 115	Pseudo R2 = .9468
	Coefficient and Standard Deviation	Significance
D Component in 1,000s	**0.029** *(0.0006)*	0.000 ***
H Component in 1,000s	**0.0023** *(0.0001)*	0.000 ***
State Unemployment (1,000s)	**-0.0001** *(0.0001)*	0.000 ***
State Per Capita Income (Squared)	**-0.0001** *(0.0001)*	0.000 ***
Number of State Sworn Full-Time Law Enforcement (100s)	**-0.0356** *(0.0012)*	0.000 ***
Number of Local Full-Time Sworn Law Enforcement (100s)	**-0.0094** *(0.0005)*	0.000 ***
Per Capita Spending on Police	**0.0037** *(0.0001)*	0.000 ***
Per Capita Spending on Judiciary	**-0.0108** *(0.0001)*	0.000 ***
Per Capita Spending on Corrections	**0.0021** *(0.0001)*	0.000 ***

Table 49 Continued

Population in 1,000s	**0.0004** *(0.0001)*	0.000 ***
Constant	**10.399** *(0.012)*	0.000 ***

* P<.1 ** P<.05 *** P<.01

Table 50 Expected state annual counts of white homicide victims

	Magnetic Field Effect on Count of White Female Homicide Victims (Poisson Model)	
	Observations = 115	Pseudo R2 = 0.9369
Variables	Coefficient and Standard Deviation	Significance
D Component in 1,000s	**0.0086** *(0.0012)*	0.000 ***
H Component in 1,000s	**0.0001** *(0.0002)*	0.567 -
State Unemployment (1,000s)	**-0.0009** *(0.0001)*	0.000 ***
State Per Capita Income (Squared)	**-0.0001** *(0.0001)*	0.000 ***

Table 50 Continued

Number of State Sworn Full-Time Law Enforcement (100s)	**-0.0281**	0.000	***
	(0.0002)		
Number of Local Full-Time Sworn Law Enforcement (100s)	**-0.0071**	0.000	***
	(0.0001)		
Per Capita Spending on Police	**0.0039**	0.000	***
	(0.0001)		
Per Capita Spending on Judiciary	**-0.0141**	0.000	***
	(0.0001)		
Per Capita Spending on Corrections	**0.0009**	0.000	***
	(0.0001)		
Population in 1,000s	**0.0003**	0.000	***
	(0.0001)		
Constant	**8.757**	0.000	***
	(0.0133)		

Figure 52 Simulated expected annual counts of white female homicide victims

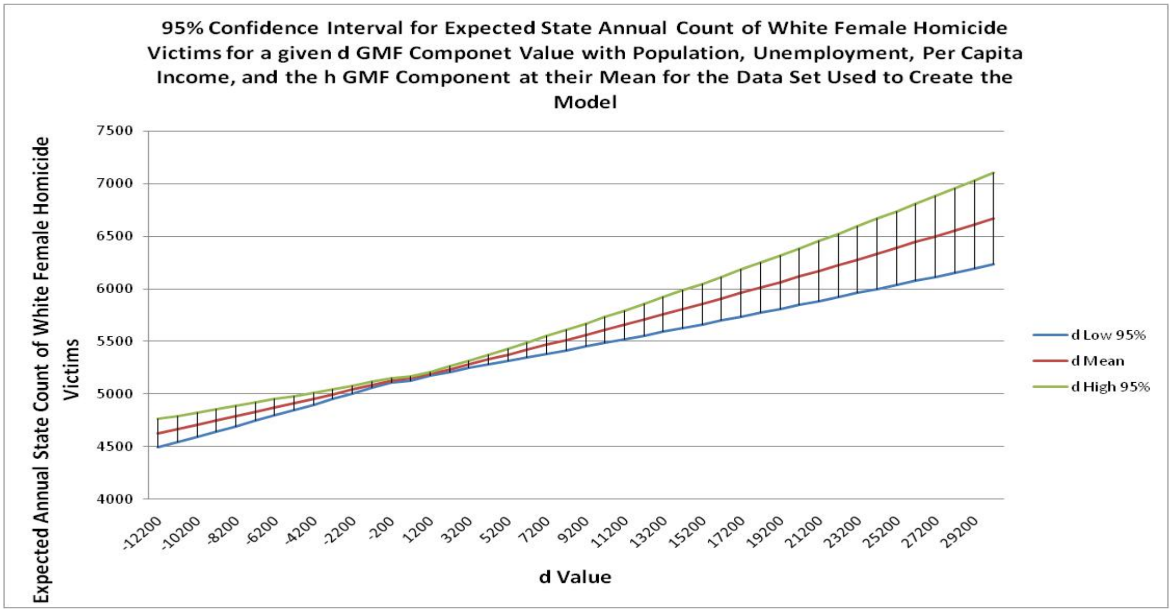


Figure 53 Simulated expected annual count of white male homicide victims

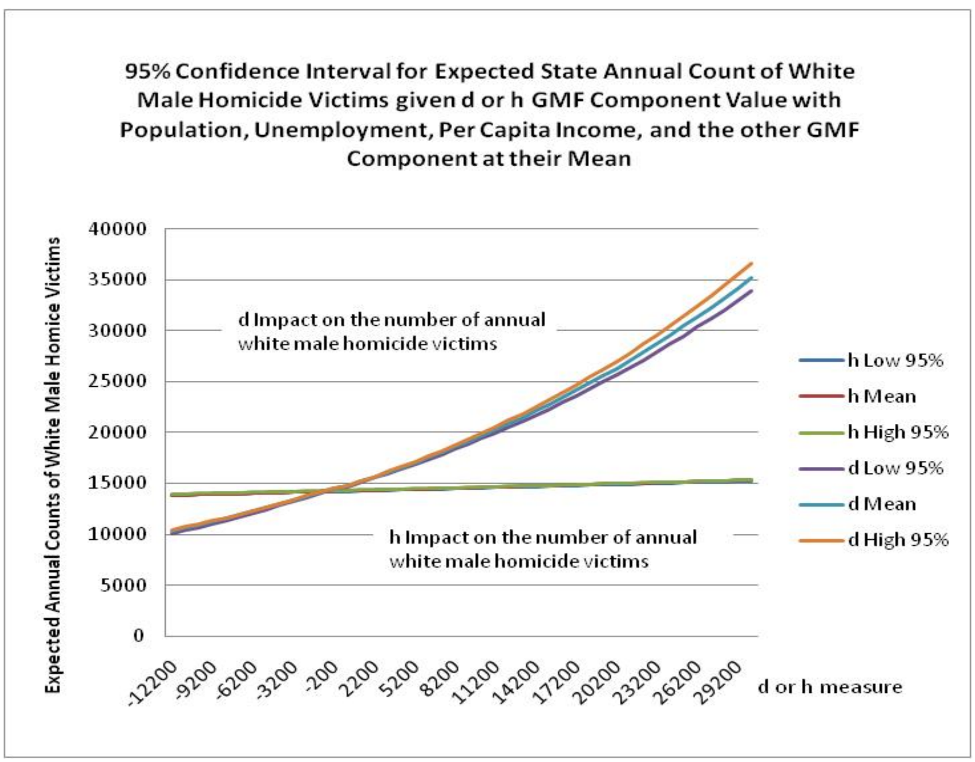
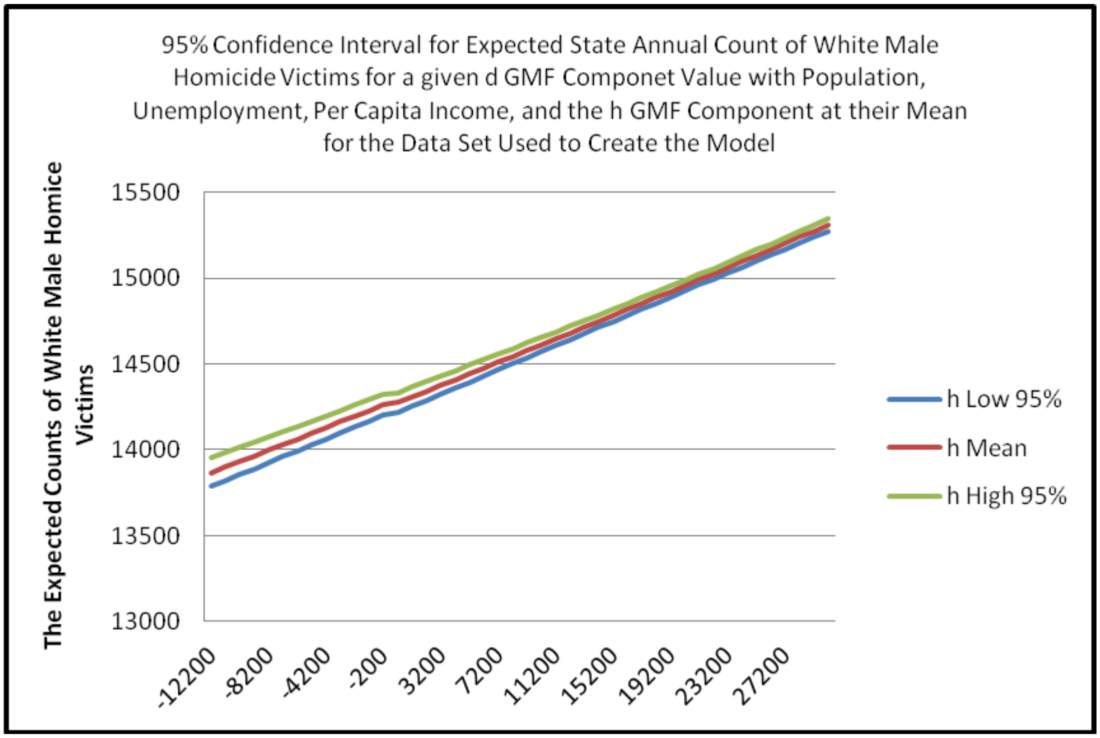


Figure 54 Simulated expected annual count of white male homicide victims



6.7 Conclusion

In most cases, the magnetic field variable was a significant explanatory variable. The magnetic field variable covaries with dependent variables in ways that indicate an effect on motivation and behavior in humans. The magnetic field variables seem useful are an important variable in explaining, predicting, and analyzing many types of crime. The variable may even help in the modeling of the distribution of crime among different genders and races.

The question remains, “What use is this geomagnetic variable?” Imagine a world that issues magnetic field and SMF warnings; akin to a smog alert. People warned that magnetic field and SMF activity will affect their judgment, that they should drive more slowly, recognize their aggressiveness, and act with patience.

Scientists model magnetic fields predictably, which allows the planning security and police efforts. What if police departments could use magnetic field to assign person-power to specific geographical areas through simple, portable magnetic field measuring devices? What if police departments could “save” overtime hours for projected periods of magnetic field activity that will increase violent crime? What if state and national police forces could be flexible enough to react to statewide or national magnetic field effects that result in an increase/decrease in violent crime counts? Currently “spot” presence and a “fireman” network of distributed bases allow law enforcement to maintain “presence patrols” and react to events, but not to do much to deter these acts.

A significant effect by magnetic field would offer a highly specific and cheap method to assist in resource planning and distributions. More scientific than “We send police there because crime happens there,” or “We save up overtime for holidays because that’s when people commit crime.” By providing a geographical non-personal profile of where and when crime is more likely to happen, we can curtail racial and social profiling.

Gathering information on the magnetic field variable is cheap. More importantly, it is possible to collect it in real-time with few added costs. A series of automated measuring stations could constantly feed information into a computer and use it to predict the probability of violent crime occurring on a specific street, or even a specific property.

More generally, if magnetic field is significant in explaining violent crime counts and it is truly because of an interaction that results in irrational behavior, it could mean a total shift in social-urban feng-shui. What if it were found that court was held in a geographic area dominated by magnetic field that affects rationality negatively? What if court could be held and jury deliberations completed in an area where magnetic field contributed to rationality? Perhaps road intersections are in poor locations. Maybe counties should build schools in areas that maximize magnetic field effect on rationality and creativity. In the realm of economic development, geographical areas that contribute to rationality (reduced injuries on the job) and creativity would be a premium for research centers, customer relations centers, factories, or company headquarters.

The standard control variables for population, crime models income, education, race, gender, law enforcement spending, employment, etc., are used in some models of crime in this chapter, if the data were available for the time increments and level being analyzed. When traditional control variable data were not available, or to demonstrate the parsimonious and unmasked effect of the magnetic field on crime counts, these variables were removed to make the model less restrictive. There is confidence that, as demonstrated in the Chapter 3 appendices, the geomagnetic field is causally prior to possible social, political, and economic control variables – so fear of omitted variable bias is unwarranted. XT models and ARIMA models indicate that temporal autocorrelation diagnostics reduce the significance of magnetic variables in models of crime to 0.1 from between .001 and .05. Only models of rape demonstrate high risk of temporal autocorrelation with magnetic variables falling in significance when adjusted for autocorrelation. The presence of temporal autocorrelation in almost all these models, although categorized as low risk, compels analysts to seek a deeper understanding of how temporal autocorrelation impacts crime analysis using magnetic fields. However, it is important to note that almost most other variables of interest used in the criminology literature suffers more from temporal autocorrelation.

The model being used is based on the seminal work of Cantor and Land (Cantor & Land, 1985), and whenever possible remains true to its theoretical foundation. Given that this chapter mainly explores the relationship between the geomagnetic field and the opportunity or motivation to commit crime as theorized by Cantor and Land's opportunity-motivation model, the goal was to focus as narrowly as proper model specification would permit on their conceptual framework. Combining the analysis without the controls with models applying control variables at each level of analysis (from the city to the national level) allows a comprehensive view of the benefits and concerns of the geomagnetic field as an explanatory or control variable.

The result of merging the geomagnetic field into a data set built around Cantor and Land's methodology demonstrates the statistical effect of the field on crime counts relative to the traditional control variables. The results consistently illustrate the main point that is the burden of this thesis: Adding magnetic field measures tightens up the 95% confidence intervals returned by these statistical models, and therefore allows them to be more precise in their predictive ability than models that left out this natural phenomenon.

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Chapter 7 Stock Market Volatility, Risk, and Chance

Rationality, in word or concept, goes back to the initial works of Max Weber in the late 19th and early 20th centuries. It could be argued that the roots of the rationality story goes back even further, to the classical scientific method of Aristotle(Aristotle, 1938) and the efforts of Ibn al-Haytham (Alhazen, 1974), or to François' Quesnay's Tableau Economique (Quesnay, 1759) and its foundational economic theories that informed much of Adam Smith's work in the Wealth of Nations (Smith A. , 1776). Let us start with a very different concept, that of probability, epitomized in the early 1500s with a brainteaser.

> A and B are playing a fair game of *balla*. They agree to continue until one has won six rounds. The game actually stops when A has won 5 and B has won 3. How should the stakes be divided? (Hogben, 1968).

This was a first and formative moment in the development of the concept of risk and probability that has in many ways waylaid the whole idea of rationalism in social science. The importance of risk goes back to the origin stories of the Greeks, who explain the "big bang" as a game of chance among the Gods in which Zeus won the heavens and the other Gods were assigned to their areas according to chance. It was the characteristics of the Greek civilization (a rich system of mathematics, a lack of a domineering priesthood, *etc*.) that set the conditions for significant breakthroughs in risk and probability. Unfortunately, their numbering system only allowed for the recording of results and little utility for calculating (Florence-Nightingale, 1962, p. 2).

The Greeks were able to develop the concept of probability with little problem and even made the critical assessment that "like truth" is not the same as "truth" (Sambursky) (Kendall & Plackett, 1977, pp. 1 - 14). However, the distinct separation of thinking about games of chance and playing games of chance (and all other relevant events that are risk/chance/probabilities based) remained firmly in place for more than 1,000 years. Shmuel Sambursky, an historian and philosopher, argued this was the case because the Greeks found order only in the heavens and could not accept any ordering of the messiness of life. Literature, art, and culture were interwoven with drama and tragedies that tell of the helplessness of humans in the grasp of impersonal fates. Even Gods were victims of the unpredictable and messy existence.

It was not until the view of the future radically changed that civilization was able to develop a sophisticated theory and application of probabilities and risk. Until the Renaissance, people viewed the future as just a matter of luck, a random assortment of variations, with instinct as the best guide in a world of randomness. The conditions of life were so connected to nature, and the demands of survival so high, people were could not conceive they could influence their futures in any way that mattered. Even when civilizations advanced, that advancement alone was not sufficient in itself to drive the development of risk concepts and risk based methodologies (Eves, 1983).

It was the rise of the Arab empires and their contact with the Indian civilizations of the time that spread a numbering system from India westward that would allow for a transformation of mathematics and measurements. The Hindu numbering system gradually replaced the abacus, and the Roman system of numerals. Yet, the five hundred years that passed, the development of more abstract mathematical thinking, and the use of written numerology was not enough to spawn a field of probability and risk. It would not be until a civilization realized that human beings were not at the mercy of randomness and nature, but could influence outcomes through understanding, action, or inaction that this would occur (Rabinovitch, 1969). In the 1200's, Europeans were introduced to written works that taught the difference between 10 and 100. This was not enough to motivate a development of risk or uncertainty or probability theory, as most people still perceived risk because of the unpredictability of nature (Bernstein P. L., 1998). Re-enter our earlier brainteaser:

> A and B are playing a fair game of *balla*. They agree to continue until one has won six rounds. The game actually stops when A has won 5 and B has won 3. How should the stakes be divided? (Hogben, 1968)

It was not until 1545, that an author published a work focused on probability and chance. The author was an admitted gambler (sometimes every day for a year), a well-known medical professional, and a prolific writer. *Book on Games of Chance* (Cardano, 1526) was the title of the work. It took 50 more years for Galileo to take a break from his astronomical musing and mathematical studies to move the understanding of probability forward and another 100 years for the terms associated with probability to come into common usage (Hacking, 1975).

By the start of the 17th century, advances in calculus and the study of chance resulted in foundations laid for disparate subjects ranging from insurance and investment to medicine, behavior of matter, war, and weather forecasting (Bernstein P. L., 1998). In 1654, three French Mathematicians set out to solve the riddle posed in 1500 as to the division of the pot of an incomplete game of chance among the players. One of the many lines of analysis to solve the problem would lead to the theory of decision making (Hacking, 1975). A short time later, in 1662 theorists introduced a critical component in the application of probability theory. The critical component was the concept of "gravity" or utility. A new idea was published that both the chance of an event happening and the gravity/payoff/cost associated with an event should both be used when determining how useful taking a chance would be; hence utility (Hacking, 1975).

Later in 1693, Sir Edmund Halley would publish a detailed analysis of the population of the town of Breslaw for the years 1687 through 1691. He would use the town's detailed birth and death records to estimate the town's population as well as the chance of dying of one of many causes in a given year. He went on to apply the risk of death to a most common financial instrument: the annuity (Newman, 1988). Since at least 1540, the English government had sold annuities that repaid their purchase price in but seven years without regard to the age of the buyer. The sale of the annuity, with the intent of filling the kingdom's treasury, turned into a long-term drain as buyers outlived the payback period (Hacking, 1975).

It is in 1738 that Bernoulli coined the explicit use of the term utility as well as the concept that different people perceive risk differently. He also defines "expected value" and "mathematical expectations." Having established these concepts and supported the supposition that different people viewed risk differently, he argued, "The utility resulting from any small increase in wealth will be inversely proportional to the quantity of goods previously possessed." These concepts and statements transformed probabilities from a process to "procedures for introducing subjective considerations into decisions that have uncertain outcomes (Bernstein P. , 1998)." The assertion that different people perceived risk differently was the beginning of the divergence from the classical rational man, who shared similar rationality with all other classically rational men.

Earlier, in 1705, Bernoulli's father structured and defined the problems with application of probability theory. First, for most people and situations, only partial information is available. Second, events in the future will follow the same pattern as events in the past (independence). Third was the relevance of the quantitative valuation (Bernoulli, 1713). It was also around this time (1711) that De Moivre developed the normal distribution, a graph that allowed the derivation of the standard deviation, and inspired/motivated Thomas Bayes' efforts that led (well after his death) to the foundation of statistical inference and the idea that you could measure uncertainty (Bernoulli, 1713). Towards the end of the 1800s, Francis Galton, would make two critical contributions to risk theory and analysis. The first was that measures (samples) tended to return to the mean of a population and this trend tended to resist efforts at manipulation in real life. The study of eugenics demonstrated this. The second was that samples of samples maintained the same distribution of the population. He designed a machine that would randomly drop balls into a series of bins that would result in the normal distribution. Randomly dropped balls from this array would in turn create a normal distribution (Forest, 1974). These exciting and novel concepts came together through the 1800s to make the normal distribution the core of risk management and lay the foundation for all that would happen in the 1900s. In fact, regression to the mean provides many if not all decision-making systems' philosophical foundations (Bernstein P. L., 1998, p. 172).

However, Bernstein points out in his discussion of regression to the mean that there are three reasons why using regression to the mean is such a problematic guide to both understanding and executing decision making (Bernstein P. , 1998, p. 172). First, regression to the mean can progress at any rate. At times, the process can progress at such a gradual pace that shocks can disrupt it. The pace and impact of such shocks can result in a never-ending regression. Second, the rate of movement to the mean, and a lack of any natural "door stop" may result in the trend swinging back well beyond the mean. The result is "erratic and unstable" swings one each side of the mean that never come to rest at the prior mean. The unstable and erratic swings may not even provide enough information to estimate a valid mean. Finally, it is possible that the mean itself is unstable. Tomorrow's new normal replaces yesterdays'. While we may have had plenty of information about the mean yesterday, we may not know anything about the mean that exists today and not have enough information to project or predict the mean of tomorrow.

Once people were able to define, quantify, describe, and recognize risk it was inevitable that they would attempt to mitigate, control, and manage it. Risk management is maximizing the areas where one has control over the outcome of processes and minimizing the areas where one does not. However, it is difficult to define such spaces when "real" world processes and interactions are the subject of risk management. Often there is no ready explanation for extraordinary events that require strong explanatory proofs in order to claim understanding of what drove the extraordinary event (Bernstein P. L., 1998, p. 199).

Along these lines a profound observation by an, at the time an unremarkable French mathematician, describes the basic expectation of such extraordinary events. He asserted the expected likelihood of such extraordinary events; such as swings greater than 20% in stock market value, war, devastating shocks to economic and social systems, *etc*., is zero (Bernstein P. L., 1992).

What makes matters worse is that one can never have all the relevant information to generate a 100% correct decision. Further, we are never sure of the quality, relevance, efficiency, or validity of the information we do have. This information is but a sample of the entire population of existing data that affects a prediction, inference, deduction, process, or outcome. One never knows how efficient, or representative, the "sample" of information they are operating under is when compared to the population of all possible information. In situations where we cannot adequately support the inference that the sample of information available is representative of the population of possible information, one must revert to inductive reasoning to develop an estimate of the probability of an event or outcome. John Maynard Keynes discussed this dynamic when he asserted that while there may in fact be a relationship among the evidence and an outcome there is no guarantee that it is possible to measure it (Keynes, 1921).

Keynes produced a flurry of criticism that spares none of the previous section's leaders in identifying, quantifying, and managing risk and uncertainty. He even spares some time to be critical of the use of the arithmetic mean, which, while easy to use, in no way reflects nature's lack of concern for ease of analysis (Keynes, 1921, pp. 206 - 209).

This brings us back to the issue of rationality and the first explicit works penned by Max Weber. Rationality as a concept has an evolving meaning in the social sciences. From Weber (Weber, 1922) to Reed (Reed, 2000) the debate has sought to understand and defend the role of rationality in matters of research interest (Swedberg, 1999). A corollary coming from this debate is the role of "non-rationality" in research interests (Genoc, 1991). The methodological and substantive arguments in favor of rationality as a foundational concept and explanation for event processes and outcomes found its home in rational choice and exchange theorists such as Morrow (Morrow J. D., 1994), Ordeshook (Ordeshook, 1992), Mitchell (Coleman, 1990), Hogarth (Hogarth R. M., 1980), Reder

(Hogarth & Reder, 1987), Coleman (Coleman, 1990) and (Coleman, 1986) and others. Rational choice theory assumes that "The elementary unit of social life is the individual human action. To explain social institutions and social change is to show how they arise as the result of the action and interaction of individuals (Elster J. , 1989)."

Alongside this, are a variety of "thin" and "thick" rational models that have differing levels of restriction and adjustments that bring the rational decision making models closer to the de facto choices that people make (Yee, 1997). These modifications to the original theory mainly deal with adjusting the assumption that rationality equates to maximizing value of outcomes. In other words, moving the theory away from assuming that individuals desired to get themselves the best outcome they could for themselves. Although, in fairness to rational choice, it must be acknowledge that it is not so much a theory as it is "a descriptive phrase used to describe any of a number of individual theories that use the rationality assumption (Quackenbush, 2003)."

In the 1950s, Kenneth Arrow asserted that people generally over-estimate the value, amount, and even relevance of the information they possess and use to make decisions. Already established was that an infinite number of insignificant yet relevant influences cause zero percent-expected events. Arrow then asked why anyone accepts risk and "plays the game" under these conditions? His answer applies to two groups; those who gamble and those who insure. Gamblers are willing to accept the small probability of a big payoff in exchange for a large probability of a small loss. Those who use insurance prefer a 100% chance of a small loss (insurance premium) in exchange for the small chance of a large gain (insurance payout to cover a catastrophe). It seems reasonable to argue what divided people into each group was a psychological process likely never captured for political or economic analysis. Researchers and analysts would only be able to evaluate the hypothetically available choices, outcomes, and intervening benefits and costs and risks.

In attempts to address the criticisms of rationality the concept of rationality as inherent in outcome has devolved to a point of stipulating that all decisions are rational and therefore analysts ignore rationality as a variable. This allows the disciplines to continue to use rationality as an assumption in models that describe processes and explain outcomes while not having to measure or quantify the concept. Other researchers assume that preferences are observed and revealed through behaviour. These researchers reject the mental or psychological factors involved in determining rationality as being too subjective (Yee, 1997). Others have called for an integrated and more elaborate analysis of mental event factors such as norms, ideas, and beliefs arguing that unobserved mental context prevent the revealing of preferences through behaviour. (Mitchell 1969 and1993). To overcome difficulties presented by critics of these approaches others' attempts to assign probabilities and values to each outcome to get an expected utility value. Preferred outcomes would be those with the highest expected utilities (Morrow J. , 1994).

Reconnecting with an earlier discussion of risk, the phenomenon of regression to the mean, the stock market is one of the strongest examples of its application to risk analysis, risk management, and decision-making. The concepts of "Buy low and sell high," "You never get poor taking a profit," intraday averages (generally 200 day averages), "support levels," and much of "technical analysis" rests on regression to the mean.

However, most investors tend to follow trends; in a world where uncertainty defines tomorrow, the only available dependable data is that which has happened in the past. Investors, absent any compelling reason not to, tend to assure that tomorrow will be more of yesterday and today. In this way, investors deem stocks that have been raising recently better investments than stocks that have been falling recently. In this way, people benefit from the concept of momentum. Indeed Wall Street has a whole class of investors who trade on momentum. In this class, professionals as well as amateurs tend fall into the same tendency (Bernstein S. C., 1994). In fact, a study found that professional investors who projected higher-than-average growth for a company consistently overestimated the actual performance of the company. On the other hand, those who projected lower-than-average growth consistently underestimated the actual performance; on average. What ends up happening under the pressure of momentum trading and the tendency to overestimate or underestimate performance by analysts and investment advisors is that stocks with high expectations rise to high values while stocks with low expectations fall to low values. This is when regression to the mean asserts its influence. Investors and realistic analysis of the valuation of stocks bring people into the market as those who held the unreasonable expectations leave the market, or shift to new stocks. As buying and selling accelerate, the prices of stocks move to the "actual" valuation, the mean.

As Peter Berstein's *Against the Gods the Remarkable Story of Risk* (Bernstein P. , 1998) points out so well, when asking whether the regression to the mean underlay the performance of stocks and the market as a whole, what one is really asking is whether predictability exists. If the answer is that predictability exists, then the obvious next question is under what conditions it exists (DeBondt & Thale, 1986). The answer from research looking at losers and winners in the market is that losers tend to outperform markets and winners tend to underperform markets around 36 months after analysts assign stocks either winner or loser status. Regression to the mean seems to be taking place. Later research showed that for the S&P 500, a basket of 500 stocks that represent the U.S. economy from 1926 to 1993, variance of returns over specified periods was less than expected meaning that long run volatility is significantly less than expected if regression to the mean was not at work in the market. Then why are not all investors rich, and why do not all investors, because of the success of "regression to the mean investors" and the failure of "momentum investors" invest with regression to the mean as a fundamental component of their analysis and strategy? The answer is that no one know what the mean is, how fast the regression occurs (although research has indicated that in the past it took less than 36 months), or when the mean may have changed.

To continue the earlier discussion of risk, uncertainty, and risk mitigation it is important to realize that these concepts are largely new, that for almost 200 years in the United States and much longer in the markets of Britain, France, and the Netherlands, they did not exist. Through the years, risk was accepted, and to prosper one had to beat it. Risk, removed from mathematics, remained a game of instinct, gut, intuition, and constitution (Bernstein P. , 1998).

In this vein, the seminal work on rationality, risk, uncertainty in building stock portfolios, and describing ways to minimize risk came about at a doctoral dissertation of a 25-year-old computer programmer. Harry Markowitz's analysis of market risk and return and how to build a minimally risky portfolio while maximizing returns, published in 1952 (Markowitz, 1952) could not have come at a better time, if only anyone paid any attention. In the 1960's a group of aggressive investment advisors and managers solely focused on performance became demi-gods among those "in-the-know." The "good times" hid the fact that these investors were just riding a wave of valuation growth that ended in the 1973 – 1974 market crash that from crest to trough wiped out 50% of the market's value. Taken with the other crises of the day; Watergate, the breakdown of the Bretton Woods Agreements, and a 50% drop in the value of the dollar, the market crash brought into stark relief that "performance" as defined by the "gurus" of the 1960s was a fantasy built upon a convenient absence of shocks in the market and steadily increasing valuations of markets.

The resulting search for ways to protect from suffering the losses experienced in the 1973 crash brought Markowitz renown throughout the investing community. His position was that portfolio construction should focus on both an expected return and a minimal variance in that return. While he never uses the word *risk* in his analysis, he identifies "variance of return" as something one avoids; over the years, risk and variance have come to mean the same thing. While Von Neumann and Morgenstern had in the past put a value, or number, on utility, Markowitz had put a number on stock market risk. In this, way risk rose to take on equal status with return. However, it is only valuable *if* investors are rational. If they invest on instinct, follow the herd, or prefer fad investment strategies not grounded in mathematical analysis, rationality, game theory and the like such as momentum investing then the application of risk vs. return balancing is irrelevant. It is unfortunate that research has pointed to deviations from "rational" are systematic among investors and that all the conditions (following fads and such) for eroding the value of Markowitz's analysis, more often than not, grip the investor and only lets them go after the "crash". While "irrational" may be an inappropriate term to apply to these behaviors, generally the outcome is no different from when one assumes no rationality.

Capital markets have been volatile throughout history. The level of volatility has largely gone unexplained, since capital markets are "bets on the future," and the future is uncertain leading to unexpected outcomes. The willingness of people to cooperate defines markets. As a buyer, one is at the mercy of what price the seller is willing to accept. As a seller, one is at the mercy of that price others are willing to buy. In an orderly market, buyers and sellers agree on the value of equity and all sellers match all buyers in price and number of shares. Disorderly markets occur when buyers and sellers have a distinctly and significantly different idea of the value of equity. Volatility occurs on the way to a disorderly market. Volatile markets have buyers and sellers entering and leaving the market at different times with random and intermittent meetings of buy/sell prices and share counts. Volatile markets may result in stock prices moving up and down until all "intermediate" buyers and sellers are cleared out. Once that happens, two camps warily eye each other across a chasm of buy and sell prices: the spread. This condition persists until information is made available that proves one group more correct than the other in their valuation of an equity.

Looking at volatility, the swings, and moves of the market, and presidential tone (whether positive or negative) yields the following findings. In the model below, the volatility is a count of "points" that the market moves as measured by the distance between the low and the high of the day. In this model all information assists in reducing volatility, which indicates that the key value added by the President is not "pushing" the market in a direction, but providing information that assists in reducing volatility. Volatility is an interesting area to analyze because it is a mark of inefficiency in the market and creates uncertainty and risk (Black F. , 1986). Little is known about the determinants of financial market volatility, largely because we have no proven theory of volatility, although we have several measures of volatility (Shiller, 1988).

Two groups dominate the thinking concerning financial volatility. The first is a qualitative explanation called behavioral finance (Shiller, 1981). The second is the efficient market hypothesis (Fama, 1965). Behavioral finance started with an argument that market volatility was a result of the mental state of the investing and trading public (Seldon, 1912). Later, the idea of cognitive dissonance (Festinger, Riecken, & Schachter, 1956) was developed. Cognitive dissonance was an uncomfortable feeling that arose from conflicting thoughts and information. To alleviate the problem, investors would ignore information that conflicted with expectations (Caplan, 2007). This leads to irrational decision-making (Tversky & Kahneman, 1981) and speculative markets (Arrow K. J., 1983).

Efficient market hypothesis argues that large numbers of rational, profit maximizers, will compete to predict future market values. As information becomes available to the public, actors will race to inefficiencies, thereby eliminating them (Fama, 1965) (Merton R. C., 1973) (Lucas, 1978) (Breeden, 1979) (Malkiel, 1973). Actors act in a profit-maximizing manner and the whole market has all information required to be efficient in the long run available to it. It is possible for short duration inefficiencies to exist, but these rapidly disappear.

Mounting evidence is available that points to market actors acting in ways that do not align with the efficient market hypothesis. Indeed, a range of actions from responding to the market instead of news, crisis reactions, and opinion are important drivers of market activity in many studies (Shiller, 1988) (Landberg, 2003) (Hilsenrath, 2004). One of the earliest of these theories is feedback theory that asserts that when markets behave a certain way and some investors benefit, others attempt to emulate the success and expectations are heightened for further market moves (Shiller, 2003) (Andreassen & Kraus, 1990) (Smith V. , 1988) (Marimon, 1993) (Daniel, 1998). Other research demonstrates that markets are more volatile than efficient market theory would indicate (Le Roy & Porter, 1981). Another dynamic that affects market behavior is the aggregate aversion or acceptance of risk (Dalton, 1988).

Martin's analysis places his conceptual framework within the context of the efficient market hypothesis. He sees presidential signals as being available to all actors in the market. Since all actors are profit seeking, they add the signals to their information and make market decisions. Adding a variable that affects decision making, risk taking, or perception and asserting that it's influence is felt as market volatility and that this variable can better define the effect of presidential signaling is taking Martin's work out of the efficient market model and places it squarely in the behavior model. Magnetic fields may result in increased anxiety, risk aversion, risk taking, and enhanced or altered perceptions. Every day market volatility, performance, and how the market views presidential signals all reflect the possible influence of magnetic fields.

7.1 Daily Trading Range

The analysis of magnetic field influence on markets and how they may or may not assist analysts in understanding how presidential signaling may be perceived starts with a simple look at how magnetic fields on their own may be influencing a measure of market volatility. One measure of stock market volatility is the distance or space that exists daily between the lowest trading value of the market and the highest. "Wild" swings in prices are indicative of markets that are in crisis, lack transparency, or are suffering from information and perception problems. Analysis shows a possible relationship between the high-low ranges of the stock market a day after total field strength is measured. The model shows that the magnetic field variable is significant, and, as the total field increases in value, the distance between the daily low and the daily high of the stock market gets smaller. If the total field is broken down into its component parts three components are significant. Analysis shows the three components are significant. It also shows as the y and h component increases in value, the distance between the daily low and daily high increases. The z component tends to offset the effects of increases in the h component.

Table 51 Expected daily market volatility

Variables	Daily Market Volatility (Distance between High and Low) and Magnetic Fields		Daily Market Volatility (Distance between High and Low) and Magnetic Fields	
	Observations = 3,246	Pseudo R2 = .5216	Observations = 199	Pseudo R2 = 0.0227
	Coef & Std Dev	Significance	Coef & Std Dev	Significance
Total Magnetic Field (1,000s)	**-.904**	0.000 ***		
	(0.0026)			
H Component			**.0014**	0.010 ***
			(0.0005)	
Z Component			**-.0011**	0.000 ***
			(0.0002)	
Y Component			**-.0127**	0.000 ***
			(0.0018)	
Constant	**-6.028**	0.000 ***	**-1.009**	0.000 ***
	(0.0313)		*(0.158)*	

* P<.1 ** P<.05 *** P<.01

By themselves these models only tell us that there is a possible relationship between the magnetic field and stock market volatility, or the daily range between the low and the high. When the magnetic variable is included in a developed model the results become much more compelling.

7.2 The Influence of the President and Magnetic fields

Research has looked at the President of the United States as an influence on the market. Volatility resulting from signals from the President as well as the influence of magnetic field can be determined with appropriate models (Martin, 2008). Thomas Martin's research sought to determine if the "President's rhetorical leadership produces tangible outcomes, market responsiveness (Martin, 2008). Market responsiveness is a term Martin uses to denote market volatility. Some disagreement exists among scholars as to the effectiveness of presidential rhetoric on market outcomes. Many insist that the evidence is problematic and that often the relationship is spurious, with the market reflecting public opinion that already existed prior to the presidential communication. Therefore, presidential rhetoric is largely symbolic (Edwards, 2003) (Cohen J. E., 1997). A substantial body of literature on the President's impact on economic variables also exists, even though there is little in the way of analysis on his direct or indirect influence on stock market volatility (Beck, 1991) (Light, 1999) (Niskanen, 1988) (Roundtree, 1995) (Tufte, 1978) (Wood, 2004) (Eshbaugh-Soha, 2005).

The President rises to a singular level of importance because of a couple of factors. First, the President is a singular voice versus the hundreds that are in congress (Corwin, 1957). Second, the executive is "always in session, has first mover advantage, and acts swiftly" (Martin, 2008). Finally, while the President's power is limited by the constitution and necessity of working with congress and being checked by the courts, the perception and expectation that the public have are not limited (Peffley & Williams, 1985) (MacKuen, Stimson, & Erikson, 1992).

Martin's conceptual framework for presidential influence on markets rests in the traditional veins of presidential study and analysis but also on the influence on markets through rhetoric (Martin, 2008). He bases his premise on Alter's (Alter, 2005) assertion that "presidential rhetoric is the most underappreciated force in politics." Authors acknowledge that presidential rhetoric could be both positive and negative (Muir, 1992). Martin concludes that presidential rhetoric is important because the President is the only official who is elected by a national constituency (Martin, 2008, p. 14). As President, the chief executive has three types of power available to them: formal, informal, and implied (Corwin, 1957) (Neustadt, 1960) (Skowronek, 1997) (Genovese, 1995). It would be through the extension of formal executive power, rhetorical leadership TULIS 1987. Martin's study focuses on the power of the presidential "signal." The signal represents information communicated to individuals that allow them to make decisions (Eshbaugh-Soha, 2006). Marin hypothesizes that what Presidents say formally and informally influences financial decisions and through them stock market volatility.

Presidents express their optimism or pessimism about the U.S. economy and become the most visible economic commentator in the U.S. system (Wood, 2004) (Wood, Owens, & Durham, 2005) (Wood, 2007). The President can communicate their rhetoric without delay and unilaterally (Wood, 2004, p. 573). Evidence suggests that Presidents can use rhetoric to influence approval ratings (Cohen & Hamman, 2003) and media and Congressional attention to economic issues (Druckman & Holmes, 2004) (Eshbaugh-Soha & Peake, 2005). Presidential rhetorical power is enhanced because the public views the President has an informed opinion given the office's unsurpassed resources (Roundtree, 1995, p. 330).

Others assert that the study of the presidency is primarily concerned with the "institutional practice, political authority, the exercise of presidential power, and influence" (Tulis 1987). Therefore, presidential rhetoric is a legitimate area of study with important relationships to explore (Whittington, 1997). There is also a compelling body of analysis that demonstrates empirical relationships between presidential rhetoric and economic variables, such as inflation and unemployment (Wood, 2004) (Wood, Owens, & Durham, 2005) (Wood, 2007). Further, the speed of presidential rhetoric differs significantly from the rate of bargaining. Unlike executive bureaucrats who move at their leisure, presidential rhetoric moves at the speed of the news cycle (Howell, 2003).

Table 52 shows the results of Martin's analysis on how presidential signaling may affect volatility in stock markets. Table 53 shows what Martin's analysis would have shown with magnetic field as an independent variable. Martin codes the first time that a President brings positive or negative messages to the market, ignoring repeats or recasting of the same message. Martin's measure of volatility is the percentage change in value of the market as defined by the various Dow indexes and the NASDAQ index (Martin, 2008).

Adding in the impact of magnetic field in the form of Ap shows a slight improvement in the explanatory power of the model. Given the range of values for Ap, its impact in relative terms seems less than that of the President's tone on the relevant issues. As Ap is higher, volatility is lower. However, the weakness in this model lies in the fact that it does not distinguish among the many ways in which the distance is generated and what the daily outcome of market moves look like. First, the distance could have fallen from a high value to a low value. Second, the distance could have risen from a low value to a high value. Third, the distance could have resulted from an increase, then a decrease, and then another increase resulting in a small, if any, difference in closing and opening prices. In the end, this model provides some explanatory power and highlights the effectiveness that Presidents have in communicating to the public and reducing volatility through providing information.

Table 52 Expected market daily volatility without magnetic field

Daily Market Volatility (Martin's Measure), Presidential Messaging, and Economic Control Variables

	Observations = 4,811	Pseudo R2 = .1952	
Variables	Coefficient and Standard Deviation	Significance	
Positive Deficit Message	**0.6691** *(0.0953)*	0.000	***
Negative Deficit Message	**0.1243** *(0.0361)*	0.001	***
Positive Economic Message	**-0.0091** *(0.0038)*	0.015	**
Negative Economic Message	**0.0001** *(0.0000)*	0.001	***
Positive Inflation Message	**-.6975** *(0.0194)*	0.000	***
Negative Inflation Message	**-.5666** *(0.0341)*	0.000	***

Table 52 Continued			
Positive Interest Rate Message	**-.4703** *(0.023)*	0.000	***
Negative Interest Rate Message	**-.7975** *(0.0305)*	0.000	***
National Unemployment Rate	**-.7215** *(0.0009)*	0.000	***
National Inflation Rate	**-.0526** *(0.0005)*	0.000	***
Federal Reserve Board's Funds Rate	**-.1921** *(0.0007)*	0.000	***
Ap Index (Magnetic Field)			
Constant	**-10.938** *(0.0063)*	0.000	***

* P<.1 ** P<.05 *** P<.01

Table 53 Expected market daily volatility with magnetic field

Daily Market Volatility (Martin's Measure), Presidential Messaging, and Economic Control Variables

Observations = 4,811   Pseudo R2 = 0.1969

Variables	Coefficient and Standard Deviation	Significance	
Positive Deficit Message	**0.8951** *(0.0127)*	0.000	***
Negative Deficit Message	**-0.6891** *(0.0265)*	0.060	*
Positive Economic Message	**-0.8614** *(0.0082)*	0.100	*
Negative Economic Message	**-0.9613** *(0.0092)*	0.087	*
Positive Inflation Message	**-.7264** *(0.0194)*	0.000	***
Negative Inflation Message	**-.5222** *(0.0342)*	0.000	***

Table 53 Continued			
Positive Interest Rate Message	**-.4302** *(0.0229)*	0.000	***
Negative Interest Rate Message	**-.8204** *(0.0305)*	0.000	***
National Unemployment Rate	**-.7124** *(0.0009)*	0.000	***
National Inflation Rate	**-.0494** *(0.0005)*	0.000	***
Federal Reserve Board's Funds Rate	**-.1900** *(0.0007)*	0.000	***
Ap Index (Magnetic Field)	**-.0078** *(0.0001)*	0.000	***
Constant	**-10.967** *(0.0063)*	0.000	***

* P<.1 ** P<.05 *** P<.01

If one looks at the President as a communicator and provider of information regardless of tone, positive or negative the model looks like Table 54. This may indicate that the net effect of presidential signaling is to increase volatility. Perhaps his signals only confuse and increase uncertainty in the market?

Table 54 Expected daily market volatility

Daily Market Volatility (Martin's Measure), Presidential Messaging Without Regard to Positive or Negative Message

	Observations =3,863	Pseudo R2 = .7853	
Variables	Coefficient and Standard Deviation	Significance	
Presidential Messaging	**0.0284**	0.000	***
	(0.0047)		
National Unemployment Rate	**-.3420**	0.000	***
	(0.0040)		
National Inflation Rate	**-.0025**	0.000	***
	(0.0009)		
Federal Reserve Board's Funds Rate	**-.0989**	0.000	***
	(0.0022)		
Total Magnetic Field (1,000s)	**-.8308**	0.000	***
	0(.0111)		
Constant	**-2.592**	0.000	***
	(0.161)		

* P<.1 ** P<.05 *** P<.01

To get a true view of presidential impact, a look at the volatility as a percentage of the total composite value is necessary and displayed in Table 55. Repeating the analysis and adding magnetic field variable results in Table 56. Such a model using presidential tone by subject area does nothing to assist in explaining or predicting volatility, while the total field strength does.

Including a magnetic field variable in models moves some subjects of presidential communications towards significance. Collapsing Presidential Signals into only two categories, positive and negative, does not produce an appreciably better model or additional significant variables. Collapsing Presidential Signals into only *one* category, Presidential Market Signals does not either.

Table 55 Expected daily market volatility

Daily Market Volatility (Distance from High to Low), Presidential Messaging, and Economic Control Variables

	Observations = 4,781	Pseudo R2 = .0050
Variables	Coefficient and Standard Deviation	Significance
Positive Deficit Message	**0.0742** *(0.0748)*	0.321 -
Negative Deficit Message	**-.0357** *(0.1371)*	0.795 -
Positive Economic Message	**0.493** *(0.0504)*	0.328 -
Negative Economic Message	**0.0548** *(0.0610)*	0.369 -

Table 55 Continued			
Positive Inflation Message	**-.0023**	0.983	-
	(0.1071)		
Negative Inflation Message	**.0299**	0.868	-
	(0.1798)		
Positive Interest Rate Message	**-.0456**	0.749	-
	(0.1424)		
Negative Interest Rate Message	**-.0958**	0.573	-
	(0.1699)		
National Unemployment Rate	**-.0513**	0.000	***
	(0.0077)		
National Inflation Rate	**-0119**	0.008	***
	(0.0045)		
Federal Reserve Board's Funds Rate	**.0022**	0.601	-
	(0.0042)		
Total Magnetic Field (1,000s)			
Constant	**1.043**	0.000	***
	(0.0472)		

* P<.1 ** P<.05 *** P<.01

Table 56 Expected daily market volatility with and without magnetic field variable as control part 2

Daily Market Volatility (Distance from High to Low), Presidential Messaging, and Economic Control Variables

	Observations = 3,866	Pseudo R2 = 0.0121
Variables	Coefficient and Standard Deviation	Significance
Positive Deficit Message	**0.1132** *(0.0798)*	0.156 -
Negative Deficit Message	**-0.0814** *(0.1624)*	0.616 -
Positive Economic Message	**.0448** *(0.0571)*	0.433 -
Negative Economic Message	**.0582** *(0.0672)*	0.386 -
Positive Inflation Message	**-.0188** *(0.1325)*	0.887 -
Negative Inflation Message	**-.0844** *(0.2496)*	0.735 -

Table 56 Continued			
Positive Interest Rate Message	**-.0435** *(0.1594)*	0.1594	-
Negative Interest Rate Message	**-.0930** *(0.1982)*	0.639	-
National Unemployment Rate	**-.1584** *(0.0213)*	0.000	***
National Inflation Rate	**-.0054** *(0.0055)*	0.331	-
Federal Reserve Board's Funds Rate	**-.0377** *(0.0111)*	0.001	***
Total Magnetic Field (1,000s)	**-.1451** *(0.0607)*	0.017	**
Constant	**3.554** *(0.0472)*	0.000	***

* P<.1 ** P<.05 *** P<.01

Perhaps presidential signaling affects the scale of volatility and not its absolute measure or relative percentage volatility. Analysts could use Presidential signals to explain or predict whether market volatility as measured as the distance the market moves from low to high for the day will rise above its average volatility. Table 57 shows the results of a model of a market having volatility higher than average. This model categorizes negative economic messages as significant and resulting in an increase in volatility, but the magnetic field variable is not significant.

Table 57 Probability that daily market volatility will be above average

Variables	Probability of Above Average Daily Market Volatility (Distance from High to Low)	
	Observations = 3,863	Pseudo R2 = .0923
	Coefficient and Standard Deviation	Significance
Positive Deficit Message	**0.1861**	0.226 -
	(0.1535)	
Negative Deficit Message	**-.1281**	0.659 -
	(0.2898)	
National Unemployment Rate	**-.4658**	0.000 ***
	(0.0381)	
National Inflation Rate	**-.0437**	0.000 ***
	(0.01)	
Federal Reserve Board's Funds Rate	**-.0847**	0.000 ***
	(0.0193)	
Total Magnetic Field (1,000s)	**.1449**	0.186 -
	(0.1095)	
Constant	**5.23**	.001 ***
	(1.55)	

* P<.1 ** P<.05 *** P<.01

Collapsing the categories of presidential messaging into only positive and negative presidential signals in general yields the results displayed in Table 58. Neither of the presidential message variables is significant in modeling above average volatility. The magnetic field variable is significant though.

Table 58 Probability that daily market volatility will be twice the average

Probability of Average Daily Market Volatility Twice the Average
(Distance from High to Low)

	Observations = 3,863	Pseudo R2 = .0078	
Variables	Coefficient and Standard Deviation	Significance	
President Positive Message	**0.0775** *(0.0793)*	0.328	-
President Negative Message	**-.0637** *(0.1165)*	0.584	-
Positive Interest Rate Message	**-.1112** *(0.2944)*	0.706	-
Negative Interest Rate Message	**-.2644** *(0.3493)*	0.449	-
National Unemployment Rate	**-.1827** *(0.0423)*	0.000	***

Table 58 Continued			
National Inflation Rate	**-.0194** *(0.0111)*	0.081	*
Federal Reserve Board's Funds Rate	**-.0189** *(0.0218)*	0.386	-
Total Magnetic Field (1,000s)	**.3637** *(0.1215)*	0.003	***
Constant	**4.552** *(1.725)*	.008	***

* P<.1 ** P<.05 *** P<.01

The model for days when the market volatility is twice as large as average market move demonstrates that the President's negative or positive message is not significant in explaining this behavior, but the total geomagnetic field's strength is significant. However, positive Presidential signals can result in days where the movement as a percentage of the market value is three times the size of average market volatility as measured by the distance the market moves as a percentage of value, while the total field strength remains significant. This chart displays the results of estimating the marginal influences on the dependent variable, volatility, when a one-unit increase in the explanatory variables occurs. The marginal influence represents the likelihood that the dependent variable will be 1. In this sample, 1 equates to having volatility 3 times greater than the average. If the President presents a positive message then it increases the likelihood of the next day having 3 times the average volatility around 2.7%. The change in likelihood associated with the Federal Reserve rate is -.16% for each 1 unit change in the interest rate. A one-unit change in the total magnetic field only changes the probability of having a 3 times the average volatility day by .0011%.

Evaluating the values in the sample allows us to say that *in this sample* the net effect of the magnetic field is much larger. The explanatory variable positive presidential message only has two values, 1 and 0. Likewise, the Federal Funds rate has a limited range of values, 1 to 20. Since 1971, the highest Federal Funds rate has been is 20%

(Bank, 2012). The total magnetic field can have a value from 0 to over 11,000 units. This means that it is possible that a positive presidential message will only have an expected effect of increasing the likelihood of the outcome by 2.7%. The Federal Funds rate could have an effect equal to approximately 3% increase in the likelihood of a day having volatility 3 times higher than the average. If unemployment is at 10% then the likelihood of having a day with volatility 3 times the average is 5.9%. Finally, if the total magnetic field moves 50% of its estimated 11,000 units, it would result in an increased probability of volatile days equal to at least 3 times the average of around 6.22%. To increase the probability equal to that of unemployment would require a change in total magnetic field of only 5,300 units. A change of only 2,650 units, or 24%, is necessary to find a 3% change in likelihood that a day will be 3 times as volatile as the average day. Only around 2,380 units, 22% has the same effect as presidential messaging. Remember, one cannot claim any knowledge of the population or what the *actual* values of the variable impacts on the dependent variable may be. This model only tells us that it is unlikely that these coefficients are actually zero.

Table 59 Change in probability that the daily volatility will be three times the average

Change in Probability that a Day with be Three Times as Volatile as the Average Volatility for the Sample

dprobit model	Observations = 3,719	Pseudo R2 = .1008	
	Change in Probability		
Variables	Standard Error	Significance	
President Positive Message	**0.0027 (2.7%)**	0.052	-
	(0.0016)		
National Unemployment Rate	**-.0059 (5.9%)**	0.000	***
	(0.0016)		
National Inflation Rate	**-.0005 (.05%)**	0.885	-
	(0.0003)		
Federal Reserve Board's Funds Rate	**-.0016 (.16%)**	0.042	**
	(0.0008)		
Total Magnetic Field (1,000s)	**0.0113 (1.13%)**	0.002	***
	(0.1215)		

* P<.1 ** P<.05*** P<.01

7.3 Absolute Change in Market Value

Another dynamic may be at play and needs to be considered. It could be that presidential signals are only good if they conform to existing economic and financial data. For instance, a presidential speech replete with positive tones about the economy may have a measurable effect only when supported by measures of finance and improving economic indicators. In this model the fed rate, unemployment, and inflation get better if they are lower than the day before. If they are lower than the day before and the President spoke in positive terms about that metric the same day then the market listens, the President is coded giving a valid message. If the President speaks in positive terms and the metrics are the same or worse, then his attitude is interpreted as cheerleading and discounted. The message is coded as invalid. This may explain why his theoretic and tone are not found to be a significant explanatory variable for market moves in many previous analysis. Table 60 shows the probability that the market will be up at close versus the open if the presidential signals match economic indicators. This model shows that if market conditions match presidential positive signals, then the market will close up higher than if the President's positive economic indicators do not support message.

We see in the Table 61 that, in fact, when analysts view the President as having his tone on unemployment confirmed by the unemployment rate getting better, the probability of the market closing higher increases. The direction of effect that unemployment rate getting better is in line with expectations. Lower unemployment rates result in smaller decreases in the probability of having an up day. Of note, this model does not have a significant magnetic field variable. It represents a weakness in the hypothesis that the magnetic field may have more influence than the President's message. A model with the market closing down from its open has no variable of interest significant in explaining the outcome.

Table 60 Change in probability that the Dow Index will close up versus its open

	Change in Probability that the Dow Jones Will Close Up Versus its Open	
dprobit	Observations = 3,876	Pseudo R2 = .0023
Variables	Coefficient and Standard Deviation	Significance
President Positive Message Valid	**0.3586 (35.86%)** *(0.1771)*	0.043 *
National Unemployment Rate Gets Better	**-.1089 (-10.89%)** *(0.0562)*	0.056 *
National Inflation Rate Gets Better	**.1240 (12.40%)** *(0.0519)*	0.022 **
Federal Reserve Board's Funds Rate Gets Better	**-.0643** *(0.0687)*	0.351 -
Total Magnetic Field (1,000s)	**-.0007** *(0.0174)*	0.966 -

* P<.1 ** P<.05 *** P<.01

If one categorizes the President as a catalyst that pushes markets up or down beyond the average expected move, then determining if the President's tone results in increases or decreases significantly beyond the average is necessary. The President talking positively in general about economic and financial metrics is useful in modeling market increases above the lifetime average daily increases. This chart shows that, by itself, positive presidential tone can increase the probability that the market will end the day up above its lifetime average daily increase. By itself, positive presidential tone about the economy and finance are not useful in modeling market increases two and three times the lifetime average.

When we add magnetic field to the model presidential tone is no longer significant, while the magnetic field variable is significant at the 0.1 level. This model is different from the previous examination of the magnetic field's effect on presidential messaging. The previous model evaluated a validated presidential message and its probability of having the market close up. Table 61 highlights the spurious nature on the President's positive message (regardless of whether they are validated) on the market closing up above the average for market increases. When the magnetic field variable is included in the model, the President's positive messages are not significant and the probability for closing higher than the average percentage close is much reduced. Without the magnetic field variable, the President's positive message has a very large influence in the probability that the market will close a percentage higher than the average percentage increase. These two models indicate that presidential messaging may be spurious and its effect over-estimated.

Table 61 Effect of a magnetic field variable on the significance of presidential positive messaging.

	Change in Probability that the Dow Jones Will Close Up Above the Average Increase		Change in Probability that the Dow Jones Will Close Up Above the Average Increase	
	Observations = 19425	Pseudo R2 = .0614	Observations = 4,125	Pseudo R2 = 0.0011
Variable	Coefficient and Standard Deviation	Significance	Coefficient and Standard Deviation	Significance
President Positive Message	**0.1775 (17.75%)** *(0.0170)*	0.058 *	**0.0173** *(0.0210)*	0.410 -
Total Magnetic Field (1,000s)			**.0193 (1.93%)** *(0.0105)*	0.066 *

* P<.1 ** P<.05 *** P<.01

Negative presidential messages, even when controlling for magnetic field values, do not help in modeling days when the market is down above the average decline, when the market is down twice as much as the average daily decline, or when the market is down three times as much as the average daily decline by itself. There were 3,168 days in the sample when the market declines more than the average and 16,257 days when the sample declined less than the average. There were 963 days when the market declined twice the average daily decline. There were 354 days when the market declined three times the average daily decline. There are 19,425 total days of market activity in the sample.

7.4 Highs and Low vs. Open and Close Values

A possible criticism of the previous analysis is that we are trying to model the wrong dynamic. It could be that what one really wants to know about presidential tone's impact on volatility is how much it makes the market move between its daily high and low in relation to its final distance traveled from open to close. For instance, a day in which the market has a high and low that was 100 units apart but the difference between the open and the close was only 10 units would have a ratio of 10:1 or 10. Another day may see the market high and low that was 200 units apart but the difference between the open and the close was actually 100 units. This day would have a ratio of 2:1 or 2. In the first example, even though the high and low represented less distance than in the second example, it represents greater volatility and increased uncertainty. Since our assumption is that presidential tone provides signals that are integrated as information to reduce uncertainty, presidential information should reduce this ratio, unless the information directly contradicts established economic and financial evidence.

Table 62 shows, when the ratio measure of volatility is modeled, Martin's model shows presidential signaling as being strongly significant. The magnetic field variable is significant as well. Of interest in Table 62 is deficit messaging, both positive and negative, which indicates its tendency to increases the ratio measure of volatility. However, negative deficit messages almost double the ratio versus the positive defense messages. In contrast, economic messaging reduces the ratio measure of volatility, but negative messaging has double the effect of positive messaging. Positive messaging about inflation results in lowering the ratio measure of volatility while negative messaging about inflation increases the ratio. Positive messaging about interest rates result in increasing ratio measure of volatility while negative messaging decreased the measure.

Table 62 Expected ratio of the distance from daily low to high versus the daily open and close prices of the Dow Index

	The Ratio of Daily High-Low Range to the Distance from the Open to the Close Value	
	Observations = 3,849	Pseudo R2 = .0256
Variable	Coefficient and Standard Deviation	Significance
President Positive Deficit Message	**0.4219** *(0.0278)*	0.000 ***
President Negative Deficit Message	**.7518** *(0.0465)*	0.000 ***
Positive Economic Message	**-0.7518** *(0.0257)*	0.000 ***
Negative Economic Message	**-0.3197** *(0.0326)*	0.000 ***
Positive Inflation Message	**-1.1003** *(0.0917)*	0.000 ***
Negative Inflation Message	**.2168** *(0.1010)*	0.032 ***

Table 62 Continued			
Positive Interest Rate Message	**.5926** *(0.0481)*	0.000	***
Negative Interest Rate Message	**-0.5270** *(0.1078)*	0.000	***
National Unemployment Rate	**-.0603** *(0.0092)*	0.000	***
National Inflation Rate	**-.0110** *(0.0024)*	0.000	***
Federal Reserve Board's Funds Rate	**-.0804** *(0.0048)*	0.000	***
Total Magnetic Field (1,000s)	**.1277** *(0.0262)*	0.000	***
Constant	**1.873** *(0.375)*	.000	***

* P<.1 ** P<.05 *** P<.01

Using both previous models and Clarify (Tomz, Wittenberg, & King, 2001) (King, Tomz, & Wittenberg, 2000) one can run simulations and see based on the sample that if the President is able to avoid commenting either negatively or positively on deficits, the economy, inflation, and interest rates but unemployment, inflation, and the federal funds rate are at their historical averages the expected amount of volatility is 11.36 units. This means that the distance between the daily high and low will be 11.36 times the distance between the daily open and close. Therefore, a day the index opens at 8000 and closed at 8005 could see a low-high range of 55 points. This analysis does not have anything to say about where on the continuum of market valuation the 55 points fall around the open and close space. Given the information available, we would expect on average that the market would remain roughly in the range of 7945 and 8060 points in this example.

There is evidence that there is an impact on markets from presidential tone. First, positive, and negative tones on the deficit result in increases in volatility. Negative tones have a coefficient almost twice that of positive deficit statements. The context of deficit positive statements dealt with budget surpluses spurned uncertainty as to what government would do with those surpluses. In the context of negative statements, dealing with deficits the context is generally that continuing deficits could threaten solvency, dollar values, exports, consumer spending, and other critical aspects of the economy. It could be that the best way to use discussions of the deficit to reduce uncertainty and have less volatility in market indexes is not discuss the deficit.

Using Clarify (King, Tomz, & Wittenberg, 2000) to run simulations and estimate the effect on volatility when the President talks positive about only deficits and unemployment, interest rates, and inflation are at their historical average yields the following expected outcome on volatility. This is 6 units higher than when the President does not comment on deficits. When the President talks of deficits in negative terms, volatility increases significantly. The low-high range for the day is on average 17 times the distance of the daily open and close distance when the President speaks positively about deficits. This grows to 24 times on average when the President talks negatively about deficits, or twice the volatility as when the President refrains from messaging.

Positive talk about the economy generally decreases volatility as measured by the ratio of the distance between the daily low and high and the distance between open and close. Negative talk about the economy results in lower volatility as well. Simulating the expected level of volatility and comparing the impact of presidential positive versus negative talk concerning inflation shows that negative talk results in lower volatility. A note of interest is that positive discussion of the economy puts volatility near, but still below, the historical average volatility for the composite index. Negative talk of the economy puts volatility well below the historical average volatility.

Analysis in this chapter shows that talk of inflation in positive terms results in a decrease in volatility while talk of inflation in negative terms results in an increase in volatility. In the sample, the coefficient of positive talk of inflation is almost 5 times as large as the coefficient for talking negatively about inflation when controlling for the total geomagnetic field strength. Positive presidential talk concerning inflation results in volatility that is 1/4th the historical average for the composite index and less than 1/4th the volatility of when the President speaks negatively about inflation, which results in volatility that is higher than the historical average.

Previous analysis is evidence that positive talk of interest rates result in a counter-intuitive conundrum for markets. Interest rates that are "good" are low rates. Low interest rates are generally indicative of an economy that is attempting to recover from some economic or financial misfortune. Also, low interest rates result in constant "guessing" and "projecting" that higher rates are imminent while markets react to rumors and attempt to interpret all messages related to rates to glean information as to when rates will increase and by how much. Increasing rates disrupts the economic and financial trajectories and changes the risk-reward calculus of today and the future. Positive talk of interest rates results in volatility that is almost twice the historical average volatility in the composite index.

Negative talk of interest rates generally deals with rates that are too high, rates that are choking off economic and financial innovation, growth, and strength. High rates are meant to do one of two things. First, they are designed to increase the cost of money so that economic growth will fall to sustainable levels, thereby avoiding inflation and smoothing out "boom-bust" cycles. Second, high interest rates are the critical tool in battling high inflation regardless of the reason for the inflation. Therefore, high rates signal to the market that the Federal Reserve is engaged and winning the fight on inflation and on track to manage an over-heated economy to a "soft landing." More importantly, high rates rarely go higher. High rates are generally followed by lower rates as economic and financial management succeeds in either tames the economy and inflation or crashes the economy. Negative talk of interest rates as being too high guarantee an eventual decline in rates; which is a good thing from the market's perspective. Therefore, the fact that positive presidential talk of interest rates results in increased uncertainty as to when rates will be forced higher by economic growth or inflation, while negative presidential talk of interest rates results in decreased uncertainty as market players start to look forward to a time of reduced interest rates and the accompanying growth.

Negative talk about where interest rates are results in a decrease in volatility to almost ½ the historical average the composite index and 1/3rd of the volatility had the President talked positive instead. In this case, negative messaging ensures that the direction of the open and close of the market moves in the same direction as the high and low market value relationship in given days. Table 63 shows from left to right:

1. The classification of the presidential messages included in the simulation.

2. The estimated ratio of the daily low to high range divided by the daily open to close range.

3. The lower 95% confidence interval value of the volatility ratio

4. The higher 95% confidence interval value of the volatility ratio.

5. The set of dummy variables. Marked yes if the variable was valued at 1, marked no if the variable was valued at 0, for the simulation.

6. The list of control variables set their sample mean.

Table 63 Simulated estimated market volatility ratio determined by explanatory variables

Message	Estimated Volatility Ratio	Lower 95%	Upper 95%	Dummy Variables (YES, NO or 1,0)							
				Negative Deficit Message	Negative Inflation Message	Negative Economic Message	Negative Interest Rate Message	Positive Interest Rate Message	Positive Deficit Message	Positive Economic Message	Positive Inflation Message
NEGATIVE	**24.043**	*22.011*	*26.419*	YES	NONE	NONE	NONE	NONE	NONE	NONE	NONE
NEGATIVE	**14.132**	*11.438*	*16.82*	NONE	YES	NONE	NONE	NONE	NONE	NONE	NONE
NEGATIVE	**8.257**	*7.735*	*8.811*	NONE	NONE	YES	NONE	NONE	NONE	NONE	NONE
NEGATIVE	**6.773**	*5.508*	*8.28*	NONE	NONE	NONE	YES	NONE	NONE	NONE	NONE
NONE	**11.365**	*11.255*	*11.478*	NONE	NONE	NONE	NONE	NONE	NONE	NONE	NONE
POSITIVE	**20.609**	*18.624*	*22.679*	NONE	NONE	NONE	NONE	YES	NONE	NONE	NONE
POSITIVE	**17.346**	*16.454*	*18.355*	NONE	NONE	NONE	NONE	NONE	YES	NONE	NONE
POSITIVE	**9.776**	*9.321*	*10.28*	NONE	NONE	NONE	NONE	NONE	NONE	YES	NONE
POSITIVE	**3.825**	*3.149*	*4.545*	NONE	NONE	NONE	NONE	NONE	NONE	NONE	YES

As unemployment, interest rates, and federal funds rates increase volatility decreases. These relationships are probably due to two facts. First, as these metrics deteriorate, the distance between open and close is probably all negative, or decreasing in value while the daily low and high represented by volatility stays close to the value of decline, meaning less volatility but a straight shot down in value. Second, as these values deteriorate, investors will become progressively more assured that action is on its way. Traditionally action taken to combat unemployment has been stimulus spending and jobs programs. Interest rates fall when economic activity is reduced and so is demand for liquidity in the market. To put the impact of the President's signals in perspective see the impacts of changes in unemployment, interest rates, and federal funds rate on expected volatility..

Figure 55 Simulated expected volatility given the unemployment rate with no presidential signals

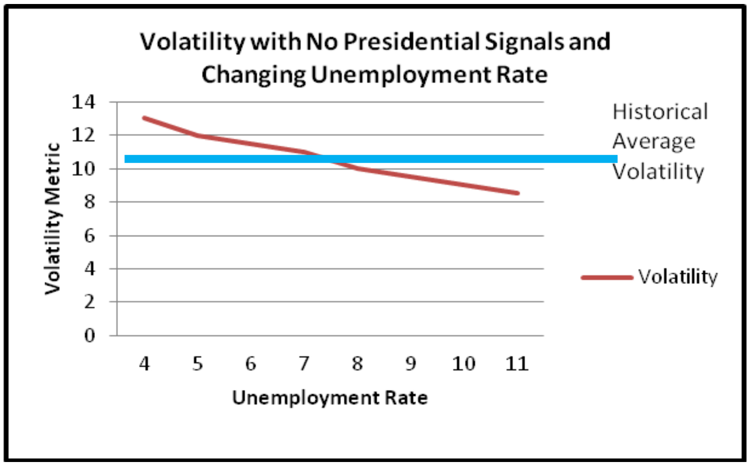


Figure 56 Simulated expected volatility given the interest rate with no presidential signals

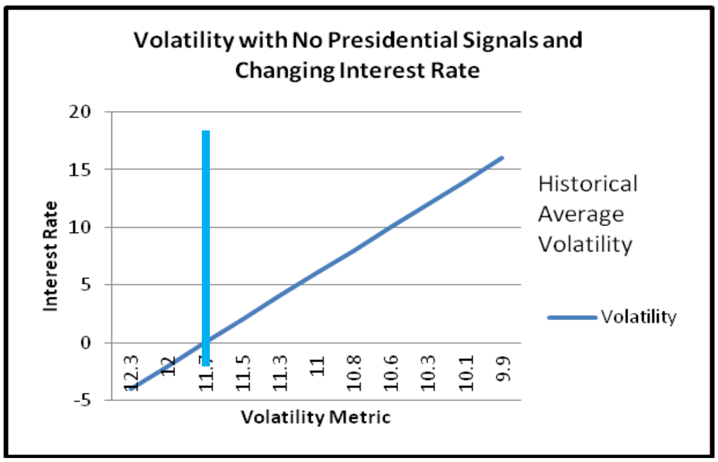
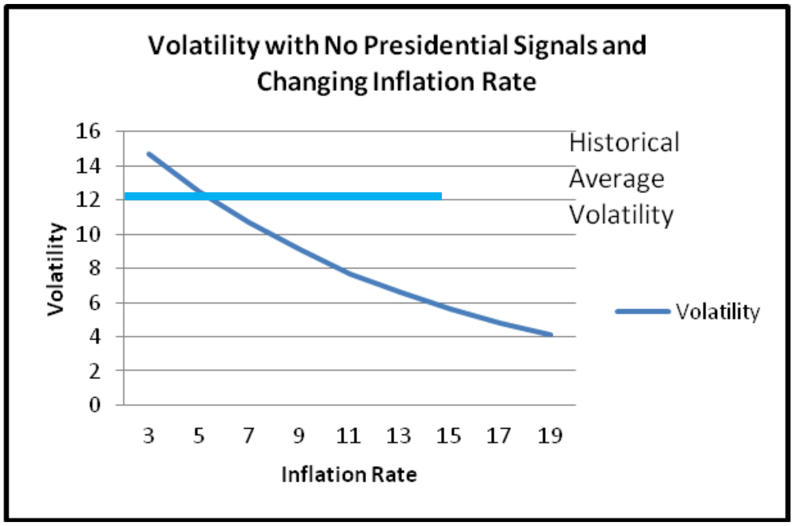


Figure 57 Simulated expected volatility with no presidential signals and inflation



7.5 Volatility Scenarios

Let us look at the impact of presidential communications and the total magnetic field measure on volatility of the Dow Jones Index in different situations with simulations using the sample available. What would the measure of volatility be if we had a situation in which the President communicated positive information about the deficit, economy, inflation, and interest rates while unemployment, magnetic field, the fed funds rate, and inflation were all at their historical mean? Unemployment would be 6.5% or well above full employment, estimated to be 4%. Inflation would be higher than the Federal Reserve target of 3% at 3.6%. The fed funds rate would be at a high of 7.25%, which is much higher than recent history. The combination of high unemployment and high interest rates would in today's market signal a President not in touch. However, over the historical period of analysis these values are quite possible. In the 1970s and early 1980s, interest rates were high to reduce inflation while unemployment was also high. Economists refer to periods like this as stagflation.

In this situation, the model would predict volatility measures between 7 and 11. Even in the worst case, this is below the historical average volatility. This may indicate that even in the face of economic data shouting negativity, in the face of total geomagnetic field effects, the President's signals resulted in reduced volatility. If we replay the simulation for a day in which the President communicated only negative information to the public concerning the economy, inflation, the Federal Reserve rate, and unemployment the expected values for volatility show that negative messaging results in higher volatility than positive messaging.

Therefore, under the exact same circumstances, volatility increases by 33% when the President communicates negative messages about deficits, inflation, interest rates, and unemployment versus sending no message according to the simulation. Other control variables are included in the simulation, but they are set to their mean. In this and previous models of presidential messaging, it seems that while controlling for magnetic field positive presidential messages tends to result in greater volatility than negative presidential messages. This finding calls for future analysis. Presidents seem to design their messages to calm the market through reduction of volatility, or the up and down gyrations of the market around its open and close values. If this is true, then any messaging is ill advised, and positive messaging just makes the situation worse, even with the message validated by other economic data.

Table 64 Simulated estimated volatility ratio with positive presidential messaging versus negative presidential messaging

Message	**Estimated Volatility**	*Lower 95%*	*Upper 95%*	Neg Deficit Msg	Neg Inflation Msg	Neg Economic Msg	Neg Interest Rate Msg	Pos Interest Rate Msg	Pos Deficit Msg	Pos Economic Msg	Pos Inflation Msg
POS	**9.096**	*7.3*	*11.1*	NONE	NONE	NONE	NONE	YES	YES	YES	YES
NEG	**12.924**	*9.7*	*16.8*	YES	YES	YES	YES	NONE	NONE	NONE	NONE

National Unemployment Rate at Mean

National Inflation Rate at Mean

Federal Funds Rate at Mean

Total Magnetic Field at Mean

7.6 Presidential signaling and magnetic field

Since some analysis on the effects of presidential signaling controlling for magnetic fields is complete, a graphical depiction of the impact of magnetic fields on volatility may be useful. Figure 58 shows the results of simulations based on statistical analysis of a sample and depicts the expected volatility ratio when the President communicates all positive messages, the other explanatory variables are at their means, but the magnetic field changes from its lowest to highest values. Figure 59 does the same for all negative presidential messaging. Both graphics depict the volatility ratio discussed previously in either an all positive or all negative presidential messaging environment. Additionally, interest rates, inflation, and unemployment are at their sample means. Finally, the graphic depicts volatility in relation to the value of the Total Geomagnetic Field.

Figure 58 Simulated expected volatility of U.S. stock market

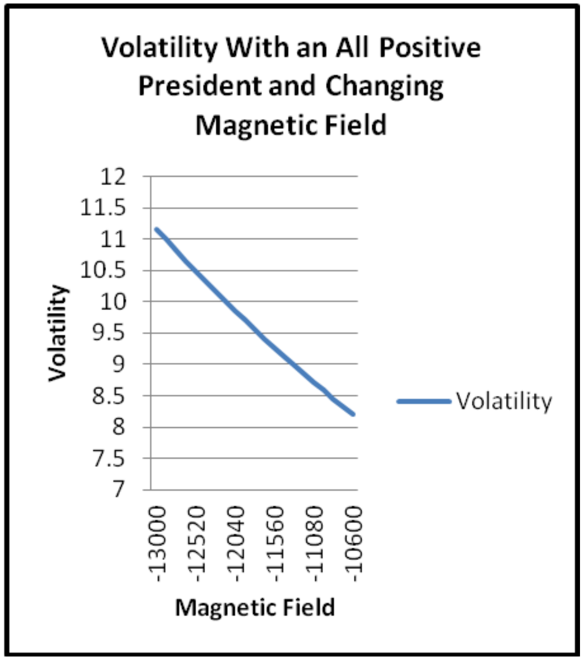
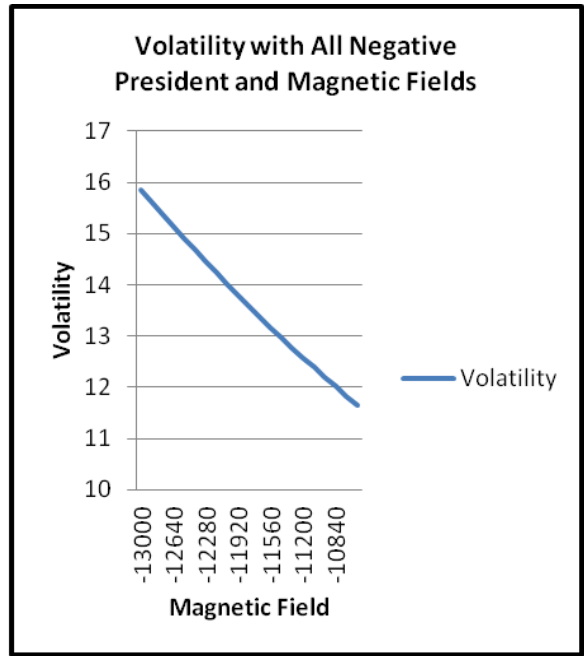


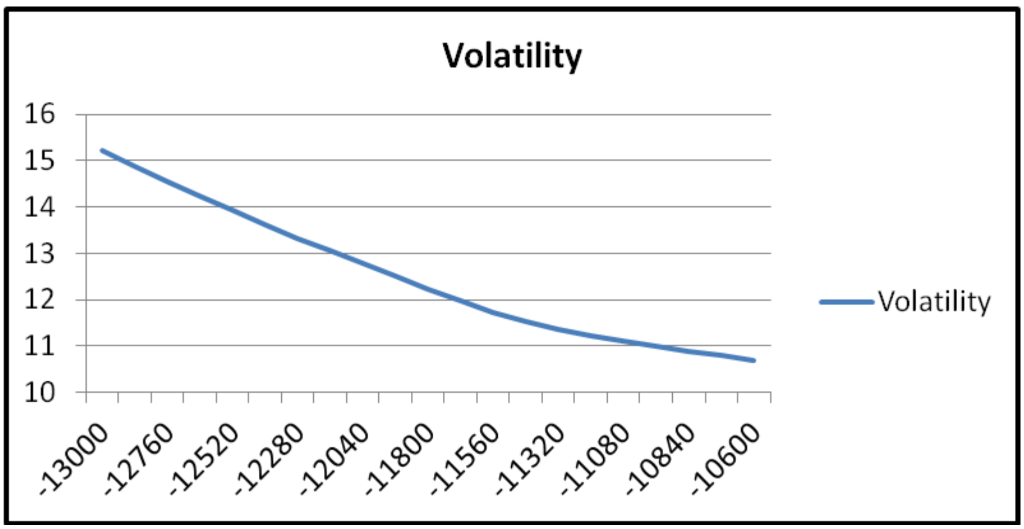
Figure 59 Simulated expected volatility of U.S. stock market



These two simulations show that in the sample when unemployment, inflation, and interest rates are at their historical average, and the President is all positive in signals, the changing magnetic field from its lowest value in the sample to its largest value in the sample is associated with the reduction of volatility. If the President is all-negative, changing magnetic field from lowest to highest value is associated with a decrease in volatility Allowing the magnetic field variable value to vary demonstrates that the control variable results in presidential signaling resulting in the market behavior desired. A negative presidential messages result in higher volatility than positive presidential messages and the effect is not only significant statistically it is substantial.

If the President is not signaling, either positive or negative, changing the magnetic field from lowest value to highest value in the sample makes volatility look like Figure 58, a simulation based on the statistical analysis of the data set.

Figure 60 Simulated expected volatility of U.S. stock market without Presidential signals



Without the President to provide signals in the sample, the magnetic field moving from its lowest value in the sample to its highest value in the sample, decreases volatility. However, when magnetic field increases to its highest value in the sample the expected level of volatility, keeping unemployment, inflation, and interest rates at their mean and without presidential signals, falls. There are indications that presidential messaging does have an impact on moderating volatility in the stock market within the sample.

The analysis presented on presidential messaging centers around understanding the nature of the magnetic field's effect on market volatility and what, if any, role it could pay in clarifying presidential rhetorical power as an influence on market volatility. The results have demonstrated a relationship among presidential signaling, magnetic fields, and the volatility of markets as measured by the ratio of the daily high and low and the final open and close values of the market index. While this measure has the weakness of not being able to differentiate among the different types of market moves and whether the market moves up or down, it does provide a useful proxy for market volatility in an absolute and relative sense. Further analysis using a more precise measure of market movements in relation to their direction and magnitude would have needed to make any definitive statements on this topic. However, including the magnetic field in Martin's models resulted in an increase in efficiency, an increase in significance, compelling simulations, and estimates of effect for both variables, and a richer context within which to understand the dynamics of presidential rhetorical power in relation to market behavior.

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Chapter 8 Conclusion: Rationality, Uncertainty, Fuzziness, Chaos and Risk

One of the first works that examined examples of systemic irrationality is the *Extraordinary Popular Delusions and the Madness of Crowds* by Charles Mackay and published in 1841. His book described a number of historical European examples of mass hysteria, manias, bubbles, and systemic irrationality. He examines one of the earliest examples of economic bubbles, the Mississippi Company of 1684-1720. The bubble began in 1719 when the Company was given monopoly over the French territory of Louisiana and earned a monopoly on all French naval commerce and burst in 1720. Around the same time, Britain suffered from the South Sea Bubble, caused by the granting of monopoly trading rights with South America to the British public-private partnership called the South Sea Company. The company stock soared in value and finally burst in 1720. There was never a realistic expectation that the company could make a profit, as England and Spain were involved in the War of the Spanish Succession and all of South America was a Spanish colony. Mackay also detailed the Dutch Tulip mania that occurred during an outbreak of plague and a break in the Thirty Years War in the early 1600's. Of particular interest is Mackay's analysis of other non-economic mania. For instance, he argues that the entire period of the Crusades was but a mania of the Middle Ages. He also classifies the 16th and 17th century witch hunts as mania. He has a number of other mania examples such as haunted houses, duels, and fashion trends such as haircuts and facial hair (Mackay, 2009).

A later work examines crowd psychology and concludes that crowds act in ways that are irrational. He asserts that crowds have reduced ability to reason, have their own unique sentiments and morality, their own crowd-beliefs, and take on definitive characteristics with definable and identifiable characteristics. These crowds act as an organism that find itself stimulated and affected by outside influences as one entity and not as a group of individuals (Le Bon, 2002).

Manias, Panics and Crashes: A History of Financial Crises by Charles P. Kindleberger, and in later editions Robert Aliber, is a much more contemporary look at modern economic mania, or economic bubbles. Kindleberger retraces Mackay's steps and examines the early manias of France, Britain and the Dutch. He then examines the U.S. stock price bubble from 1927 to 1929 and again from 1995 to 2000, loans to developing countries in the 1970s, Japanese real estate in the late 1980s and southeast Asia in the 1990s, and finally the real estate bubbles from 2002 to 2007. The themes running through the book are rationality became subsumed and decision making became corrupted as a result of the recall ability fallacy and a collective willingness to forget economic theory and that the Minsky Instability Hypothesis holds true. The Minsky Instability Hypothesis states that periods of economic stability leads to periods of instability as risk becomes increasingly ignored. This implies that the longer stability is present, the more risk is ignored. When the risk finally manifests itself the system is not prepared and incapable of mitigating the impacts of that risk and instability results. This argues that a systemic process of stability followed by instability occurs (Kindleberger & Aliber, 2011).

The mania that Mackay identified with the Crusades has been resurrected in the form of Jihad, Intifada, and most recently suicide warfare. *Suicide Warfare: Cuture, the Military, and the Individual as a Weapon* by Rosemarie Skaine, details the evolution and growth of the suicide bomber mania that seemed to grip the Muslim world from the 1990s to today (Skaine, 2013).

UFO hysteria swept the United States and England in the 1950s and lasted through the 1980s. The most authoritative work to debunk UFOs is David Clarke and Andy Roberts *Out of the Shadows UFOs, the Establishment & The Official Cover-Up*. Clarke and Roberts show that UFO sightings were largely founded in first and second generation radar systems and the Cold War. U.S. and British interceptor scrambles and military responses to poor quality radar information fed the hysteria. Government cover-ups to hide the inability of the government to explain the radar images and the desire to not let Cold War enemies know how many false positives the radar systems were reporting gave legitimacy to the growing conspiracy theorists. But Clarke and Roberts could not explain conditions drove membership in the UFO hysteria, or what made people see or feel that they had witnessed or experienced encounters with UFOs. As far as they could go in their conclusions is that as radars improved in reliability the number of UFO sightings, and the scope of the UFO hysteria, has been significantly reduced (Clarke & Roberts, 2002).

Some irrational phenomena of the last twenty years include the U.S. obsession with "beanie babies", the original gold rush that brought British, Spanish, French, and Dutch colonists to the new world in the 17^{th} Century (Thomas, 2005), Y2K fears (Hunt, 1999), collecting the U.S. State Quarter series (Quarter Mania Grips States, 2005), pandemic flu (Silverman, 2007), zombies (Centers for Disease Control and Prevention, 2011), and fear of nuclear power (Der Spiegel, 2011). These can be considered system-wide mass phenomena depending on how you define the system you are evaluating. Y2K, pandemic flu, fear of nuclear power, and gold rushes were truly global mass phenomena. Each was based on an irrational fear or irrational belief in a possible return. While it is possible that one can argue these phenomena were actually based on risk analysis that validated responses to the conditions at the time, such an argument would go against what we know about how people, groups, and communities think, make decisions, and evaluate information (Sloman, 2009) (Klein, 1999) (Janis, 1982).

Outcomes and choices that are irrational may have their root in one of several dynamics. First, and most obvious, is that some psychological, physiological, or deviancy leads people who perform irrational acts to do so regardless of the cost-benefit analysis. Some people, regardless of the cost, will commit vile, stupid, or utterly counter-productive acts (Chai, 2009). Under these assumptions, models of outcomes that seem irrational are explained by biological or psychological variables that lead individuals or aggregates of individuals to do things that are either risky or assuredly directly counter to rationality (Jacoby, 2000) (Von Neumann & Morgenstern, 1953). These types of models of "deviance" are not satisfactory, interesting, or aesthetically pleasing. Placing explanatory and predictive power in the hands of a group's genes, DNA, biology, and psychological health seems problematic as it is practically and ethically prohibitive to use such variables in models for most useful policy purposes.

Less problematic have been attempts to define the environmental stress and opportunities that lead people with only a "propensity" to commit "irrational acts" to commit them. In these models, socioeconomic status, societal stress, and breakdown of economic opportunity "drive" people and groups to prey upon others (Lea, 1999). Further refinement of these models added the effects of environmental factors that led to an increase in "opportunity" to commit irrational acts. Examples of this would be reduced policing in a community, increased access to capital in investment markets, or a country that has failed to maintain its military equipment resulting in a substantial inferiority of arms.

In the previous examples, the models with "irrational" outcomes showed how either the biological proclivity or the environment "pushed/drove" actors and groups of actors into making decisions, choices, or executing actions that were detrimental. Another way of looking at the problem, and perhaps more sophisticated, is by looking at the decision-making process as information dependent. However, a possible relationship exists among the environment, biology, and the outcome that isn't grounded in genes. This possibility is that an effect on the perception is occurring. It could be that the error range that exists within models explaining/predicting behavior results from the influence of independent variables of interest. It could be that pushing-motivating-influencing actors to make the choices they do and moving them towards an outcome that the variables of interest makes it more difficult to determine the relationships among variables and the outcome as it adds uncertainty to an actor's decision making process. This is different from a lack of information leading to unfortunate outcomes. Rather it is a fundamental "clouding" of the decision space. Even with the correct information, the decision space might be unclear and the relationships among the choices and between the choices and each outcome are difficult to evaluate.

"Random" outcomes and choices become more understandable in relation to why success at one point and failure at another, given similar conditions, is reduced. It is possible that much "irrationality" as defined by outcomes can be explained within this "clouded" decision space. If this clouded space could be defined or modeled then the discipline would benefit from being able to bring actors and models in line with its rationality assumptions and be able to deal with the paradoxes created in Social Choice Theory (Gaertner, 2006) and economics (Bairoch, 1995). Currently Political Science attempts to deal with these issues by defining uncertainty and using "fuzzy" logic.

The concept of rationality had been so well defined and so accepted by most actors it became a central theme for managing risk and maximizing utility. While theorists were developing concepts of uncertainty, risk, and management of risk, the concepts of rationality remained implicit in their models, their arguments, and their conclusions. The concept of maximum utility is itself a "rational" concept. In it, utility can be defined and actors rationally pursue it to its maximum possible value given the conditions under which the actor is operating.

While the development of probability theory and “chance” models took off and began to be increasingly useful and powerful tools for describing and even modeling the world from the 1920s to the 1990s, everything that rested its core on the concept of the “rational” came under attack from a growing group of divergent research paradigms and programs.

The chinks in the “rational” armor began to show as thinking about rational acts and defined interests began to frame them in terms of “norms” that are interests that drive action. Norms provide a baseline that can reinforce, coincide, or rationalize interests (Elster J.). Likewise, norms create obligatory or expected behavior and provide the basis for determining deviation from the norm. In this situation, deviation from the norm would be associated with deviation from rationality. Moving from the norm would result in social ire, negative feedback, and require resources to move back in line with the norm. However, this does not preclude the baseline, or norm, from shifting. Indeed, the norm would move throughout a space of possible conditions with what is “the norm” changing over time. It is possible that what in the short term is not a norm will be a norm in the long term. An irrational act comes to be seen rational it also comes to be seen as the “norm.” Examples of this include same-sex relationships, protests for civil rights, or protests against war.

Some have articulated an argument that social scientists have tackled the issue incorrectly from the beginning. Social scientists concocted a world in which they based their analysis on the idea that individuals use deductive reasoning. Further, deductive reasoning as a process was viewed as efficient, constrained primarily by the quality and amount of information available for evaluation. Individuals and states acting in the political, military and economic sphere would act in rational ways based on the information available. If actions looked irrational, it was only because the observer did not have the complete set of bounded information that the actor in question possessed. This approach was able to address the criticism that arose as the discipline became more interested in defining cultural factors affecting decision making. Cultural factors were defined as information inputs to the deductive reasoning process.

While one group rested their theories on deductive reasoning, another developed theories based on inductive reasoning. They believe that humans, states, and organizations act in accordance with inductive reasoning: they induce a number of working hypotheses, act upon what seems to be the most credible, and, if the chosen hypothesis ceases to work, replace it with a new one (Arthur, 1994). It is in this context that decision makers are influenced by what would be considered non-rational biological, physiological and psychological factors in the formation of their inductive hypothesis.

Finally, the rise of institutionalism and rational theory has brought about the study of institutions, such as the state, and its rational decisions as well as the human –

institution interaction within a rational context. One group of institutionalists attempted to incorporate institutional constraints into the traditional rational-choice theory. In this hybrid theory, institutions place constraints on individual behavior based on economic rationality. Another group uses the concept of bounded rationality and defined institutions as the vessel to which individual rational behavior is cultivated and promoted. The first group adds variables that account for institutional effects on rational choice, while the second group defines the boundaries of rational choice according to the institutions the individuals are operating within. The primary criticism of these approaches is how far apart the rationalist assumption and real situations are from each other in every day activity (Kato, 1996).

Another of the many critical issues of the rational concept in political science is that of the difficulty associated with isolating a winning strategy, which results in the "winning strategy" or "higher payoff." Individuals who perceive the world around them in a certain way will find it difficult to identify a strategy that will give them maximum payoff if the world works in a manner anathema to the way they see it (Conn, Meltz, & Press, 1973). The workers who choose to strike thinking that their labor is a critical part of customer's shopping experience may find that customer's get quite used to packing their own grocery bags or pulling an item from an open box instead of off a shelf. Likewise, a state that perceives that its cotton is essential to the economic wellbeing of the world's premier military, economic, and political power will see going to war with a state three times its industrial and demographic might as a rational act, never realizing that the world's premier power can get its cotton from elsewhere (Adams, 2008).

Two identified limitations exist in determining an individual's capability of choosing the correct maximizing strategy. The first is the resources required to identify and choose strategies. The second is the resources necessary to enact a strategy (Conn, 1973). Likewise, without understanding the rules of the game, individuals cannot choose outcomes rationally. For example, without knowing the methods by which federal and state authorities rate school performance or their capabilities, schools cannot rationally proportion resources.

In reply to the question of what decision is "rational," it is rational for an individual to choose a specific thing or a specific outcome in a given situation, given the information that is available and evaluated and given a standard for that evaluation. In this definition, rationality means that for an individual's choice to be rational, the individual must determine and evaluate the full set of possible outcomes and then rank those outcomes in preferential order. It therefore involves three considerations: the identification of the possible alternatives of choice, identification of what the outcomes of choice are, and then the conduct of an evaluation to rank the desirability of the identified outcomes (Conrad, 1970). Further, because individuals order their preferences and choose the one with the highest payoff, the observed choice is always the rational choice. This concept of rationality is only useful beyond the heuristic if preferences are also static (Conn, 1973).

Modern decision theory represents the fundamental theory (Spohn, UNK) of rationality. It attempts to work out the issue of how to determine rationality through outcomes, or whether the beliefs, desires, actions, and outcomes of decisions result in a rational expenditure of "capital" for the outcome received. It systematizes all rationality claims and believes that the decision itself, versus the outcome, is the proper level of analysis. Decisions should be determined rational by the relative rationality of the beliefs and evaluations undertaken by the choice maker. These beliefs and evaluations can themselves, in turn, be assessed as rational in relation to other's beliefs and evaluations. In this paradigm an outcome can be irrational while all decisions leading to it were rational. Likewise the outcome can be perfectly rational while the decisions leading to it were irrational.

Max Weber, the father of the modern typology of rationality, established four types of rationality: practical, theoretical, substantive, and formal. Practical rationality, according to Weber, is that reasoning in which actions are evaluated in relation to an individual's personal interests, whatever those interests may be at the time of the action. The second, theoretical rationality comes from a concerted effort to understand reality through complex concepts instead of action. Substantive rationality directly orders action into patterns. This is done based on a complex and holistic measure of value in relation to past, present, and potential values as clusters of outcomes. Formal rationality uses universally applied rules, laws and regulations to calculate means-end rational tendency (Kalberg, 1980).

The common aspect of these approaches to rationality is a mental process that attempts to master reality through understanding the values of choices in reference to the outcome of those choices (Kalberg, 1980). Also common to most of the views on rational theory is the absence of a discussion of what influences the risk acceptance and risk perception of the individuals making choices. Yet a characteristic must exist that influences the ability of an individual to process information in a logical and rational manner. In this instance, rational means accurately interpreting information, measuring its influence on the situation, understanding how it could probabilistically influence the outcome of decisions, and assessing whether the second- and third-order effects of a decision line up in accordance with the individuals values, goals, and desires.

The same characteristic would also explain why it is that people become more or less risk acceptant. In other words, risk acceptance is not a force, but a misperceived event that occurs because of an inability to process and evaluate information accurately and precisely. Much like the centrifugal force in physics is not a force at all, just a combination of the effects of inertia and a direction change, the force of risk acceptance is a consequence of factors that make information processing inaccurate and imprecise. The result is the illusion of risk acceptance or risk aversion. The illusion also fosters arguments over what is rational and irrational as theorists battle to explain peoples' actions when they are, from the perspective of an outside observer, clearly damaging to the actors goals and desires and those actions hurt the actor.

Geomagnetic fields affect these discussions in several ways. First, magnetic field would affect cognitive processes and reasoning in ways that would measurably impact views of utility. It also would affect subjective considerations as well as perceived risk. Differing measures of magnetic field would make different people with the same information perceive risk differently. Qualitative assessments of value and risk change with measures of the magnetic field fields. Theoretically, magnetic field could be responsible for much of the variance in not only processes of evaluation, valuation, and risk assessments but in the resulting outcomes. Magnetic field may have influence on the rate of regression to the mean and the size of the variance around the mean.

Magnetic fields would impact the fundamental components of analysis. The very process of measurement, whose efficiency, accuracy, and precision are critical to valid data, is affected by magnetic field's push of mental and cognitive processes closer to or further way from "rational" adherence to established standards and rules. Analysis using data through deduction or induction would be affected by magnetic field in ways that would influence outcomes using both processes.

It is of critical importance that geomagnetic field measures are included in the full range of processes that go into "rational" models and analysis. It offers measurable and significant influence on the act of collecting data, interpreting data, perceiving data and relationships, understanding linkages, how people perceive risk, how people assign value, and tendency to cooperate or not.

Statistical models that predict or explain outcomes using average effects of measurable variables possess uncertainty, which is inherent in their data, measurements, and depiction of the relationship among the variables. The uncertainty can be divided into two types; systematic uncertainty and random uncertainty. Systematic uncertainty causes measures to be skewed in certain directions that are consistent. Random uncertainties are variations in measurement that are often inconsistent and remain so after systemic uncertainty has been corrected, either through techniques of measurement, the inclusion of additional information, or theoretically thorough model building and storytelling.

A key point when dealing with uncertainty is that effective decision making is not possible without rationality and measurement. Rational decision makers use available information without recourse to bias, and any errors are made in their analysis or predictions are a consequence of random errors. Rational decision makers understand their preferences and use available information to meet their preferences (Bernstein P. , 1998).

Several works have addressed the issues associated with uncertainty and political choice as it is affected by perception (Alvarez M. R., 1992) (Bartels, 1986) (Franklin, 1991) (Palfrey & Poole, 1987) (Shepsle, 1972) as well as that associated with response to surveys (Zaller & Feldman, 1992). The two methods so far devised for measuring uncertainty in political choice are indirect measurement (Alvarez M. R., 1992) (Bartels,

1986) and indirect modeled (Franklin, 1991). The indirect method primarily involves having survey question responses that indicate the level of surety the respondent has in their answers (Alvarez & Franklin, 1994). The modeled method involves estimating uncertainty as a parameter in the model (Franklin, 1991).

This research attempted to characterize how decisions might grapple with uncertainty, but it did so by focusing on a natural phenomenon that could interfere with how they attempted to make rational decisions in the face of uncertainty: geomagnetic fields. The many models and analyses presented here could not provide a definitive answer to any one question about the relevance or usefulness of including magnetic field variable(s) in traditional models of behavioral outcomes, because it moved over the models in summary form and lacked the space to develop any one of them fully. Instead it presented a series of statistical relationships across a number of sub-disciplinary subjects at each level of analysis from the system down to the individual.

The findings were that in a great many number of cases, magnetic field variables were significant predictors, as judged by the traditionally accepted minimal level of confidence and in most of these cases far surpassed it. Often, using simulation software and graphical presentation the expected effects of magnetic fields were illustrated to be consequential. These results still would need to hold up in the face of additional control variables, as well as likely adjustments for autocorrelation and other model assumptions that might not be sustainable. Nevertheless, for such a unconventional explanatory variable in Political Science, it offers a suggestive start.

The growing literature discussing and analyzing the possible effects of magnetic fields on human and group behavior is compelling. Even the Federal Reserve has conducted an analysis of the effects of magnetic fields on stock market performance. The growing medical evidence that magnetic fields affect biological and physiological systems supports the behavioral analysis. The mechanism of influence is compelling and research on it is ongoing. This basis points to a possible future for a program of study that evaluates how the magnetic field can help reduce uncertainty in models. The potential implications are varied and relevant:

First, evidence that magnetic fields influence decision making, risk taking, and behavioral outcomes is not an argument for deterministic approach to behavior. Instead it points to an easily measured and used metric of the exogenous influences on decision making. It potentially offers a variable that bridges the gap between theories of rationality and what actually happens in the world.

Second, it offers a basis for looking at the international system as more than a space. The magnetic field is a characteristic of the space, a defining characteristic of the international system that is separate from and influences state behavior. Magnetic fields offer a possible solution to the problem of anarchy as the only defined characteristic of the international system that does not arise out of state interaction.

Third, magnetic fields could provide invaluable information to law enforcement. Estimated magnetic field effects are relevant and considerable. It is safe to assume that other unidentified factors act to suppress the impact of magnetic field changes. However, the power and efficiencies associated with the crime-magnetic field analysis begs for its inclusion in policy, resourcing, and pre-emptive planning to manage crime risk.

Fourth, market volatility response to magnetic fields indicates a possible link in the chain of investor and market behavior. As participation in markets continues to grow in depth and breadth it will be important to identify and leverage all the variables influencing market behavior. As social norms change and individuals become increasingly dependent on and engaged in market activities it is important that any possible relationship between magnetic fields, or system characteristic, and actor behavior and market behavior be fully analyzed and recognized.

Finally, magnetic fields as information for policy makers may be a useful tool. Magnetic fields may be able to allow policy makers to apportion resources in line with increases or decreases in probability associated with crime. It can inform national budget makers that much of the variance in U.S. budgets may be related to magnetic fields. Defense policy and mission planners can take magnetic fields into account when doing contingency and crisis planning. Magnetic fields are associated with coups and terrorism as well as insurgency operations and success. While not fully explored within this work, many applications exist that would carry policy relevance: the Federal Reserve, mitigating suicide, abortion, and political and judicial consensus building are just a few of the surveyed relationships within this work.

Future research should expand on the research that seems to hold the greatest promise and utility for policy makers and in helping understand human behavior. The first area that meets these criteria is crime and magnetic fields. An exogenous variable, such as magnetic fields that can aid in refining probabilities of criminal acts occurring by location and count, without recourse to racial or economic profiling could prove to be very useful. The second area of potential use is in managing the international system. The probability of disputes, wars, and escalation across the full range of potential magnetic field values indicate that magnetic fields could have a relevant and significant effect on state behavior, both conflict and cooperation behaviors.

If these conclusions are true, information on the magnetic field could become a valuable tool in predicting, managing, mitigating, and resolving interstate disputes. If the breadth of magnetic field influences significant models presented in this survey persist as research digs deeper into each area then any field whose research is related to individual or group behaviors may find value in controlling for the magnetic field. Its pervasiveness, variance, and demonstrated possible influence make a compelling case to not ignore this exogenous, causally prior variable that happens to be a characteristic of the very space in which actors operate.

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Appendix I: Ap and C9 Measurements in Bivariate Model

Table 65 Appendix I: Bivariate Analysis with Magnetic Field Measurements (1 of 6)

		Ap Index				**C9 Index**			
Dependent Variable	Model Type	Coefficients and Standard Error	Significance Level	Obs	Adj R2	Coef & Std Error	Significance Level	Obs	Adj R2
Misery Index	Regression	**0.2431** *(0.1424)*	0.0950 *	48	0.0391	**2.4440** *(3.3207)*	0.0090 ***	42	0.1397
Unemployment	Regression	**0.1438** *(3.7980)*	0.0040 ***	48	0.1446	**1.5282** *(1.6205)*	0.0000 ***	42	0.4112
Inflation	Regression	**0.0969** *(3.0141)*	0.4280 -	41	- 0.0090	**0.8688** *(2.0446)*	0.2500 -	40	0.0092
Number of People in Labor Force Unemployed	Regression	**171.1526** *(87.4904)*	0.0570 *	42	0.3321	**1982.423** *(428.7064)*	0.0000 ***	42	0.3321

Table 65 Continued

Percent GDP Change From Start to End of Year	Regress	**-0.1134** *(0.0863)*	0.2010	-	27	0.0272	**-0.2454** *(0.6788)*	0.7210	-	22	- 0.0432
All Crimes Annually (1,000s)	Poisson	**0.0197** *(0.0004)*	0.0000	***	43	0.0434	**0.1682** *(0.0023)*	0.0000	***	42	0.0853
Murders Annually (1,000s)	Poisson	**0.0228** *(0.0093)*	0.0150	**	43	0.0225	**0.1592** *(0.0574)*	0.0060	***	42	0.0301

Table 66 Appendix I: Bivariate Analysis with Magnetic Field Measurements (2 of 6)

		Ap Index					C9 Index				
Dependent Variable	Model Type	Coefficients and Standard Error	Significance Level		Obs	Adj R2	Coefficients and Standard Error	Significance Level		Obs	Adj R2
Rapes Annually (1,000s)	Poisson	**0.0240** *(0.0047)*	0.0000	***	43	0.0272	**0.2086** *(0.0293)*	0.0000	***	42	0.0557
Robberies Annually (1,000s)	Poisson	**0.0316** *(0.0018)*	0.0000	***	43	.0739	**0.2421** *(0.0117)*	0.0000	***	42	0.1158
Assaults Annually (1,000s)	Poisson	**0.0209** *(0.0015)*	0.0000	***	43	0.0224	**0.1904** *(0.0095)*	0.0000	***	42	0.0504
Property Crimes Annually (1,000s)	Poisson	**0.0191** *(0.0004)*	0.0000	***	43	0.0430	**0.1630** *(0.0025)*	0.0000	***	42	0.0853

Table 66 Continued

Strike Occurring in Argentina	Probit	**0.0022** *(0.0013)*	0.0840	*	27728	0.0011	**-0.0124** *(0.0123)*	0.3110	-	27728	0.0004
Number of Strikes Initiated on a Day that Has Argentine Strikes Initiated	Poisson	**0.0015** *(0.0003)*	0.0000	***	208	0.0014	**-0.2110** *(0.0100)*	0.0000	***	208	0.0328

Table 67 Appendix I: Bivariate Analysis with Magnetic Field Measurements (3 of 6)

		Ap Index					C9 Index				
Dependent Variable	Model Type	Coefficients and Standard Error	Significance Level		Obs	Adj R2	Coefficients and Standard Error	Significance Level		Obs	Adj R2
Number of Abortions Performed on all races of women (1,000s)	Poisson	**0.0715** *(0.0086)*	0.0000	***	26	0.1089	**0.0716** *(0.0085)*	0.0000	***	26	0.1100
Proportion of Abortions to Live Births for all Races of Women	Regression	**3.7506** *(1.9718)*	0.0680	*	28	0.0884	**18.9406** *(11.4217)*	0.1100	-	27	0.0631
1000's Abortions Performed on White Women	Regression	**17.1508** *(6.9534)*	0.0210	**	28	0.1585	**70.4057** *(42.2987)*	0.1090	-	27	0.0638

Table 67 Continued

Proportion of Abortions to Live Births for White Women	Regression	**4.9996** *(2.6624)*	0.0720	*	28	0.0856	**27.4134** *(15.2703)*	0.0850	*	27	0.0788
Number of Abortions Performed on Minority Women	Regression	**0.0373** *(3.6280)*	0.9920	-	28	-0.0385	**-23.8372** *(20.9998)*	0.2670	-	27	0.0110
Proportion of Abortions to Live Births for Minority Women	Regression	**-0.9833** *(1.4744)*	0.5110	-	28	-0.0210	**-11.1947** *(8.6305)*	0.2060	-	27	0.0256

Table 68 Appendix I: Bivariate Analysis with Magnetic Field Measurements (4 of 6)

Dependent Variable	Model Type	Ap Index: Coefficients and Standard Error	Ap Index: Significance Level		Ap Index: Obs	Ap Index: Adj R2	C9 Index: Coefficients and Standard Error	C9 Index: Significance Level		C9 Index: Obs	C9 Index: Adj R2
Total SAT Scores Male and Female	Regression	**-0.2962**	0.2680	-	198	0.0012	**-3.5795**	0.0320	**	180	0.0201
		(0.2669)					*(1.6564)*				
Female Math SAT Score	Regression	**-0.4297**	0.3460	-	33	-0.0026	**-4.5430**	0.0540	*	29	0.0981
		(0.4486)					*(2.2585)*				
Female Verbal SAT Score	Regression	**-0.3043**	0.4040	-	33	-0.0089	**-2.0248**	0.4180	-	29	-0.0117
		(0.3595)					*(2.4600)*				
Male Math SAT Score	Regression	**-0.4010**	0.1930	-	33	0.0235	**-3.8554**	0.0090	***	29	0.2003
		(0.3014)					*(1.3619)*				

Table 68 Continued

Male Verbal SAT Score	Regression	**-0.0463**	0.8780	-	33	-0.0315	**-0.2163**	0.9160	-	29	-0.0366
		(0.2991)					*(2.0350)*				

Table 69 Appendix I: Bivariate Analysis with Magnetic Field Measurements (5 of 6)

		Ap Index				C9 Index			
Dependent Variable	Model Type	Coefficients and Standard Error	Significance Level	Obs	Adj R2	Coefficients and Standard Error	Significance Level	Obs	Adj R2
Supreme Court Consensus Percentage	Regression	**-0.8236** *(0.4490)*	0.1000 -	11	0.1912	**-1.5000** *(0.9039)*	0.2750 -	11	0.0338
Supreme Court Percent Affirmed Cases	Regression	**-0.4561** *(0.9135)*	0.6300 -	11	-0.0812	**-1.3693** *(1.6437)*	0.4260 -	11	-0.0316
Supreme Court Percent Over-ruled Lower Court Cases	Regression	**0.3877** *(0.4579)*	0.4190 -	11	-0.0291	**1.3693** *(1.6437)*	0.4260 -	11	-0.0316

Table 69 Continued

General Aviation Accident Counts	Poisson	**0.1268** *(0.0140)*	0.0000	***	11	0.0219	**0.1237** *(0.0139)*	0.0000	***	11	0.0211
Deaths in Aviation Accident Counts	Poisson	**0.3617** *(0.0629)*	0.0000	***	11	0.0166	**0.3726** *(0.0627)*	0.0000	***	11	0.0177
Predicted Change in probability of a change in Freedom House Scores as predicted by a Probit Model	Regression	**0.0370** *(0.0163)*	0.0230	**	1091	0.0038	**0.1286** *(0.1083)*	0.2350	-	1091	0.0004

Table 70 Appendix I: Bivariate Analysis with Magnetic Field Measurements (6 of 6)

		Ap Index					C9 Index				
Dependent Variable	Model Type	Coef & Std Error	Significance Level		Obs	Adj R2	Coef & Std Error	Significance Level		Obs	Adj R2
3 Month Treasury Bond Interest Rates (Annual Average Rates)	Regression	**0.1616**	0.1120	-	44	0.0366	**1.4840**	0.0140	**	41	0.1238
		(.0997)					*(0.5754)*				
Corporate Bond Interest Rates on Aaa Moody's Rated Bonds	Regression	**0.1958**	0.0460	**	44	0.0701	**1.9280**	0.0010	***	41	0.2285
		(0.0950)					*(0.5379)*				
Corporate Bond Interest Rates on Baa Moody's Rated Bonds	Regression	**0.2270**	0.0420	**	44	0.0735	**2.2122**	0.0010	***	41	0.2300
		(0.1081)					*(0.6148)*				
Municipal Bond Interest Rates (High Quality)	Regression	**0.1761**	0.0260	**	41	0.0909	**1.5905**	0.0010	***	41	0.2300
		(0.0765)					*(0.4420)*				

Table 70 Continued

Mortgage Interest Rates (Annual)	Regression	**0.3389** (*0.0875*)	0.0000	***	40	0.2638	**2.0861** (*0.4737*)	0.0000	***	38	0.3320
Prime Interest Rate (Annual)	Regression	**0.2181** (*0.1205*)	0.0770	*	44	0.0503	**2.0311** (*0.7034*)	0.0060	***	41	0.1550
Discount Interest Rate (Annual)	Regression	**0.1517** (*0.0969*)	0.1250	-	44	0.0327	**1.3914** (*0.5547*)	0.0160	**	41	0.1168
Federal Funds Interest Rate (Annual)	Regression	**0.1978** (*0.1210*)	0.1100	-	44	0.0374	**1.8199** (*0.7039*)	0.0140	**	41	0.1244

Appendix II: The Total (F) Field Strength

Table 71 Appendix II: Bivariate Analysis with the total magnetic field, F. (1 of 3)

		F Field				Constant		
Dependent Variable	Model Type	Coefficient and Standard Deviation	Significance		Adj R2	Coefficient and Standard Deviation	Significance	
Supreme Court Cases Not Heard Per Session	Regression	**0.0528** *(0.0133)*	0.0170	**	0.7471	**-2519.4050** *(715.6931)*	0.0240	**
Female Math SAT Scores (100s)	Regression	**-0.0063** *(0.0011)*	0.0000	***	0.4758	**831.0300** *(65.3480)*	0.0000	***
Female Verbal SAT Scores (100s)	Regression	**0.0041** *(0.0013)*	0.0030	***	0.2341	**274.9790** *(71.5000)*	0.0010	***

Table 71 Continued

Male Math SAT Scores (100s)	Regression	**-0.004** *(0.0007)*	0.0000	***	0.4557	**745.0850** *(43.4640)*	0.0000	***
Male Verbal SAT Scores (100s)	Regression	**0.0041** *(0.0009)*	0.0000	***	0.3644	**282.0700** *(53.4714)*	0.0000	***
Supreme Court Consensus (Percentage)	Regression	**0.0075** *(0.0022)*	0.0050	***	0.3975	**-341.1150** *(130.5420)*	0.0200	**

Table 72 Appendix II: Bivariate Analysis with the total magnetic field, F (2 of 3).-

		F Field				Constant		
Dependent Variable	Model Type	Coefficient and Standard Deviation	Significance		Adj R2	Coefficient and Standard Deviation	Significance	
Supreme Court Percent of Cases Affirmed	Regression	**0.0086** *(0.0043)*	0.0660	*	0.1662	**-431.7271** *(248.0240)*	0.1040	-
Supreme Court Percent of Cases Overruled Lower Court Decisions	Regression	**-0.0086** *(0.0043)*	0.0660	*	0.1662	**531.7271** *(248.0240)*	0.0500	*
All Suicides (Age Adjusted)	Regression	**0.0008** *(0.0001)*	0.0000	***	0.3912	**-31.7130** *(6.3700)*	0.0010	***
All Suicides (Age Adjusted)	Regression	**0.0008** *(0.0001)*	0.0000	***	0.3912	**-31.7130** *(6.3700)*	0.0010	***

Table 73 Appendix II: Bivariate models with annual change in the Total (F) Field as the only explanatory variable (3 of 3)

		Annual % Change in F Field				Constant		
Dependent Variable	Model Type	Coefficient and Standard Deviation	Significance		Adj R2	Coefficient and Standard Deviation	Significance	
Change in Annual % Change in U.S. Federal Budget Deficit (Billions of U.S. Dollars)	Regression	**2591.4030** *(847.3083)*	0.0050	***	0.2123	**5.1686** *(1.3269)*	0.0030	***
Percent Change in Percent of Votes Cast for 3rd Party Candidates	Regression	**-0.0002** *(0.0001)*	0.0270	**	0.0654	**4.3690** *(0.7261)*	0.0000	***
Probability that the winner is a Republican (f measured in 1,000s)	Probit	**0.0749** *(0.0388)*	0.0540	*	0.0509	**-3.4870** *(2.0020)*	0.0820	*

Appendix III: Models with Magnetic Component Explanatory Variables

Table 74 Appendix III: U.S budget deficit Scholastic Aptitude Test Scores (1 of 10)

	Total Federal Deficit			Female Math SAT Score		
	Model Type: Regression			Model Type: Regression		
	Observations = 33	Adj R2 = .5047		Observations = 30	Adj R2 =.9323	
Explanatory Variable	Coefficient and Standard Deviation	Significance		Coefficient and Standard Deviation	Significance	
H Component	**-55.56**	0.057	*	**2.4799**	0	***
	(27.8823)			*(0.5797)*		
V Component	**0.6465**	0.755	-	**-2.3173**	0	***
	(2.0542)			*(0.4947)*		
N Component	**51.5179**	0.039	**	**-0.1299**	0.02	**
	(23.7304)			*(0.0524)*		
Component	**-1.1597**	0.884	-	**0.4506**	0.034	**
	(7.8507)			*(0.2008)*		
D Component	**9.7045**	0.199	-	**0.2226**	0	***
	(7.3631)			*(0.0478)*		
E Component	**-25.7882**	0.09	*			
	(14.6283)					
Constant	**80354**	0.796	-	**-14028.17**	0.081	*
	(307622)			*(7713.095)*		

Table 75 Appendix III: Scholastic Aptitude Test scores (2 of 10).

	Female Verbal SAT Score			Male Math SAT Score		
	Model Type: Regression			Model Type: Regression		
	Obs = 31	Adj R2 =.8183		Obs = 31	Adj R2 =.8515	
Explanatory Variable	Coefficient and Standard Deviation	Significance		Coefficient and Standard Deviation	Significance	
H Component	**1.8881**	0.037	**	**1.2142**	0.04	**
	(0.8593)			*(0.5602)*		
V Component	**-0.0673**	0.395	-	**-1.1631**	0.023	**
	(0.0777)			*(0.4782)*		
N Component	**-1.8502**	0.018	**	**-0.0574**	0.268	-
	(0.7334)			*(0.0507)*		
I Component	**0.2238**	0.459	-	**0.173696**	0.38	-
	(0.2977)			*(0.1941)*		
D Component	**0.1799**	0.018	**	**0.12**	0.016	**
	(0.0709)			*(0.0462)*		
E Component						
Constant	**-5484.752**	0.636	-	**-4344.567**	0.565	-
	(11434.22)			*(7454.659)*		

Table 76 Appendix III: Scholastic Aptitude Test scores and suicide counts (3 of 10).

	Male Verbal SAT Score			Male Suicide Age 15-19		
	Model Type: Regression			Model Type: Regression		
	Obs = 31	Adj R2 =.6930		Obs = 12	Adj R2 =.9156	
Explanatory Variable	Coefficient and Standard Deviation	Significance		Coefficient and Standard Deviation	Significance	
H Component	**0.8539**	0.361	-	**-1.584**	0.07	*
	(0.9171)			*(0.7196)*		
V Component	**-0.1863**	0.034	**	**0.0186**	0.665	-
	(0.083)			*(0.0411)*		
N Component	**-0.6175**	0.438	-	**1.5075**	0.054	*
	(0.7827)			*(0.6291)*		
I Component	**0.6148**	0.064	*	**-0.0926**	0.602	-
	(0.3178)			*(0.1685)*		
D Component	**0.0979**	0.208	-	**-0.1577**	0.048	**
	(0.0757)			*(0.0638)*		
E Component						
Constant	**-19585.48**	0.121	-	**3965.773**	0.576	-
	(12202.73)			*(6711.902)*		

Table 77 Appendix III: Voting in congressional elections (4 of 10).

	Total Number of 3rd Party Votes Cast			Total Votes Thrown Away		
	Model Type: Regression			Model Type: Regression		
	Obs = 66	Adj R2 = .1073		Obs = 66	Adj R2 = .1880	
Explanatory Variable	Coefficient and Standard Deviation	Significance		Coefficient and Standard Deviation	Significance	
H Component	**0.7815**	0.0180	**	**0.000269**	0.0010	***
	(0.3208)			*(0.000074)*		
X Component	**-0.6764**	0.0180	**	**-0.000224**	0.0010	***
	(0.2787)			*(0.000064)*		
Y Component	**-0.0533**	0.0020	***	**-0.000014**	0.0000	***
	(0.0161)			*(0.000004)*		
Z Component	**0.0246**	0.1290	-	**0.000012**	0.0030	***
	(0.0160)			*(0.000004)*		
D Component						
I Component						
Constant	**-3474.250**	0.087	*	**-1.119**	0.012	**
	(1994.196)			*(0.460)*		

Table 78 Appendix III: Winners and how much they win (5 of 10).

Explanatory Variable	Probability of a Republican Getting Majority of Votes Model Type: Probit Obs = 66 Coefficient and Standard Deviation	Adj R2 = .4297 Significance		Total Percentage Distance Between Winning and Losing Candidates Model Type: Regression Obs = 66 Coefficient and Standard Deviation	Adj R2 = .2455 Significance	
H Component	**-0.0051**	0.0150	**	**-0.1071**	0.0000	***
	(0.0021)			*(0.0240)*		
X Component	**0.0048**	0.0070	***	**0.0860**	0.0000	***
	(0.0018)			*(0.0202)*		
Y Component	**0.0001**	0.0790	*	**0.0377**	0.0100	***
	(0.0001)			*(0.0141)*		
Z Component	**0.0033**	0.0640	*	**0.0033**	0.0640	*
	(0.0018)			*(0.0018)*		
D Component				**-0.0197**	0.0210	**
				(0.0083)		
I Component	**-0.0052**	0.0740	*			
	(0.0029)					
Constant	**52.408**	0.136	-	**728.303**	0.000	***
	(35.150)			*(151.273)*		

Table 79 Appendix III: Winning candidates and by how much they win (6 of 10).

Explanatory Variable	Ratio of Percentage Votes for Winning-to-losing Candidates			Percent of Votes for Winning Candidate		
	Model Type: Regression			Model Type: Regression		
	Obs = 66	Adj R2 = .2288		Obs = 66	Adj R2 = .2455	
	Coefficient and Standard Deviation	Significance		Coefficient and Standard Deviation	Significance	
H Component	**-0.0028**	0.0000	***	**-0.0357**	0.0000	***
	(0.0006)			*(0.0080)*		
X Component	**0.0023**	0.0000	***	**0.0286**	0.0000	***
	(0.0005)			*(0.0067)*		
Y Component	**0.0012**	0.0020	***	**0.0125**	0.0100	***
	(0.0003)			*(0.0047)*		
Z Component	**-0.00008**	0.0060	***	**-0.0012**	0.0060	***
	(0.00003)			*(0.0000)*		
D Component	**-0.00065**	0.0050	***	**-0.0065**	0.0210	**
	(0.00022)			*(0.0027)*		
I Component						
Constant	**18.640**	0.000	***	**2.761**	0.000	***
	(4.041)			*(0.504)*		

Table 80 Appendix III: Second place and by how much they lose (7 of 10).

Explanatory Variable	Percent of Votes for Second Place Candidate Model Type: Regression Obs = 66 Coefficient and Standard Deviation	Adj R2 = .2455 Significance		Number of Votes for Democratic Candidates Model Type: Regression Obs = 66 Coefficient and Standard Deviation	Adj R2 = .5873 Significance	
H Component	**0.0374**	0.0000	***	**5.8404**	0.0000	***
	(0.0077)			*(0.8191)*		
X Component	**-0.0298**	0.0000	***	**-4.9374**	0.0000	***
	(0.0064)			*(0.6879)*		
Y Component	**-0.0150**	0.0020	***	**0.8739**	0.0750	*
	(0.0045)			*(0.4818)*		
Z Component	**0.0011**	0.0020	***	**0.2662**	0.0000	***
	(0.0000)			*(0.0363)*		
D Component	**0.0083**	0.0030	***	**-0.6397**	0.0027	***
	(0.0026)			*(0.2823)*		
I Component						
Constant	**-1.904**	0.000	***	**-32948.950**	0.000	***
	(0.485)			*(5141.930)*		

Table 81 Appendix III: Votes for the parties (8 of 10).

	Number of Votes for Republican Candidates		Number of Votes for 3rd Party Candidates	
	Model Type: Regression		Model Type: Regression	
	Obs = 66	Adj R2 = .6396	Obs = 66	Adj R2 = .1073
Explanatory Variable	Coefficient and Standard Deviation	Significance	Coefficient and Standard Deviation	Significance
H Component	**4.8540**	0.0000 ***	**0.7815**	0.0180 **
	(0.6685)		*(0.3208)*	
X Component	**-3.7832**	0.0000 ***	**-0.6764**	0.0180 **
	(0.5614)		*(0.2787)*	
Y Component	**0.8065**	0.0450 **	**-0.0533**	0.0020 ***
	(0.3932)		*(0.0161)*	
Z Component	**0.2480**	0.0000 ***	**0.0246**	0.1290 -
	(0.0296)		*(0.0160)*	
D Component	**-0.5755**	0.0150 **		
	(0.2304)			
I Component				
Constant	**-29413.390**	0.000 ***	**-3474.285**	0.087 *
	(4196.462)		*(1994.196)*	

Table 82 Appendix III: Votes (9 of 10).

	Number of Total Votes Cast for Candidates	
	Model Type: Regression	
	Obs = 66	Adj R2 = .5630
Explanatory Variable	Coefficient and Standard Deviation	Significance
H Component	**11.0286**	0.0000 ***
	(1.6839)	
X Component	**-9.2687**	0.0000 ***
	(1.4143)	
Y Component	**1.8537**	0.0660 *
	(0.9905)	
Z Component	**0.5381**	0.0000 ***
	(0.0746)	
D Component	**-1.3485**	0.0240 **
	(0.5803)	
Constant	**-64681.560**	0.000 ***
	(10570.750)	

Table 83 Appendix III: Federal budget deficit (10 of 10).

	Change in Total Federal Deficit		
Explanatory Variable	Model Type: Regression		
	Observations = 32	Adj R2 = .5047	
	Coefficient and Standard Deviation	Significance	
Change H Component	**14465.5500**	0.1420	-
	(9530.9040)		
Change V Component	**5330.3710**	0.0080	***
	(1848.1680)		
Change N Component	**-17448.2100**	0.0800	*
	(9563.5700)		
Change I Component	**-15146.4200**	0.0120	***
	(5568.4760)		
Change D Component	**-545.0414**	0.3800	-
	(609.4114)		
Change E Component	**422.6255**	0.4980	-
	(615.1447)		
Constant	**-3.6571**	0.3880	-
	(4.1648)		

Appendix IV: Earth Magnetic Fields and Traditional Control Variables.

Table 84 Appendix IV: Votes (1 of 5).

	Total Number of Votes Cast in an Election (1,000s)		Total Number of "Thrown Away" Votes (1,000s)	
	Model Type: Regression		Model Type: Regression	
	Observations = 66	Adj R2 = .6701	Observations = 66	Adj R2 = .8915
Explanatory Variable	Coefficient and Standard Deviation	Significance	Coefficient and Standard Deviation	Significance
Winning-to-loser vote ratio	**-757.1289**	0.0170 **	**-105.2540**	0.0000 ***
	(307.6558)		*(5.8231)*	
Republican Winning Candidate	**-1484.7720**	0.0040 ***	**-38.9777**	0.0000 ***
	(493.7090)		*(9.3161)*	
H Component	**6.2886**	0.0010 ***		
	(1.7880)			
X Component	**-5.1152**	0.0010 ***	**0.0091**	0.0060 ***
	(1.5207)		*(0.0032)*	
Y Component	**3.0245**	0.0020 ***		
	(0.9305)			
Z Component	**0.4992**	0.0000 ***	**0.0045**	0.0000 ***
	(0.0707)		*(0.0012)*	

Table 84 Continued						
D Component	**-1.9292**	0.0010	***			
	(0.5400)					
Constant	**-46598.950**	0.000	***	**198.456**	0.110	**-**
	(10696.710)			*(122.420)*		

Table 85 Appendix IV: Abortions (2 of 5)

Dependent Variable	Total Number of Abortions by White Women (1,000s)			Rate of Abortions by White Women per 1,000 Live Births		
	Model Type: Regression			Model Type: Regression		
	Observations = 7	Adj R2 = .8647		Observations = 7	Adj R2 = .9346	
	Coefficient and Standard Deviation	Significance		Coefficient and Standard Deviation	Significance	
Total White People Living Below Poverty	**-0.0406** *(0.0149)*	0.0730	*	**-0.0013** *(0.0002)*	0.0100	***
Total White Unemployed	**97.6282** *(15.9832)*	0.0090	***	**2.0760** *(0.2393)*	0.0030	***
C9 Index	**148.8138** *(54.0716)*	0.0710	*	**3.7476** *(0.8097)*	0.0190	**
Constant	**198.456** *(122.420)*	0.110	**-**	**-46598.950** *(10696.710)*	0.000	***

Table 86 Appendix IV: Annual Interest Rates (3 of 5)

	Annual Average Interest Rates on 3 Month Treasuries			Annual Average Interest on Corporate Bonds rated aaa		
	Model Type: Regression			Model Type: Regression		
	Obs = 30	Adj R2 = .6608		Obs = 30	Adj R2 = .7321	
Explanatory Variable	Coefficient and Standard Deviation	Significance		Coefficient and Standard Deviation	Significance	
H Component	**-0.1891**	0.0960	*	**-0.1116**	0.1660	-
	(0.1090)			*(0.0780)*		
V Component	**-0.0944**	0.0010	***	**-0.0802**	0.0000	***
	(0.0239)			*(0.0171)*		
N Component	**0.3366**	0.0080	***	**0.2423**	0.0080	***
	(0.1163)			*(0.0832)*		
I Component	**0.3008**	0.0010	***	**0.2650**	0.0000	***
	(0.0806)			*(0.0577)*		
Unemployment Rate	**0.5330**	0.0680	*	**0.9921**	0.0000	***
	(0.2782)			*(0.1992)*		
Inflation Rate	**0.5419**	0.0000	***	**0.2189**	0.0250	**
	(0.1274)			*(0.0912)*		
Constant	**-10418.140**	0.002	***	**-9352.770**	0.000	***
	(2947.175)			*(2110.662)*		

Table 87 Appendix IV: Interest Rates (4 of 5).

Explanatory Variable	Annual Average Interest on "High" Grade Municipal Bonds Model Type: Regression Obs = 30 Coefficient and Standard Deviation	Adj R2 = .6921 Significance		Annual Average Discount Rate (Interest Charged to Commercial Banks) Model Type: Regression Obs = 30 Coefficient and Standard Deviation	Adj R2 = .7160 Significance	
H Component	**-0.2295**	0.1010	-	**-0.2408**	0.0210	**
	(0.1343)			*(0.0975)*		
V Component	**-0.0989**	0.0030	***	**-0.0828**	0.0010	***
	(0.0294)			*(0.0213)*		
N Component	**0.3724**	0.0160	***	**0.3629**	0.0020	***
	(0.1432)			*(0.1040)*		
I Component	**0.3025**	0.0060	***	**0.2500**	0.0020	***
	(0.0993)			*(0.0721)*		
Unemployment Rate	**0.8230**	0.0250	***	**0.6321**	0.0180	**
	(0.3427)			*(0.2488)*		
Inflation Rate	**0.7673**	0.0000	***	**0.5167**	0.0000	***
	(0.1570)			*(0.1139)*		
Constant	**-10153.050**	0.010	***	**-8406.322**	0.004	***
	(3631.215)			*(2635.652)*		

Table 88 Appendix IV: Annual federal funds rate and annual U.S. budget deficit (5 of 5).

	Annual Average Federal Funds Rate (Rate Banks Charge Each Other)			Annual United States Budget Deficits in Billions of Dollars		
	Model Type: Regression			Model Type: Regression		
	Observations = 30	Adj R2 = .6431		Observations = 30	Adj R2 = .9340	
Explanatory Variable	Coefficient and Standard Deviation	Significance		Coefficient and Standard Deviation	Significance	
H Component	**-0.2111**	0.1350	-	**25.2418**	0.0000	***
	(0.1364)			*(1.9449)*		
V Component	**-0.1112**	0.0010	***	**-1.4930**	0.0020	***
	(0.0990)			*(0.4264)*		
N Component	**0.3870**	0.0140	***	**-19.4775**	0.0000	***
	(0.1455)			*(2.0747)*		
I Component	**0.3571**	0.0020	***	**10.2730**	0.0000	***
	(0.1008)			*(1.4383)*		
Unemployment Rate	**0.4587**	0.2010	-	**20.1827**	0.0000	***
	(0.3480)			*(4.9630)*		
Inflation Rate	**0.6822**	0.0000	***	**-4.6521**	0.0520	*
	(0.1594)			*(2.2734)*		
Constant	**-12432.480**	0.003	***	**-466397.200**	0.000	***
	(3687.407)			*(52575.850)*		

Appendix V: Technical Appendix

On occasion, the discussion of statistical work in this thesis did not provide, with the body of the text, replication-level details about the data. This appendix provides additional information.

Chapter 2

The explanatory variables of interest include the Ap geomagnetic index and the C9 geomagnetic index. These values come from the Space Physics Interactive Data Resource (National Geophysical Data Center (NGDC) 2013). The database used for this chapter provides daily values of each of the Ap and the C9 indexes. The average values are taken over the calendar year to derive the annual values for these indexes.

Tables that have the F, or total, Field as the explanatory variable of interest come from the NGDC database from the Fredericksburg collection station available on their station data page (Space Physics Interactive Data Resource 2013). The data uses the mean annual geomagnetic value reported for the Fredericksburg, Maryland station. The Fredericksburg station is the closest station to the Capitol of the United States, Washington, D.C. The Total, F, value also comes from numerous other data collection stations.

Geomagnetic field component data (H, X, Y, etc.) are available from the Space Physics Interactive Data Resource (Space Physics Interactive Data Resource 2013). The data comes from names data collection stations.

Monitoring stations in the United States are located in Alaska, California, Maine, Maryland, Virginia, Kansas, Missouri, Colorado, Wyoming, Oklahoma, Hawaii, Louisiana, Florida, New Mexico, Arizona, Utah, and Washington. Time periods of data collection as well as specific components collected vary among monitoring stations. There are three different monitoring stations in Argentina. There are seven different monitoring stations in Japan.

Monitoring stations collect data each minute. Monitoring stations report data as means in increments of days, months, and years. Many data stations have gaps in collection, either in time or days and the stations are also affected by other conditions such as weather, funding, etc. Almost every model is constrained by the availability control and dependent variable data available at time increments to match available geomagnetic data.

Chapter 3

Data for the table that displays the changes in U.S. Regional Uniform Crime Reports 2011 come from data available at FBI.com. The data is formatted from data available in Table 4, Crime in the United States by Region Geographic Division and State 2010-2011 (FBI, 2011).

Data for the Kentucky crime index and the Local Magnetic Field comes from the output of statistical analysis of the dependent variable that is constructed out of the data presented by the Disaster Center from data compiled from the FBI.gov uniform crime reports (The Disaster Center, 2013). The model uses the Crime Index values for Kentucky from 1970 to 2008. The variable of interest comes from the Space Physics Interactive Data Resource for the Fredericksburg data gathering station (Space, 2013). The data uses the mean annual geomagnetic value reported for the Fredericksburg station. This station is the closest station that had data coverage for the years the crime data is available. Geomagnetic field component data (H, X, Y, etc.) are also available from the Space Physics Interactive Data Resource (Space Physics Interactive Data Resource 2013). This data is provided for each monitoring station.

Data for analysis of Kentucky city and country crimes in 1978 comes from the "Residual total intensity aeromagnetic map of Kentucky" (Johnson, et al. 1978). The map shows bands of geomagnetic measurements in gauss. The map has county boundaries annotated. The location of Kentucky cities had to be geo-located by referencing current political maps of Kentucky using the county boundaries. Where cities lay between two gauss "contour lines" the average was taken. If the city is obviously closer to one contour line than another, the closer line value is used. Counties that had multiple gauss lines within their border an average value is derived and used.

The Kentucky annual unemployment rate is derived from data available from the Bureau of Labor Statistics (Bureau of Labor Statistics 2013). Data is available to derive annual rates of unemployment for years 1976 to 2008.

The Per Capita Income of Kentucky comes from the U.S. Bureau of Economic Analysis (BEA) (Bureau of Economic Analysis (BAE) 2013). Data is available for the annual per capita income starting in 1929.

Information used to construct the table "Summary of significant and evaluated models using the F, total field, as the variable of interest" comes from models presented in Chapter 3 Appendices.

Information used to construct the table Summary of significant and evaluated models using field components as the variable of interest” comes from models presented in Chapter 3 Appendices.

Information used to construct the table “Summary of significant and evaluated models using the different measures of the earth’s magnetic field and including other control variables” comes from models presented in Chapter 3 Appendices.

Information used to construct the table “Summary of Survey Findings” comes from all the models presented in the Chapter 3 Appendices.

The explanatory variables of interest include the Ap geomagnetic index and the C9 geomagnetic index. These values come from the Space Physics Interactive Data Resource (National Geophysical Data Center (NGDC) 2013). The database used provides daily values of each of the Ap and the C9 indexes. The average values are taken over the calendar year to derive the annual values for these indexes.

The misery index is a measure of annual unemployment and inflation for the United States. The annual unemployment and the annual inflation rates are summed to derive the misery index. The annual unemployment rate comes from the website infoplease.com that derives annual U.S. unemployment rate from U.S. Department of Labor, Bureau of Labor Statistics data (infoplease.com 2013).

The measure of inflation comes from the U.S. Department of Labor Bureau of Labor Statistics Consumer Price Index for All urban Consumers and covers 1913 to 2010 (U.S. Department of Labor 2013).

Data for the number of people in the U.S. labor force comes from the Bureau of Labor Statistics (Bureau of Labor Statistics 2013).

Data for the percent GDP change from start to end of year is a derived value from available GDP data from the U.S. Bureau of Economic Analysis (Bureau of Economic Analysis (BAE) 2013) and additional data made available on April 30, 2008 via the infoplease.com website (Infoplease.com 2008). The percentage change between the previous year’s GDP and the current year’s GDP is used.

The United States total count of crimes, murders, rapes, robberies, assaults, and property crimes come from the Bureau of Justice Statistics (Office of Justice Programs 2013). Data is available from 1980 to 2008.

Data on Argentina labor strikes came from the “Argentina Domestic Violence and Economic Data, 1955-1972 (ICPSR 5213) Data set (O'Donnel 2000). This data set also provides the dates of strikes allowing the derivation determining whether a given day experienced the start of a strike.

Data on abortions comes from data compiled by William Robert Johnson last updated on 11 March 2012 and titled “Historical abortion statistics, United States” (Johnston 2012) and information provided in United States Census Bureau data in statistical abstracts from 1970 to 2010 (United States Cencus Bureau).

Scholastic Aptitude Scores come from the National Center for Education Statistics’ Digest of Education Statistics (Institute of Education Sciences 2012). This provides SAT scores by gender and race from 1966 to 2011 by exam portion.

Data on the U.S. Supreme Court came from the United States Supreme Court Judicial Database, 1953-1997 and came from the Ann Arbor, MI Inter-university Consortium for Political and Social Research (Spaeth 1999).

Counts of aviation accidents come from the National Transportation Safety Board’s Aviation Accident Database (National Transportation Safety Board 2013) and uses data from 1962 to 2009.

Freedom House Scores come from the annual Freedom in the World scores from 1972 to 2008 available from reports on the Freedom House website (Freedom House n.d.) .

Data on treasury bills and corporate bonds, municipal bonds, mortgage interests, prime interest rates, discount rates, and Federal Funds rates come from the Board of Governors of the Federal Reserve System’s Historical Data Database (Board of Governors of the Federal Reserve System n.d.).

Suicide data comes from the United States Census Bureau’s Annual Statistical Abstracts of The National Data Books (United States Census Bureau n.d.) of numerous dates to build a complete dataset.

Data on the annual U.S. Federal Budget Deficits comes from Table 1.3 Summary of Receipts, Outlays, and Surpluses or Deficits (-) in Current Dollars, Constant (FY2005) Dollars, and as Percentages of GDP, 1940-2017 (The Executive Office of the President 2009).

Scholastic Aptitude Scores come from the National Center for Education Statistics’ Digest of Education Statistics (Institute of Education Sciences 2012). This provides SAT scores by gender and race from 1966 to 2011 by exam portion.

Data on votes for presidential elections including the number of votes for winning, losing, and third party candidates comes from data compiled by infoplease.com (infoplease.com n.d.).

Data on Senate vote outcomes for elections in states that have a Geomagnetic monitoring station within its border or in an adjacent state that has a monitoring station comes from the Office of the Clerk of the U.S. House of Representatives (Clerk of the

House of Representatives 2013). The vote counts for senatorial elections from 1920 to the present for each state are available on this page in PDF download format.

Winning-to-loser vote ratio is derived from the election data available from the Office of the Clerk of the United States House of Representatives (Clerk of the House of Representatives 2013).

U.S. Poverty data came from the United States Census Bureau (U.S. Cencus Bureau 2013). Poverty data is available for the years 1985 to 2011.

The annual unemployment rate comes from the website infoplease.com that derives annual U.S. unemployment rate from U.S. Department of Labor, Bureau of Labor Statistics data (infoplease.com 2013).

The measure of inflation comes from the U.S. Department of Labor Bureau of Labor Statistics Consumer Price Index for All urban Consumers and covers 1913 to 2010 (U.S. Department of Labor 2013).

Data on the annual U.S. Federal Budget Deficits comes from Table 1.3 Summary of Receipts, Outlays, and Surpluses or Deficits (-) in Current Dollars, Constant (FY2005) Dollars, and as Percentages of GDP, 1940-2017 (The Executive Office of the President 2009).

Chapter 4

The analysis uses the Militarized Interstate Dispute Datasets associated with the Correlates of War project (Ghosn, et al. 2004) (Ghosn, Faten and Bennett 2003) (Jones, Bremer and Singer 1996). The data is merged with a dataset of daily and annual global measures of geomagnetism. The original MID dataset is expanded so that each day is coded for the initiation, occurrence of, participation by, the joining of, or the conclusion of a dispute. Total number of disputes, total number of participants, and geographic regions disputes occur are determined for each day. The resulting dataset has a case for each day of the year from 1816 to 2001. The global indices of geomagnetic activity are used (Space 2013) as the variables of interest. The global indices are matched to cases of the same day. A 30 day trailing average value is figured for each case as well. A 30 day average is used as a measure of the additive influence of daily exposure to geomagnetic activity. However, some consideration had to be given for "wearing off" of effects. Therefore, the 30 day average is used.

Many of the early models in chapter 4 have their variables either derived from the Militarized Interstate Dispute dataset (Ghosn, Faten and Bennett, Codebook for the

Dyadic Militarized Interstate Incident Data, Versions 2.10 2003) or the Space Physics Interactive Database (Space 2013).

Data on the number of U.S. Soldiers deployed overseas, less Europe and stationed aboard ship, comes from The Heritage Foundation dataset The Troop Dataset 1950-2003 (The Heritage Foundation 2004).

Data on defense spending in the United States comes from Congressional Budget Office tables made available on the Executive Office of the President's webpage (Office of Management and Budget 2013)

The data for the analysis on recurring civil war comes from Walter's 2004's data she used to write "Does Conflict Beget Conflict" (Walter, 2004) combined with global geomagnetic indices from the Space Physics Interactive Database (Space 2013). Walter's dataset contains 1,151 country-years observations from 1945 to 1996 which were derived from the Correlates of War Project (Sarkees and Wayman 2010). Walter uses and creates many of the standard variables used in the conflict literature; Subsequent War, Repeat War, New War, Ethnic Civil War, Total Goals, Non-Total Goals, War-Related Deaths, Duration of War, Displaced People, Grievances Settled, Decisive Victory, Partition, Infant Mortality Rate, Life Expectancy at Birth, Adult Illiteracy, and Real GDP Per Capita. She also used the Democracy/Autocracy Scale from the Polity III Dataset (Jaggers, Keith and Gur 1995). Finally, Walter uses a Peace Year variable as a spline. Walter's data set is merged with system measures of the earth's geomagnetic field.

Models of the severity of civil war come from Lacina's data used in the 2006 work, "Explaining Severity of Civil Wars". The analysis included the severity of battle violence as the dependent variable. Severity of battle violence is measured as the natural log of the total count of battle deaths. She controls for both duration and population within the regression analysis. For state strength Lacina uses the measure of military quality, which is defined as military expenditures divided by the number of military personnel and lagged one year (logged) (Bennett & Stam, 1996), the per capita GDP that is adjusted for purchasing power parity and inflation (logged), a dummy variable for possible external support that is coded 1 if the war occurred during the cold war, and the percent of the country experiencing civil war that is "rough" (logged). The measure of regime characteristic is a dummy variable that codes a state with a composite score of 6 or higher on a combined Polity scale of regime type as a democracy (1) (Marshall & Jaggers, 2003). This dataset was merged with the global indices of geomagnetic value (Space 2013).

Data on Coups come from Johnathan Powell and Clayton L. Thyne's "Global Instances of Coups from 1950 to 2010: A New Dataset." (Powerll and Thyne 2011). The coup locations are coded for region of the world and combined with the global indices of geomagnetic values.

Data on casualties (killed and wounded) from Iraqi insurgency attacks comes from http://www.icasualties.org/Iraq/USCasualtiesByState.aspx which aggregates the numbers by month to match the available data on insurgent attacks (icasualties.org, 2008).

Data on the number of Iraqi insurgent attacks per month is available from The Brookings

Iraq (O'hanlon & Campbell, 2007). Brookings assembled the information from a variety of sources. The list of sources is available on their website.

Data on terrorism comes from the "Global Terrorism Database, 1970-1997" (LaFree and Dugan 2006) and is merged with the global indices of geomagnetism (Space 2013).

Chapter 5

Data on crimes in the state of Kentucky and its cities and counties come from the annual Kentucky State Police publication Crime in Kentucky (Police, 1978). This data source provides monthly, quarterly, and annual statistics on the different violent and non-violent crimes as well as crime indices.

Data for city, county, and state population of Kentucky comes from the 1980 census and Kentucky state government historical files (United States Cencus Bureau 2013).

Data for the percent of population living below poverty in 1978 comes from the census bureau data archive as well as state of Kentucky record archives (U.S. Census Bureau 2013).

Per capita spending on police, per capita welfare spending, per capita income, unemployment, and per capita spending on education all come from county reports of statistical abstracts, the bureau of labor statistics, and U.S. census bureau (U.S. Census Bureau 2013).

Data for the states of Alaska, Arizona, California, Colorado, Hawaii, Maryland, Mississippi, Texas, and Wisconsin including crime counts, per capita spending on judiciary, number of sworn law enforcement personnel, per capita law enforcement spending, unemployment rates, per capita income, spending on corrections operations, spending on judiciary, population come from the various state managed statistical abstract archives for the period 1960 to 2007.

Crime data from the states comes from the Office of Justice Statistics in the Justice Bureau (Office of Justice Programs 2013).

Chapter 6

Data on the daily Dow Jones and NASDAQ average comes from Yahoo Finance historical price archive (Dow Jones 2010).

Data on presidential messaging comes from Martin's dataset.

Data on The Federal Reserve Board's Fund Rate came from the Federal Reserve Bank of New York (Federal Reserve Bank n.d.).

Data on the national unemployment rate comes from the Bureau of Labor Statistics (Bureau of Labor Statistics 2013).

Data on the national inflation rate comes from the Bureau of Labor Statistics (Bureau of Labor Statistics 2013).

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2013 Defense Strategist, U.S. Army War College, Carlisle, PA

2013 Read Team Leader, University of Foreign Military Studies, Fort Leavenworth, KS

2013 Intermediate Level Education, Command and General Staff School, Fort Leavenworth, KS

2005 Signal Intelligence Office, Fort Huachuca, AZ

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PUBLICATIONS:

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2014 East, Jackie, R. “Lessons From the British Defeat Combating Colonial Hybrid Warfare in the 1781 Southern Theater of Operations.” Monograph. Leavenworth, KS: U.S. Army Command and General Staff College.

2013 East, Jackie, R. “Cost Benefit Analysis for Stationing Leader Development and Assessment Course.” Fort Knox, KY: Training and Doctrine Command.

2013 East, Jackie, R. “Workload, Workflow, and Staffing Requirements for Senior Reserve Officer Training Corps Programs and Work Centers: An Approved Work Center Model.” Fort Eustis, VA: Department of the Army, Directorate of Operations and Plans.

2012 East, Jackie R. "Intelligence Preparation Owensboro and the Surrounding Area and the Possible Impacts of a 6.0 or Larger Earthquake." Frankfort, KY: Department of Military Affairs.

2011 East, Jackie, R. "(Secret) Strategy and Operational Art of North Korea Post Transition." U.S. Army.

2010 East, Jackie R. "Argentina Sanctuary, Hezbollah, and Al Qaida: Understanding the Lines of Communications." Fort Meade, Maryland: NSA RFD.

2010 East, Jackie R. "Personnel Handbook for Base Realignment and Closure: Transition of U.S. Army Accessions Command, U.S. Army Cadet Command, and U.S. Army Human Resource Command to Fort Knox, Kentucky." Fort Knox, KY: Office of the Senior Commander, Fort Knox.

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INVITED TALKS:

2013 "Federal Hiring Process, Office of Personnel Management, and USA JOBS" at the Kentucky Political Science Association, Lexington, KY.

2011 "U.S. Army Special Forces Airborne Operations." at Japanese Army North's Tri-Annual Capstone training Conference and Exercise, Sapporo, Japan.

2010 "Fort Knox Human Capital Strategy: Base Realignment and Closing and Fort Knox, KY." at ONEKNOX and Governor of Kentucky Symposium on BRAC, Frankfort, KY.

2007 “World Class Opposing Force and the Employment of Indirect Fire Systems.” at Mission Command Training Center Mid-Event Planning Conference, Fort Leavenworth, KS.

CONFERENCE PRESENTATIONS:

2013 “The State of Nature and Its Influence on War Propensity, Outcomes, Participation, and Expansion.” Kentucky Political Science Association, Lexington, KY.

2008 “Geomagnetic Affect on Crime Counts.” Southwest Political Science Association, Albuquerque, NM.

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TEACHING EXPERIENCE:

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PS 101 American Government

PS 212 Culture and Politics of the Third World

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2010 -	Strategic Planner, U.S. Army Cadet Command, Fort Knox, KY
2013 -	Senior Intelligence Officer, 38th Infantry Division, Indianapolis, IN
2008-2010	Technical Consultant and Human Capital Advisor, U.S. Army Accessions Command, Fort Knox, KY
2007-2008	Intelligence Analyst, National Security Agency, Fort Meade, MD
2005-2008	Research Analyst Intelligence Domain, Future Combat Systems, Alion Science and Technology, Fort Knox, KY
2002-2005	Commander, 20th Special Forces Military Intelligence Detachment, U.S. Army, Various
2003-2004	Senior Intelligence Officer for Operation Noble Eagle, Installation Counter-Terrorism and Security Operation; Fort Campbell, Fort Knox, and Blue Grass Chemical Weapon Storage, Kentucky
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