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Economics of U.S. government debt accumulation

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ECONOMICS OF U.S. GOVERNMENT DEBT ACCUMULATION

A Dissertation

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DEDICATION

This dissertation is dedicated to my family, specially:

My grandfather Saturnino García Castillo,

whose teaching and prudence shaped my past and present.

My grandmother Paulina García Álvarez,

for her love, compassion and fortitude.

My grandparents Indalecio Jiménez Cano and Virginia de Jesus García Pernillo,

for their affection.

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ABSTRACT

The United States of America is an indebted nation in the early years of the new millennium, changing from $469 billion in 1973 to $14 trillion in 2010, as spending is justified on the basis that it promotes GDP growth which in turn increases societal benefits. Despite the benefits of debt, its effectiveness and the transmission mechanisms of fiscal policy are still on debate. Consequently, the economic effects of U.S. government debt accumulation are studied in three empirical research articles.

The dissertation is composed of five chapters. The first chapter is an introduction wherein the problem statement, the purpose, objectives and justifications are discussed. Then, the three articles are presented. The analyses used dynamic econometric models and data in the post Bretton Woods system of monetary management. Finally, the results are summarized in the fifth chapter.

The first article studied the effects of government debt on employment and the unemployment rate. The results indicate that debt has positive effects on employed labor in the economy in the long run, and it was found effective at retaining and decreasing the unemployment rate. Moreover, an unemployment rate shock produced a hump-shaped response of government debt. The second article studied the effects of government debt on exports. The causality tests did not provide evidence to support a relationship among those variables; however, the response of exports to a debt shock was positive and hump-shaped. Finally, the third article studied the transmission of U.S. government debt shocks into the Mexican economy; the results indicate that debt produces positive externalities as its GDP grows. Moreover, Mexican GDP is favored by increasing U.S. GDP; furthermore, a positive U.S. employment shock produced a hump-shaped response of Mexican GDP.

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In conclusion, U.S. government debt depreciates the currency which leads to price fluctuations of output and the inputs of production; in turn, the economy is likely to experience growth in exports, GDP, and employment that favors the economic growth of Mexico through trade. Finally, future research endeavors in the economics of government debt accumulation may contemplate to study the cooperative interdependence among political institutions involved in fiscal and economic policies.

CHAPTER 1. ACCUMULATION OF GOVERNMENT DEBT

Introduction

Throughout the history of humankind, many governments have struggled to manage their debt

obligations effectively. The extreme cases have resulted in financial crises that have threatened

the welfare of their citizens. The recovery of their economies has taken not only time but most

importantly financial resources for regaining the path of growth left behind. For instance, the

financial and economic crises of Mexico in 1994, Russia in 1998, Argentina in 2001, and to a

lesser degree in 2010-2011 European countries such as Greece, Ireland, Portugal, Spain and Italy

have shown us the tradeoffs that result from excessive accumulation of government debt.

During the last recession of the United States (December 2007- July 2009), the federal

government has increased the stock of debt to support the economy and to recapitalize banks by

means of the Emergency Economic Stabilization Act of 2008, the Economic Stimulus Package in

2008, and the American Recovery and Reinvestment Act of 2009. Policy-makers and regulators

from today emphasized the need to finance those programs in order to prevent a deeper

recession; vigorously, they have pointed out the importance to prevent further losses of jobs and

GDP growth; insistently, the reliance on government debt has been justified to prevent the loss of

competitiveness in the international financial system that could have resulted in a more serious

economic crisis with lasting implications such as higher interest rates, inflation and lower value

of the U.S. dollar.

High accumulation of debt occurs during fiscal expansions to stabilize the economy together

with expansionary monetary policy from the central bank. According to Galí (1994) government

purchases may work as automatic stabilizers. On the other hand, government debt from fiscal

deficits may also generate a financial crisis as Bratsiotis and Robinson (2004) have demonstrated

in the analysis of the Mexican case in 1994. According to the International Monetary Fund (2008), governments can also use discretionary fiscal policies to change spending levels, taxation, and income transfers. Therefore, there is contradictory empirical evidence about the functions and effects of government debt in the economy; its effectiveness may be circumstantial, depending on the economic and financial states of the country.

The role and effects of government debt in the economy are still not clear. Fatás and Mihov (2001), Blanchard and Perotti (2002), International Monetary Fund (2008) and Krugman (2009) have argued that unlike monetary policy, the transmission mechanisms of fiscal policy are still debatable. Thus, in this dissertation, I study the effects of government debt on labor demand, exports and economic growth, and, the international transmission of debt shocks to other economies. Finally, in all the evaluated models, the exchange rate is included to control for the effects of debt in the underlying value of the currency that result from not only the economic conditions but also from the expectations about future states of the economy.

Frenkel and Ros (2006), Hua (2007), and Ngandu (2008) have found a negative relationship between the exchange rate and employment. Ngandu (2008) made a thorough analysis of previous research on the exchange rate and employment demand by including channels of transmission such as external orientation (sales abroad), developmental macroeconomics, factor intensity, imported inputs, import penetration, market structure, trade liberalization, and openness. Surprisingly, government debt is disregarded either as depreciating factor of the currency or as an opposing force to loss of jobs and GDP growth. Furthermore, Soto (2008) argues that existing models of the exchange rate have ignored labor market characteristics. Thus, econometric models of labor demand can be improved by endogenizing the exchange rate.

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McMillin and Koray (1990) found that the exchange rate depreciates temporarily as the market value of public government debt increases. Thus, an undervalued currency is likely to create price competitiveness of the goods and services in the international marketplace. Moreover, in governments of industrialized nations, debt accumulation may generate a series of favorable conditions that favor not only the exports sector but also the overall health of the economy.

These favorable conditions can be observed as effective investments in education, infrastructure in communications and transportation, increase of the stock of knowledge through advances in science, technology and innovation (research & development), and military infrastructure. All in all, that state of affairs provides healthier and more productive citizens to the labor force that strengthens the domestic economy and its position in the international marketplace. However, recently, Giles and Williams (2000), Ahmad (2001), and Gutiérrez De Piñares and Cantavella-Jordá (2007) have studied the relationship between exports and economic growth, yet, they do not mention government debt and its working mechanisms as determinants of either exports or income. Therefore, it is necessary to distinguish the effects of government debt accumulation on employment, economic growth, international trade, and its externalities abroad.

Furthermore, the aforementioned conditions facilitated by an increase in government debt are likely to produce positive effects on GDP growth. As a result, the demand for imports will increase as well. As such, government debt may facilitate the economic growth of trading partners. For instance, Mexico and the United States have shown strong cooperation in the trading sector of their economies, especially, after the ratification of the North American Free Trade Agreement (NAFTA). So, a rise in the stock of U.S. government debt is likely to spur economic growth which in turn increases the demand for imports from Mexico, in this way, the Mexican economy is likely to benefit from rising debt accumulation. Besides, it is plausible to

assume that the health conditions of the U.S. economy have significant effects on the Mexican economy. In fact, Blecker (2009) found that U.S. GDP growth significantly affected the growth of the Mexican economy. In contrast, Arin and Koray (2009) found that increasing U.S. government expenditures decreased Canadian output. But, how U.S. government debt shocks are transmitted into the Mexican economy is still unknown.

Consequently, this dissertation research project aims to understand the economic effects of government debt accumulation in the United States by focusing on three goals. The first goal is to understand the efficacy of government debt at achieving greater demand for employment. The second goal is to evaluate the effectiveness of debt in stimulating the growth of exports which in turn may lead to economic growth. Finally, the third goal is to understand the transmission of U.S. government debt shocks into the economy of Mexico. The subsequent sections of this chapter present the problem statement followed by the objectives and justification. Then, a scholarly research article is developed for each objective.

Problem Statement
The macroeconomic consequences of government debt accumulation in the economy of the United States are not known completely. There are opposing views about its function and efficacy; and yet, the debt burden has soared over the last four decades, regardless of the political party leading the White House or Congress. Fiscal irresponsibility may lead to a harsh economic crisis if the economy is not able to produce enough savings to support the domestic demand for capital as pointed out by Calvo and Mendoza (1996), Giugale et al. (2001), Krugman (2007), International Monetary Fund (2008) and Krugman (2009).

The reliance by the U.S. government on debt to expand the economy can be corroborated by the quarterly average gross debt to GDP ratio which changed from 32% in 1980 to 69% in 2008. The common explanation for this policy is justified on the promise of increasing jobs and/or at the least to sustain the employment level and to improve growth in GDP to support a level of business activity that keeps the economy afloat.

The International Monetary Fund (2008) argues that such discretionary spending may be a stimulus for the economy to recover even when the workings of fiscal policy are still debatable. But, in another point of view, Alesina and Ardagna (1998) and Barry and Devereux (2003) have argued that fiscal contractions may be expansionary. Despite these ambiguities, increasing government debt in a developed economy may also create advantageous conditions for achieving greater competitiveness in the trading sector of the economy. Furthermore, Fatás and Mihov (2001), Blanchard and Perotti (2002), and Arin and Koray (2009) claim that unlike monetary policy, the transmission mechanisms of fiscal policy are still arguable.

Increasing government budget deficits depreciates the currency which in turn may lead to gains in the trading sector by stimulating exports growth. Nonetheless, exchange rate as a channel of transmission of debt has not been analyzed in the context of labor demand (Ngandu, 2008; Soto, 2008). Similarly, thorough analyses of the literature on the relationship between exports and economic growth have been conducted by Giles and Williams (2000), Ahmad (2001), and Gutiérrez De Piñares and Cantavella-Jordá (2007).

However, these studies neither investigated nor mentioned the role of government debt accumulation on exports growth. Consequently, it seems plausible to discern the effects of debt in the economy, because it is likely that growth in the exports sector may lead to economic

growth if debt is able to stimulate growth in the exports sector by lowering the underlying value of the currency. Hence, the increase in GDP may have effects on trading partners—as emphasized by Souki (2008), Blecker (2009), Voss and Willard (2009), and Arin and Koray (2009). For instance, growth of the Mexican economy may be stimulated by the growth of the U.S. economy.

Consequently, the natural questions that arise are: Does government debt have positive and significant effects on employment? Are exports increased by changes in government debt? Does the U.S. government debt have effects on economic growth of trading partners such as Mexico? The central purpose of this dissertation research project is to find answers to these questions and to evaluate the following hypotheses:

- U.S. government debt changes the foreign exchange value of the dollar, which leads to price fluctuations of output and labor; if there is an increase in the stock of debt, then, as the currency depreciates—more labor is likely to be employed.

- U.S. government debt changes the foreign exchange value of the dollar; if there is an increase in the stock of debt—as the currency depreciates, and GDP and employment increase—then, the exports component of GDP is likely to increase.

- U.S. government debt influences the Mexican economy through trade; if there is an increase in the stock of debt—as GDP and employment increase, and the Peso depreciates—then, Mexican GDP will grow since U.S. imports from Mexico will increase.

The conceptual basis of this dissertation is founded on a Cobb-Douglas production function previously used by Emery (1967), Michaely (1977), Balassa (1985), Greenaway, Hine, and

Wright (1999), Fu and Balasubramanyam (2005) and Hua (2007). Determinants of output are established, and the labor demand function is derived. Government debt is assumed to have effects on total factor productivity. The same specification is used in the search for understanding the effects of debt on exports and output growth; besides, the trade balance between two countries can be analyzed, thus, important variables in the international transmission of government debt shocks can be recognized through the trade channel.

The selected variables signaled by economic theory are modeled by specifying dynamic econometric models, they are commonly applied in macroeconomics research, e.g. Ahmad (2001), Souki (2008), Voss and Willard (2009). The data comes from the International Monetary Fund, Federal Bank of St. Louis, World Economic Outlook Database, the Foreign Trade Statistics Office of the U.S. Census Bureau, and Instituto Nacional de Estadística y Geografía.

Purpose and Objectives
The purpose of this dissertation is to empirically evaluate the economic effects of government debt accumulation in the United States of America. Specifically, the study investigates the effects of government debt on employment demand, the potential growth in exports that may lead to economic growth, and the international transmission of government debt shocks. Furthermore, an exchange rate index is evaluated as an indicator for the value of the U.S. currency that serves as a shock absorber of fiscal and monetary policies that lead to price fluctuations of the output and the factors of production.

Given the conditions and expectations about the economy, this dissertation may help guide the economic rational choices carried out by economic agents such as taxpayers, businesses, policy-makers and regulators, economic and financial institutions, domestic and international providers of capital.

The dissertation follows the journal style of writing dissertations. Specifically, it will pursue the general purpose of understanding the economic effects of government debt accumulation by focusing on the following articles along with their specific objectives:

I The Effects of Government Debt on Employment in the United States.

- To determine causality between government debt and labor demand, and labor demand and the exchange rate.

- Analysis of the dynamic responses of the unemployment rate to shocks on government debt and the exchange rate.

- Analysis of the dynamic responses of the exchange rate to government debt shocks.

II Assessment of the Consequences of U.S. Government Debt on Economic Growth and Exports.

- To determine causality of government debt on exports and economic growth.

- Analysis of the dynamic responses of exports, exchange rate, and GDP to debt shocks.

- Analysis of the dynamic responses of U.S. employment to shocks on exports.

III Transmission of U.S. Government Debt Shocks to the Economy of Mexico.

- Analysis of the dynamic responses of Mexican GDP to debt and M2 money stock shocks.

- To investigate the responses of chosen variables to shocks in the U.S./Mexico bilateral real exchange rate and the trade weighted exchange rate index of major currencies.

Justification and Significance

Recovery from an economic crisis is costly because of the high losses of jobs, high inflation, low liquidity in the financial system that holds credit lines, and the high financial burden on supporting the unemployed and business activity for avoiding a deeper recession. For instance, the 2007/2009 recession in the United States was triggered by a weak regulatory framework that lead to tremendous fluctuations in house prices that threatened to collapse the financial system and overall health of the economy. As economic policies for the recovery were enacted, fiscal expansion followed (appendix I), the federal debt changed from $9.2 trillion in 2007:4 to $11.9 trillion by 2009:3. Moreover, the debt to GDP ratio changed from 64.6% to 84.4% in the same period—close to a 30.6% increase.

In other countries, lack of fiscal responsibility has led to financial and economic crises; as a result, their currencies were depreciated, and their economies inherited a rising unemployment rate, lower production levels, less capital, restricted access to bank loans, and lower real wages due to inflationary forces; for instance, Mexico in 1994 as documented by Calvo and Mendoza (1996) and Giugale et al. (2001).

Likewise, banking crises may also generate the same effects as exemplified by Bernanke (1983) for the case of the great depression in 1930-1933 and Manchester and McKibbin (1994) in the savings and loans crisis of the 1980's. Consequently, it seems that there is still a need to understand the role of fiscal policy in the economic system; in fact, in reference to the last financial crises around the globe, Krugman (2009) has emphasized that "*depression economics is back*" and urged researchers to re-evaluate our understanding about the economy.

When governments face either recessions or economic and financial crises, they have three feasible possibilities for financing their spending needs and/or fiscal deficits. The first choice is

the issuance of money (seigniorage), the second alternative is to rely on government bond markets, and the third option entails either to enact new taxes or to increase tax rates. But, any policy that raises the tax burden is politically sensitive. Hence, government officials are left with the options of seigniorage and bond financing. But repeatedly, seigniorage has been shown to have inflationary effects; thereby, bond financing seems a reasonable possibility to finance government expenditures in combination with other choices.

However, the consequences of mismanaging deficit spending financed with external and internal debt are too costly to dismiss; specially, when the effects are still not well understood. Fatás and Mihov (2001) pointed out that fiscal policy has not received much attention because much of the public debate has been focused on the macroeconomic effects of government spending and taxation. Perotti (2007) asserts that "*perfectly reasonable economists can and do disagree on the basic theoretical effects of fiscal policy, and on the interpretation of the existing empirical evidence*," while Arin, Mamun, and Purushothman (2009) proclaim that "*our understanding of the transmission of fiscal policy innovations is far from complete.*"

Furthermore, government debt may create a competitive exports sector and lead the country to economic prosperity. Nonetheless, the direct effects of debt on exports through changes in the relative value of the currency have not being investigated; for instance, surveys of the literature conducted by Giles and Williams (2000), Ahmad (2001) and Gutiérrez De Piñares and Cantavella-Jordá (2007) do not report or consider government debt as a factor that influences the relationship between debt, exports and economic growth. Henceforward, it is important to study the macroeconomic effects of government debt accumulation.

Because of the importance and urgency to understand fiscal policy and the gaps in knowledge that had been reviewed, this dissertation endeavors to understand the economic effects of government debt accumulation in interaction with macroeconomic variables of the economic system. Specifically, the research effort is focused on the response of labor demand, exports and economic growth, and the transmission of U.S. government debt shocks into the Mexican economy.

Additionally, an index for the foreign exchange value of the dollar is incorporated in the analyses given the high level of integration of the United States into the global economy. Thus, throughout the dissertation, the evaluation of the effects of government debt accumulation on the exchange rate can be performed; as such, the relationship is studied in the context of both domestic factors and trade relationships of the U.S. economy.

Outline

Three empirical research articles are developed in this dissertation. The first article is titled "The Effects of Government Debt on Employment in the United States", followed by "Assessment of the Consequences of U.S. Government Debt on Economic Growth and Exports." Finally, the third article is titled "Transmission of U.S. Government Debt Shocks to the Economy of Mexico." In each article, thorough descriptions of the implemented methods and utilized data are presented. Lastly, the results of the dissertation are summarized in the fifth chapter while providing general concluding statements and opportunities for future research endeavors in the economics of government debt accumulation.

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CHAPTER 2.   THE EFFECTS OF GOVERNMENT DEBT ON EMPLOYMENT IN THE UNITED STATES

Background Information

The United States of America is increasingly relying on government debt to promote growth in employment and to put the economy out of a recessionary path. The new administration lead by President Barack Obama has sponsored new bills such as the 2009 American Recovery and Reinvestment Act that will make the economy more dependent on government spending; sharing similar goals with the previous administration that enacted the 2008 Emergency Economic Stabilization Act and the 2008 Economic Stimulus Act.

These laws have increased the debt; but, the economic stimulus package also cuts taxes, continuing the practice of lower taxation that was institutionalized by Ronald Reagan (Economic Recovery Tax Act, 1981) and followed by President George W. Bush (Economic Growth and Tax Relief Reconciliation Act, 2001; Job Creation and Worker Assistance Act, 2002; Jobs and Growth Tax Relief Reconciliation Act, 2003). These policies, together with the last recession and spending on the wars on terror in Afghanistan and Iraq, have exacerbated the fiscal deficit problem of the nation.

The reliance on debt by the U.S. government to expand the economy can be corroborated by the gross debt to GDP ratio which changed from 32% in 1980 to 69% in 2008 (Figure 2.1); evidently, this ratio has constantly increased in the period 1980-1992. Thereafter, however, it should be pointed out that the ratio decreased from 66% in 1993 to 56% in 2001. Since then, the reliance on government debt has gradually increased, and by the third quarter of 2010 the aforementioned ratio reached 92%. In sum, the quarterly growth rate of the debt/GDP ratio was .56% in the 1980-2008 period versus 2.5% in the 2009:1-2010:3 period. A closer inspection of Figure 2.1 shows that periods of rising unemployment rate (peaks can be noticed in the years

1975, 1982, 1992, 2003 and 2009) had been accompanied with more reliance on government debt as measured by the gross debt/GDP ratio (scaled down by a factor of 10).

Giving the current debate on the efficacy of government debt to restore growth in the U.S. economy, a labor demand function is estimated, using a system approach in a dynamic econometric model with the objective of understanding the effects of government debt. The determinants of employment demand were chosen from a standard Cobb Douglas production function; having debt affecting the growth of productivity; the short run and long run effects of government debt are investigated. Exchange rate is included in the model to absorb currency shocks that arise from monetary and fiscal policies that have effects on the level of employment.
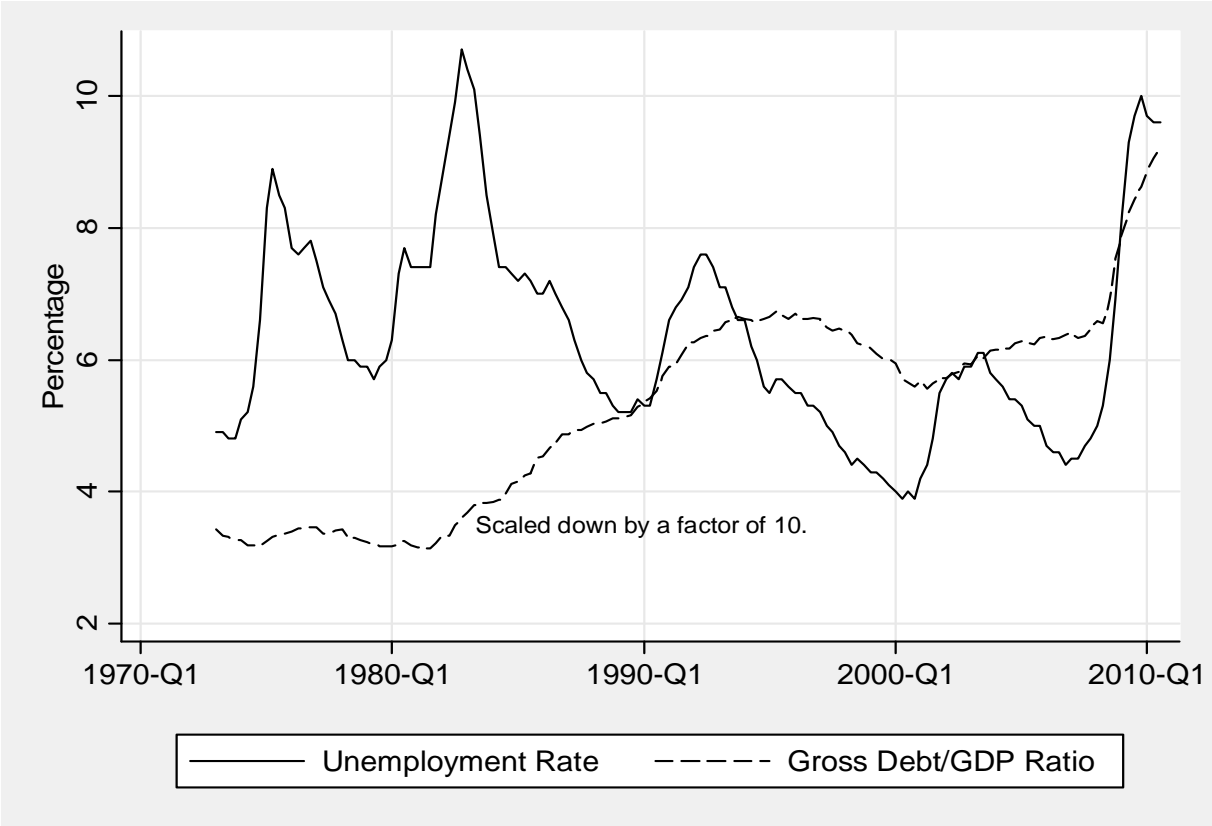
Figure 2.1 Unemployment rate and gross government debt/GDP ratio for the United States.

Literature Review

Movements in real exchange rates cause adjustments on the labor demand function due to the effects on profits, especially in those firms with high share of revenue originated from either exports or high costs of imported production inputs. Consequently, changes in the real exchange rate would alter relative prices and will eventually have effects on job creation and job reduction as recently indicated by Hua (2007), Klein, Schuh, and Triest (2003), Frenkel and Ros (2006) and Ngandu (2008).

In the case of the United States, Blecker (2007) describes empirical evidence showing that there is a significant negative effect of real dollar appreciation on aggregate investment in the U.S. manufacturing industry, the effect is transmitted through liquidity rather than changes in the desired capital stock by firms. If we assume this relationship, coupled with the fact that increasing government expenditures is likely to increase the stock of government debt; then, competition for capital with the private sector and flows of financial resources will increase too.

However, previous studies have neglected the implications of government debt as a channel of transmission of exchange rate in employment; even Ngandu (2008) disregarded the role of government debt when making a thorough analysis of the channels of transmission of exchange rate. Thereby, this study seeks to analyze the effects of government debt on employment demand, considering the role of exchange rate as a variable that changes the relative prices of the factors of production. The inclusion of exchange rate is very important for an economy that is highly integrated into global markets through financial activity and trade.

Hua (2007) exposed the negative relationship between real exchange rate and manufacturing employment in China for selected provinces during the period 1978-2003. Hua stated that in the 1993-2002 period, the average rate of Chinese currency appreciation was 4.1% per year, while

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job creation was at the average rate of -2.3%. Essentially, increasing unemployment occurred. This phenomenon coincided with lower exports compared to the 1981-1993 period. Then, it seems that as the currency appreciates, the demand for exports decrease, in turn, these combined factors decrease labor demand in the economy. The real effective exchange rate is defined as the nominal effective exchange rate multiplied by the ratio of consumer prices between domestic prices and foreign partners; thus, an increase in the real exchange rate implies a real appreciation of the domestic currency.

Hua found that in Fujian, Guangdong, and Zhejiang provinces employment increased at an annual average rate of 2.9%, 1.4% and 1%, respectively; despite an annual average real appreciation of the Chinese currency of 4%, 3.2% and 4.4% respectively. This fact shows how job creation and job destruction occur due to exchange rate movements, suggesting that it is very likely that switching of sectoral employment in the Chinese economy has occurred. This phenomenon has also been observed by Campa and Goldberg (2001) and Ngandu (2008). Output and capital/labor intensities are expected to be positively and negatively correlated with employment demand, respectively.

We would expect that the greater the output the greater the employment level, while expansion on the use of capital would reduce employment. Hua (2007) found that 1% output expansion increases employment by 0.74% and that 1% increase in capital intensity reduces employment by 0.5%. Appreciation of the real exchange rate is then detrimental to employment, Hua (2007) states that higher international competition and higher wages occur. He found that for 1% increase in the real exchange rate, employment decreases by 0.69%; but the exchange rate also has effects on capital/labor intensity, exports and the exports/GPD ratio.

The research work of Hua (2007) can be improved by analyzing many economic sectors simultaneously, like the work of Ngandu (2008). Ngandu analyzed the effect of the exchange rate on the employment level in different sectors of the South African economy. Different levels of aggregation of the different sectors of the economy can be used, taking into consideration demand and supply factors as it was done by Branson and Love (1986). Another possible route of improvement is to analyze the impact of the exchange rate on different measures of labor market activity; Campa and Goldberg (2001) used wages, employment (number of jobs and hours), overtime employment, and overtime wages. Also, a dynamic analysis of the variables in the model could be performed, with the intention of noticing the short and long run effects of exchange rate on employment.

Industries with high (low) openness are likely to show positive (negative) response in employment demand due to a depreciation of exchange rates (Kim 2005). The exchange rate also has effects on the trade deficit. Zhenhui (2008) found a long term relationship between the real exchange rate and the trade deficit. Exchange rate movements have effects on the short run economic activity and economic growth; and then, as indicated by Frenkel and Ros (2006), the exchange rate has effects on the unemployment rate. In other words, the exchange rate affects the amount of labor employed in the economy, since it ends up determining domestic prices.

Financial activity also plays a role on the determination of an exchange rate, a measure of financial markets activity needs to be included because it has effects on the flows of money and trade; thus, on the employment level. For example, in the case of the Mexican economy in the period 1971 through 1988, De La Cruz (1999) found a long term relationship between domestic credit, real exchange rate and international reserves. According to this monetary approach, an exogenous increase in domestic credit is likely to cause losses in international reserves that cause

exchange rate depreciations; but, as suggested by Wu, Chen, and Le (2001), the balance of payments will be in a sustainable path if exports and imports are cointegrated for counteracting the loss of international reserves.

By means of a bivariate vector autoregressive model, Zhenhui (2008) evaluated the relationship between the value of the Chinese currency, Renminbi (RMB), and the trade deficit with the United States. Although the Chinese government has been criticized by The United States for manipulation of the exchange rate, the author did not find a short run relation between the mentioned variables; but there was a significant relationship in the long run. Consequently, an appreciation of the RMB/$ was likely to reduce the U.S. trade deficit with China.

So, depreciated foreign currencies have implications on the demand for U.S. output. For instance, Branson and Love (1986) have found that real appreciation of the U.S. dollar reduces the competitiveness of output in the manufacturing sector that is directly or indirectly substitutable for foreign output. Since the appreciation of the currency reduces demand for domestic output due to changes on relative prices; consequently, the appreciation reduces the demand for labor. Branson and Love (1986) found that the largest exchange rate effects are in the mining and manufacturing sectors, as one would expect, with durable goods showing larger effects than non-durable goods. Capital goods that are produced domestically are increasingly substituted with cheaper imports due to appreciation of the exchange rate.

However, recently, Goldberg and Knetter (1997) and Gust, Leduc, and Vigfusson (2010) documented that import prices have become less responsive to currency changes in part due to market segmentation and market integration, respectively. As such, if markets become more competitive then firms have to adjust their profits by finding cost savings technologies that leads

to adjustments on employed labor and capital requirements or by changing the revenue structure of the firm; moreover, firms may also hedge risks in the financial markets which allows them to respond more effectively to fluctuations on the foreign exchange value of currencies.

Greenaway, Hine, and Wright (1999) state that between 1979 and 1991 the UK industry became increasingly integrated into the international economy through trade and foreign direct investment. By analyzing 167 manufacturing industries, Greenaway, Hine, and Wright (1999) found that the simultaneous phenomenon of increasing unemployment and stable production in those industries necessarily imply that output per person has been rising; although, they found high variation in productivity.

This suggest that trade promotes efficiency in domestic industries; this is what Hua (2007) has referred to as the efficiency transmission channel of exchange rate and Frenkel and Ros (2006) as the labor intensity channel. Therefore, openness to trade would reallocate the factors of production towards more profitable enterprises; moreover, policies that have favored the promotion of exports emphasize the trading sector of the economy. The reallocation of resources from trade will create employment in those industries that are competitive; thus, as Greenaway, Hine, and Wright (1999) has point out "openness serves to increase the efficiency with which labor is utilized in the firm."

Greenaway, Hine, and Wright (1999) suggests that "lags may also be introduced into the labor demand function once bargaining considerations are taken into account such as sequences of bargains or expectations formation about future wage and output levels," as bargaining occurs, the factors that cause rigidities are worked out, the market then finds a new equilibrium. However, in general, the labor market is characterized by being more rigid in comparison to the

markets for goods and financial instruments where adjustments in supply and demand are accomplished faster; thus, price changes are able to reflect greater amount of information.

As the economy receives shocks, equilibrium is going to be restored in the employment level at a slower rate due to rigidities (real wages, contracts, unions, social costs of the unemployed, costs of firing and hiring, costs of training and search of new employees, etc). Because of these rigidities, excess demand or excess supply of labor will be eliminated, requiring some time to reach the new equilibrium after the shock. Thereby, a lag structure is needed, Greenaway, Hine, and Wright (1999) suggest that if there exists serially correlated technology shocks more lags may be needed.

Movements in the exchange rate change the relative prices of domestic goods, exports and imports, and with these changes in prices, there is a new allocation of resources depending on the degree of persistence of the variability of the exchange rate. Lastrapes and Koray (1990) studied the relationship between exchange rate volatility and real activity denoted by output; using a vector autoregressive model (VAR), it was determined that the relationship is weak. Exchange rate volatility is not Granger-independent of the variables in the system, and the state of the economy strongly effects volatility (Lastrapes and Koray 1990). So, in a way, the exchange rate is a signal of the overall condition/state of the economy.

By using the same measures of exchange rate volatility, Koray and Lastrapes (1989) established that it does not affect the trade flows in the economy; but permanent shocks decreased imports, even more on flexible regimes compared to fixed exchange regimes. These results are aligned with those of Campa and Goldberg (2001), who found that transitory exchange rate movements have greater effects on overtime hours worked and overtime wages.

Transactions between individuals from different countries and currencies achieve a price for services, goods and financial instruments either in domestic or foreign currency. Independent of the arrangement, one currency will be exchanged for another, thus, the exchange rate will be determined. The impact of the exchange rate in the economy will depend on the degree of internationalization of the industries (exports, imported inputs, imported intermediate inputs, etc), thus, the exchange rate will have effects on the labor market according to the market conditions of the industry and overall state of the economy.

Campa and Goldberg (2001) indicated that the degree of effect of the exchange rate on labor demand will depend on the competitive structure of the industry, the skill level of the labor involved in the industry, and other factors related to trade orientation. Kim (2005) states that it has been shown that industries with high (low) openness show positive (negative) response in employment demand due to depreciation of the exchange rate; Kim (2005) also found the same response in industries with low (high) imported input ratio since employment demand was likely to respond positively (negatively).

From a panel study of Italian firms, Nucci and Pozzolo (2008) determined that the number of jobs and worked hours are responsive to sales and imported inputs; wages are affected by the real exchange rate and they decline even more when the firms' sector has lower monopoly power and higher foreign competition. Campa and Goldberg (2001) state that labor demand is less responsive to exchange rate when production is labor intensive, it has a higher import penetration and when export orientation raises the sensitivity of labor demand to exchange rates; they also mentioned that depreciation of the exchange rate causes labor demand to decrease when the industry relies on imported inputs due to higher production costs in domestic currency.

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Frenkel and Ros (2006) has stated that "from a Keynesian perspective, it is well known that there is a positive relationship between depreciation and exports" and considering other factors that contribute to aggregate demand, a depreciated currency would increase the demand for factors of production such as labor and capital. Consequently, exports have a positive effect on the employment level and pace of economic growth.

Fu and Balasubramanyam (2005), for the case of China over the time period 1987–1998 in 29 provinces, found that foreign direct investments and exports provided an effective demand not only for the surplus capacity of their capital stock but also for the surplus of labor. As a result, a depreciated exchange rate not only stimulates exports but also FDI. In the case of the United States, Blecker (2007) found empirical evidence that there is a significant negative effect of real dollar appreciation on aggregate investment in the U.S. manufacturing industry, the effect is transmitted through liquidity rather than changes in the desired capital stock by firms.

In the case of Vietnam, Xuan and Xing (2008) found that exports are influenced by not only the exchange rate but also by foreign direct investment. The FDI export elasticity was 0.13 while exchange rate export elasticity was 0.47, implying that depreciation of the exchange rate stimulated exports. The drawback of the research is that FDI was measured by approved FDI rather than FDI stocks. So, financial market activity and speculation play a role in the determination of exchange rate as suggested by Vargas-Silva (2009) and Soto (2008).

FDI stimulates growth in exports depending on foreign aggregate demand. The increased demand of labor caused by FDI and the added value of exports caused by domestic and foreign firms will depend on the share of inputs that are imported in the production process. Arndt (2006) refers to this as production sharing; therefore, production sharing affects the trade balance

due to fluctuations in the exchange rate. But, the effects will depend on the mobility of capital and labor, the degree of price rigidity and the level of unionization in the labor market.

Movements in real exchange rates cause adjustment of labor demand due to the effect on profits, especially to those firms with high share revenue from exports or costs of imported inputs; consequently, changing relative prices produce creation and destruction of jobs, see for example Hua (2007), Klein, Schuh, and Triest (2003), Frenkel and Ros (2006) and Ngandu (2008). Klein, Schuh, and Triest (2003) implemented an economic model of gross job creation and losses applied to detailed U.S. manufacturing industries between 1973 and 1993 to elucidate the effects of the real exchange rate (trend and cycle) on labor reallocation. They found that the real exchange rate significantly affected job reallocation but it did not affect net employment; the cyclical component of the real exchange rate affected only net employment through job losses.

Movements in bilateral real exchange rates generate a wide range of responses within traded-goods industries because trade patterns differ markedly across industries (Klein, Schuh, and Triest 2003). A study by Frenkel and Ros (2006) states that an increase in the labor intensity of traded goods due to an increase in the real exchange rate occurs through either the adoption of more labor-intensive techniques or greater reallocation of labor and investments toward labor intensive tradable goods.

Frenkel and Ros (2006) studied Latin American countries (Argentina, Brazil, Chile, and Mexico), and found that two years later after an appreciation (depreciation) of 1% in the real exchange rate, a 0.56% increase (fall) in the unemployment rate followed. So, it seems that countries have incentives to have undervalued currencies. They also found that a 1% increase in gross domestic product was associated with a 1.49% decrease of the unemployment rate.

Ngandu (2008) studied the relationship of the exchange rate and employment in South Africa. Forty three aggregated sectors were analyzed; the response of employment to exchange rate shocks was significant and varied depending on the level of openness of the industry. Ngandu made a thorough analysis of the channels of transmission of exchange rate to employment by including developmental macroeconomic, factor intensity, external orientation, imported input and import penetration, market structure, trade liberalization, and openness; government debt is disregarded either as a depreciating factor of the currency or as an opposing force to job losses.

Previous literature indicated that there is a negative relationship between the exchange rate and labor demand, studying as channels of transmission the role of exports, substitution of factors of production, terms of trade, openness, and productivity. Soto (2008) has argued that existing models of exchange rate determination have ignored labor market characteristics.

Thereby, this research article will pursue to untangle the effects on employment by increasing government debt accumulation while considering the effects of the debt on foreign exchange value of the dollar in the post Bretton Woods period. Government debt enters into the economic model by affecting the growth of productivity. If we use a standard production function, the assumption would imply that government debt has effects on total factor productivity (TFP). For instance, if we use a Cobb Douglas production function of the form $Q = A^{\gamma} K^{\alpha} N^{\beta}$, then, it is implied that government debt would have effects on the coefficient A; K and N represent production inputs such as capital and employed labor. This specification has been used by Greenaway, Hine, and Wright (1999); Fu and Balasubramanyam (2005) and Hua (2007).

Objective

The general goal of this research article is to empirically assess the effects of government debt on labor demand in the United States for the period 1973-2010 by using quarterly data. As such, the main hypothesis to be evaluated is that *U.S. government debt changes the foreign exchange value of the dollar, which leads to price fluctuations of output and labor; if there is an increase in the stock of debt, then, as the currency depreciates—more labor is likely to be employed.*

The specific objectives of this research article are:

- To specify an economic model of labor demand consistent with the main determinants of growth, taking into consideration the direct and indirect effects of government debt.

- To estimate a dynamic econometric model for the relationship between labor demand and government debt in the U.S. economy, considering the effects of debt on exchange rate. If cointegration relations are found among the variables, the specification is going to follow a vector error correction model; otherwise, a vector auto regressive model would suffice.

- Determination of the causal effects of exchange rate on labor demand as well as the causal relationship between government debt and labor demand.

- To obtain the dynamic effects of government debt and exchange rate on unemployment.

The chosen time series correspond to the post Bretton Woods System of monetary management among industrialized countries, far beyond the initial shock in 1971 for eliminating the noise that appeared from newly adopted policies for exchange rate, financial liberalization and policies that have promoted freer trade and economic coordination. Given the high openness of the country in terms of trade and financial markets, the exchange rate is included in the model as a shock absorber of fiscal and monetary policies.

Theoretical Model

The employment demand function was derived from a Cobb-Douglas production function, where

Q is real output, K is the capital stock, and N represents the amount of labor input in the

economy, equation (1). The coefficients α and β represent factor share coefficients, and, γ is a

parameter that allows efficiency growth in the use of labor during the production process. This

specification has been used by Greenaway, et al. (1999), Hua (2007), and, Fu and

Balasubramanyam (2005).

$$Q = A^{\gamma} K^{\alpha} N^{\beta} \tag{1}$$

By assuming that economic agents maximize profits, then, labor and capital will be used up to a

point where the marginal product of labor equalizes the wage (w) and the marginal product of

capital equalizes the user cost of capital (c), respectively;

$$\frac{\partial Q}{\partial N} = \beta A^{\gamma} K^{\alpha} N^{\beta-1} = MPL \tag{2}$$

$$\frac{\partial Q}{\partial K} = \alpha A^{\gamma} K^{\alpha-1} N^{\beta} = MPK \tag{3}$$

then we aim to solve for K, thus,

$$\beta A^{\gamma} K^{\alpha} N^{\beta-1} = w \tag{4}$$

$$\alpha A^{\gamma} K^{\alpha-1} N^{\beta} = c \tag{5}$$

rearranging equations (4) and (5) for K^{α} and $K^{\alpha-1}$ we get

$$K^{\alpha} = \frac{w}{\beta A^{\gamma} N^{\beta-1}} \tag{6}$$

$$K^{\alpha-1} = \frac{c}{\alpha A^\gamma N^\beta} \tag{7}$$

and given that $\dfrac{K^\alpha}{K} = K^{\alpha-1}$ we get

$$\frac{\dfrac{w}{\beta A^\gamma N^{\beta-1}}}{\dfrac{K}{1}} = \frac{w}{K\beta A^\gamma N^{\beta-1}} \tag{8}$$

$$\frac{w}{K\beta A^\gamma N^{\beta-1}} = \frac{c}{\alpha A^\gamma N^\beta} \tag{9}$$

thus,

$$K = \frac{w\alpha N}{c\beta} \tag{10}$$

and by replacing K in equation (1) we get

$$Q = A^\gamma \left[\frac{w\alpha N}{c\beta}\right]^\alpha N^\beta \tag{11}$$

Applying logarithms and solving for the labor demand equation N (appendix II), we obtain

$$\ln N = \phi_0 + \phi_1 \ln Q + \phi_2 \ln(\frac{c}{w}) \tag{12}$$

where $\phi_0 = \dfrac{-\gamma \ln A}{\alpha+\beta}$, $\phi_1 = \dfrac{1}{\alpha+\beta}$, and $\phi_2 = \dfrac{\alpha[\ln b - \ln \alpha]}{\alpha+\beta}$. The efficiency parameter A is assumed

to be affected by government debt (Debt) and the exchange rate (ER), so that

$A = e^{\phi_3 T} Debt^{\phi_4} ER^{\phi_5}$; then, the extended labor demand function (appendix III) is described as

$$\ln N = \phi_1 \ln Q + \phi_2 \ln(\frac{c}{w}) + \phi_3 T + \phi_4 \ln Debt + \phi_5 \ln ER \qquad (13)$$

Based on equation (13), by differentiating it, the effects of debt and exchange rate on labor demand can be identified as

$$\frac{\partial \ln N}{\partial \ln Debt} = \phi_4 < 0 \qquad (14)$$

$$\frac{\partial \ln N}{\partial \ln ER} = \phi_5 < 0 \qquad (15)$$

such that equations (14) and (15) provide us with the magnitudes of the debt elasticity of labor demand and the exchange rate elasticity of labor demand, respectively.

Econometric Methods
The relationship between employment and government debt is investigated in the United States by using a dynamic specification of an economic model that takes into consideration the effects of government debt on the exchange rate which in turn may have effects on the demand for labor. In accord with the economic model, the variables to be included in the econometric model are the level of employment, income, nominal interest rate, wages, government debt, and exchange rate. All the pecuniary variables will be in real terms and logarithmic transformations are used. Following Frenkel and Ros (2006), the gross domestic product (GDP) is used as a proxy measure for income.

The econometric model is specified in vector error correction form (VEC) due to integration of the variables and common trends found in the data. Thus,

$$\Delta \mathbf{y}_t = \boldsymbol{\alpha}\left(\boldsymbol{\beta}\mathbf{y}_{t-1} + \boldsymbol{\mu} + \boldsymbol{\rho}t\right) + \sum_{j=1}^{p-1}\boldsymbol{\Pi}_j\Delta\mathbf{y}_{t-j} + \boldsymbol{\gamma} + \boldsymbol{\tau}t + \mathbf{u}_t \tag{16}$$

where $\boldsymbol{\rho}$ and $\boldsymbol{\tau}$ are assumed to be zero, so that there is a trend in the un-differenced data and the cointegration equation is stationarity around a non-zero mean, see Enders (2004). The error term u is assumed to be Gaussian with the usual properties. The parameters $\boldsymbol{\alpha}$ and $\boldsymbol{\beta}$ correspond to the error correction terms and the long run estimates from the cointegrating equation, respectively.

In order to implement the cointegration tests, the variables should have the same order of integration, i.e. I(1); this research project will use the DF-GLS test for unit roots, and other tests will be implemented as a way to corroborate and/or to discern the stationarity of the variables, such tests are the ADF test, the KPSS test and the Phillips and Perron test.

Lag selection for the cointegration tests and the estimation of the VEC model used information criteria such as AIC, BIC, HQ, and those suggested by Lütkepohl (2005) as well as likelihood ratio tests. Cointegration among the variables was evaluated by the Johansen test by determining the rank of the VEC model; two tests are implemented, the trace and the maximum eigenvalue statistic. If zero rank is found among the variables, then, the model is specified as a vector autoregressive in first differences. If the variables are stationary, the estimation of the model will consist of vector autoregressions, i.e. a VAR model in levels.

Equation (17) displays a VAR model that consists of assuming endogeneity of all the variables, i.e. there is a dynamic interdependence among all the variables included in the system, the error terms are assumed to be white noise.

$$Y_t = \alpha_o + C(L)Y_t + U_t \tag{17}$$

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$Y_t = n*1$ vector of endogenous variables, $t = 1, 2, 3, \cdots t - 2, t - 1, T$

$\alpha_o = n*1$ vector of non-zero constant terms

$U_t = n*1$ vector of residuals

$C(L) = n*n$ is a matrix compound of polynomials, where L is the lag operator

$$C(L) = \begin{bmatrix} C_{11}(L) & \cdots & C_{1n}(L) \\ \vdots & \ddots & \vdots \\ C_{n1}(L) & \cdots & C_{nn}(L) \end{bmatrix}$$

$C_{11}(L)Y = c_{11}Y_1 + c_{12}Y_1 + \cdots + c_{1k-1}Y_1 + c_{1k}Y_1$, i.e. k lags

$E(U_t) = 0$, $E(U_t U_t^{'}) = \Sigma$ where $\Sigma = n*n$ and $E(U_{1t}U_{2s}) = \sigma_{12}$ for t=s

$E(U_t U_t^{'}) = 0$ and $E(Y_t U_t^{'}) = 0$ for $t \neq s$

The inclusion of deterministic terms such as structural breaks and deterministic trends, was evaluated by likelihood ratio tests as in equation (18); where Ll_0 and Ll_1 are the log-likelihood values related to the estimated models under the null and alternative hypotheses, respectively. The null hypothesis of the test assumes that the evaluated deterministic terms equal to zero.

$$LR = -2(Ll_o - Ll_1) \tag{18}$$

The statistic follows a χ^2 distribution with the degrees of freedom equal to the number of deterministic terms being evaluated. However, the final decision lies on whether the estimated parameters are statistically significantly different from zero and/or the residuals conform to white noise process. Moreover, the parameter estimates should result in a stable VAR model to ensure that is invertible and consequently it has an infinite-order vector moving-average representation.

Empirical Results

Description of the Dataset

The dataset has quarterly observations that span from 1973:1 up to 2010:3. The econometric model consists of five variables, a measure for the labor market, an indexed measure for the exchange rate, the real interest rate, total federal government debt and the gross domestic product. The last two variables were deflated by using the GDP deflator. The graphical depiction of the variables can be seen in Figure 2.2.

The chosen measure for exchange rate is the trade weighted exchange rate index of major currencies. It measures the relative value of the U.S. dollar against the currencies of the Euro Area, Canada, Japan, United Kingdom, Switzerland, Australia, and Sweden. The index uses 1973 prices as the benchmark for comparisons across years, the data was obtained from the Federal Reserve Bank of St. Louis; an appreciation (depreciation) of the U.S. dollar is captured by an increase (decrease) of the index. On average, the index has declined 0.19% per quarter.

Data for the nominal gross domestic product was obtained from the Bureau of Economic Analysis and it measures the economy's output in billions of U.S. dollars. The deflated measure of GDP was obtained using the GDP deflator that is released by the same bureau. The deflator uses 2005 prices for comparisons. In the sample period, the nominal gross domestic product grew an average of 1.58% per quarter, while in real terms the growth rate was 0.746 on average.

Data for total federal government debt was obtained through the Federal Reserve Bank of St. Louis, it is compiled from the Financial Management Service Office of the U.S. Department of the Treasury. It is measured in billions of U.S. Dollars, and it was deflated using the GDP deflator previously described. The gross total federal government debt had an average growth rate of 2.21% per quarter; in real terms the growth rate was 1.37% per quarter. Total government

debt is defined as the sum of debt held by the public and government borrowings from federal trust funds such as Social Security and Medicare.

As for the labor market, two variables are analyzed. The first measure is the total number of individuals that are employed in the economy (16 years and over), measured in thousands. The second variable was the unemployment rate (16 years and over), measured in percentage. Data for both variables were obtained from the Bureau of Labor Statistics. On average, employed individuals grew 0.372% per quarter, while the unemployment rate declined 0.181% per quarter.

The cost of capital is represented by the nominal interest rate on treasuries; it is represented by real yields on treasuries with 10 years to maturity. For obtaining the real interest rate, the effects of inflation were removed by using the percentage change in the Consumer Price Index. The CPI is benchmarked with an average value equal to 100 for the 1982-84 years. The chosen CPI pertains to all urban consumers for all items, it is generated by the Bureau of Labor Statistics and it was obtained through the Federal Reserve Bank of St. Louis. On average, the real interest rate declined 0.588% per quarter.

In the period 1973:1-2010:3, 151 observations were obtained; the descriptive statistics of the variables in the dataset are presented in Table 2.1. The lowest coefficient of variation was found on the exchange rate index, with an estimated value of 14.15%. As for employed labor and the unemployment rate, their coefficients of variation were 16.02% and 24.59%, respectively; Moreover, the coefficients of variation for deflated GDP, real interest rate and deflated debt were 32.03%, 39.18% and 54.70%, respectively (Table 2.1).
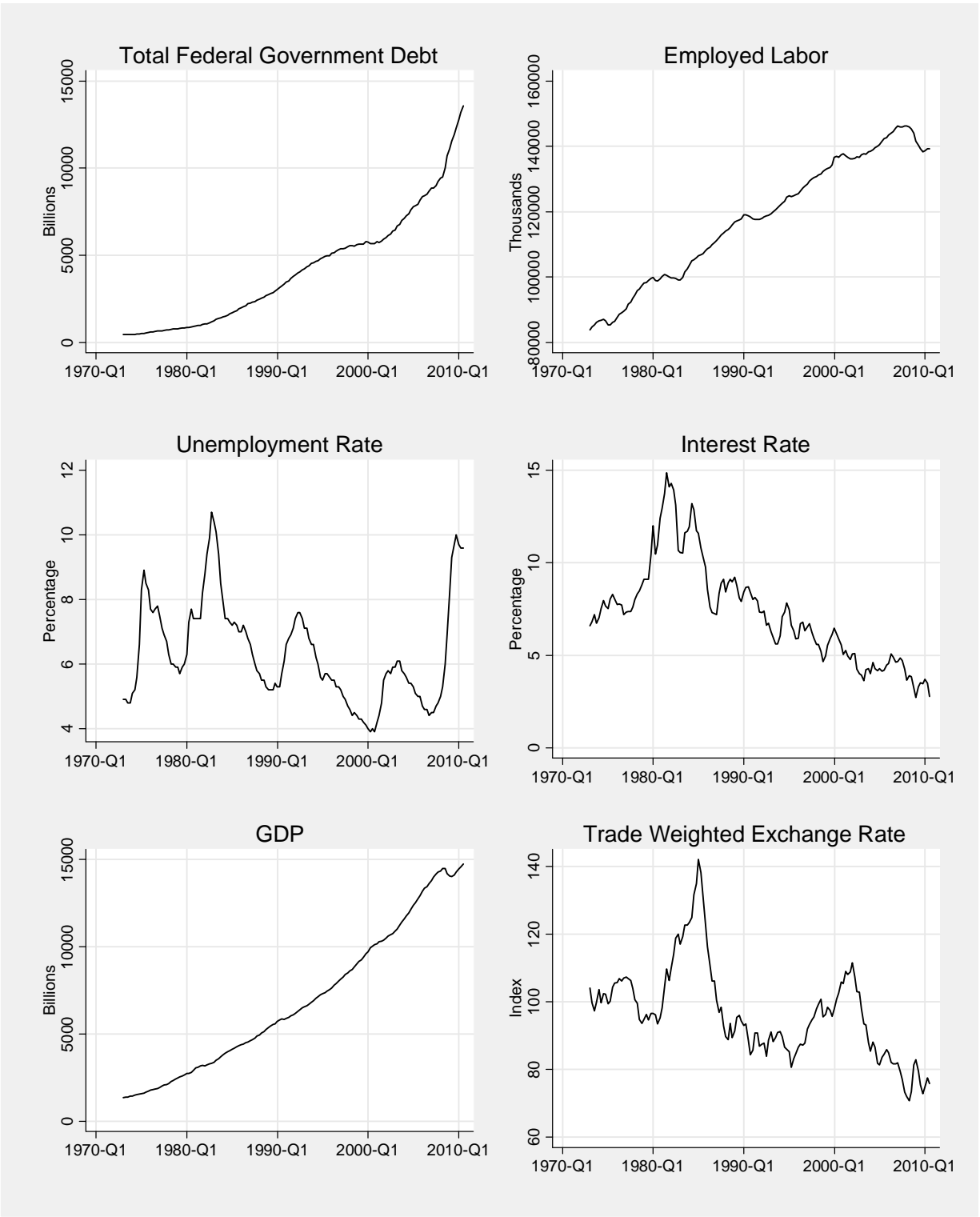
Figure 2.2 Graphs of variables in levels, 1973:1 – 2010:3.

The correlation coefficients among the variables were significantly different from zero at the 95% confidence level. The maximum absolute magnitude of the correlation coefficients occurred on deflated GDP with employed labor (.98), while the minimum absolute magnitude was found on deflated debt with the unemployment rate (-.22), Table 2.2. However, the partial correlation coefficient between deflated debt and unemployment rate was 0.608, while the coefficient between deflated debt and employed labor was -0.1538; they were significantly different from zero at the 5% and 10% levels of significance, respectively. Such coefficients are calculated after removing the effects of deflated GDP, real interest rate, and the exchange rate.

Table 2.1 Descriptive statistics of the observations in levels, 1973:1 – 2010:3.

Variables	Mean	Std. Dev.	Min	Max
Total Federal Government Debt	4168.58	3237.64	457.32	13561.62
Gross Domestic Product	6911.25	4119.49	1335.10	14745.10
Employment	117971.00	18904.17	83841.66	146264.30
Unemployment Rate	6.32	1.55	3.90	10.70
Exchange Rate	96.75	13.69	70.83	142.06
Real Interest Rate on 10 Year Treasuries	6.19	2.42	2.30	13.40
Deflated GDP	8692.97	2784.19	4795.14	13363.47
Deflated Debt	4931.30	2697.26	1540.20	12212.73

Table 2.2 Correlation structure of the variables, 1973:1 – 2010:3.

	ER	RIRATE	DGDP	EMLA	URATE	DFDEBT
Exchange Rate	1					
Real Interest Rate	0.662	1				
Deflated GDP	-0.580	-0.658	1			
Employment	-0.556	-0.573	0.980	1		
Unemployment Rate	0.275	0.434	-0.355	-0.407	1	
Deflated Debt	-0.654	-0.672	0.964	0.937	-0.221	1

Tests for Unit Roots

From the graphs depicted in Figure 2.2, variables that represent government debt, employment and gross domestic product seem to have clear upward trends. In contrast, the unemployment rate seems to meander around the average of 6.32%; however, it seems that from 1975 up to 2006 there is a downward trend. As for real interest rates and the trade weighted exchange rate of major currencies, a downward trend is evident.

Eyeballing the data to discern trends is not a substitute for formal testing of unit roots. Such testing, will determine if in fact there is statistical evidence about the non-stationary properties of the variables. The Dickey–Fuller generalized least-squares test for a unit root (DF-GLS) where used in the logarithmic values of the variables, such results are displayed in Table 2.3. Two rounds of tests were performed. The first set corresponds to tests of the variables in levels whereas the second set corresponds to the tests of variables in first differences.

From the first set of tests, it was determined that the DF-GLS tests fail to reject the null hypothesis of non-stationarity in all the variables at the 5% level of significance, the interpolated critical values came from those calculated by Elliott, Rothenberg, and Stock (1996). Given that the data presented trends, the specification of the alternative hypothesis assumed that the time series are stationary around a linear time trend (Table 2.3).

In the second set of results depicted in Table 2.3, corresponding to first differences of variables transformed to logarithms, the Dickey–Fuller generalized least-squares tests rejected the null hypothesis of non-stationarity of all variables at the 5% level of significance; the exception was total federal government debt. For such variable, the test rejected the null hypothesis only at the 10% level of significance with one lag.

Table 2.3 DF-GLS test results for unit roots.

Lags	Real Interest Rate	Exchange Rate	Employment	Unemployment Rate	Deflated GDP	Deflated Debt
Variables in levels with trend						
7	-1.092	-2.692	-1.062	-2.621	-2.466	-1.970
6	-1.325	-2.622	-1.104	-2.556	-2.591	-2.036
5	-1.226	-2.365	-1.003	-2.494	-2.414	-2.180
4	-1.263	-2.358	-1.053	-2.258	-2.447	-2.709
3	-1.418	-2.363	-1.313	-2.469	-2.383	-1.946
2	-1.467	-1.934	-0.745	-2.614	-2.442	-1.720
1	-1.733	-2.202	-0.735	-2.544	-2.099	-1.321
First differences without trend						
7	-2.449	-1.586	-1.993	-5.484	-4.183	-0.625
6	-2.955	-1.657	-1.889	-4.609	-3.914	-0.926
5	-2.954	-1.821	-2.182	-4.943	-4.033	-0.992
4	-3.805	-2.199	-2.579	-5.368	-4.479	-0.976
3	-4.779	-2.510	-2.854	-6.198	-4.818	-0.634
2	-5.768	-2.954	-2.876	-6.011	-5.285	-1.331
1	-8.190	-4.521	-3.744	-6.213	-5.786	-1.836

Note: For tests with trend, the critical values for 1%, 5% and 10% levels of significance are -3.519, -2.979 and -2.689, respectively. For tests without trend, the critical values for 1%, 5% and 10% levels of significance are -2.593, -1.95 and -1.613, respectively.

In addition to DF-GLS tests, augmented Dickey–Fuller (1979) tests were also conducted, they are depicted in Table 2.4. The series in levels were tested under the alternative of stationarity around a linear time trend. The tests fail to reject the null hypotheses of unit root at 5% level of significance for all variables. The tests on the logarithmic first differences resulted in rejection of the null hypothesis of non-stationarity of all the variables at 5% level of significance. Again, the exception was total deflated federal government debt. Therefore, further analyses were conducted for this variable. In conclusion, since the variables appear to be stationary in first differences, their corresponding order of integration is 1, i.e. I(1).

Table 2.4 Results from Augmented Dickey–Fuller unit root tests.

Variables	ADF Statistic*	Critical Values		
		1%	5%	10%
Levels with trend				
Real Interest Rate	-2.790	-4.024	-3.444	-3.144
Exchange Rate	-2.501	-4.024	-3.444	-3.144
Employment	-1.095	-4.024	-3.444	-3.144
Unemployment Rate	-3.236	-4.024	-3.444	-3.144
Deflated GDP	-2.347	-4.024	-3.444	-3.144
Deflated Debt	-1.932	-4.024	-3.444	-3.144
First differences without trend				
Real Interest Rate	-7.582	-3.495	-2.887	-2.577
Exchange Rate	-5.214	-3.495	-2.887	-2.577
Employment	-4.446	-3.495	-2.887	-2.577
Unemployment Rate	-5.023	-3.495	-2.887	-2.577
Deflated GDP	-4.993	-3.495	-2.887	-2.577
Deflated Debt	-2.642	-3.495	-2.887	-2.577

*Note: Dickey-Fuller tests were augmented with 3 lags.

Since both DF-GLS and ADF unit root tests rejected the null hypothesis of non-stationarity on the first difference of the series total deflated government debt, additional tests were conducted. The Phillips and Perron (1988) test, which is robust to autocorrelation and heteroskedasticity, rejected the null hypothesis of non-stationarity at the 5% level of significance (critical value = -2.887), the estimated statistic was -6.788. Furthermore, additional tests were conducted in different periods; same conclusion was reached. In addition, the KPSS test by Kapetanios, Shin, and Snell (2003) was conducted. The estimated statistic was 0.26598, in this way the null hypothesis of stationarity was not rejected at the 5% level of significance since the corresponding critical value was 0.464. In conclusion, both Phillips and Perron (1988) and Kapetanios, Shin, and Snell (2003) tests for unit roots provide statistical evidence that the first difference of the logarithmic transformation of total federal government debt is in fact stationary; therefore, it is inferred that the variable in levels is I(1).

Two models are estimated for discerning the effects of government debt on the U.S. labor market; one model uses the variable total employment while the second uses the unemployment rate. As depicted in Figure 2.2, the employment rate tends to meander around the average 6.32%, while total employment persistently has moved upward. Furthermore, conceptually, both measures differ since the unemployment rate is calculated as the percentage of the unemployed from the total labor force; in contrast, total employment is the number of employed individuals that the economy is able to absorb from the labor force.

Moreover, an increase in the unemployment rate may occur even when the economy creates new jobs, i.e. total employment rises. This situation can occur when part of the population that enters into the labor force is not able to find a job. Therefore, it is reasonable to assume that total employment and the unemployment rate are different indicators of the labor market in the economy. As such, governments are expected to react differently as these indicators for the labor market change; so, fiscal policies may differ.

<u>Cointegration Analysis of Employment</u>

The cointegration analysis contains the variables that explain employment demand, such as government debt, exchange rate, real interest rate and GDP; in this way, there are five variables in total. The trace tests and the maximum eigenvalue tests were performed for determining the number of cointegrating equations. For both tests, two specifications for the trend were evaluated. The first specification allowed for a trend in the cointegrating equation; this specification is favored not only by the unit root tests but also by the specification of the employment demand function. The second specification restricted the trend to zero, so that the cointegrating equation becomes stationary around a nonzero constant. The test results are

conditional on the selection of the length of the lags in the underlying VAR model; a length of five lags was selected.

The cointegration results for the employment demand function are depicted in Table 2.5. The included variables were real interest rate, deflated GDP, deflated debt, and the exchange rate index. According to the trace statistic under the specification of restricted trend, the five variables appear to have at most one cointegrating equation at 1% level of significance, whereas at 5% it appears that there are at most two. In contrast, the maximum eigenvalue tests at both levels of significance, fail to reject the null hypothesis that the maximum rank is one.

Under the second specification, unrestricted constant, the trace test failed to reject the null hypothesis that the maximum rank is one at 1% level of significance. The trace test failed to reject the null of two cointegrating vectors at 5% level of significance. The results from the trace statistic contrasted those from the maximum eigenvalue test. In conclusion, at 1% and 5%, the tests favored the existence of one cointegrating equation in the data.

Table 2.5 Cointegration results for the employment demand function.

Rank	Trace statistic	Critical Values		Max Eigen. Statistic	Critical Values	
		5%	1%		5%	1%
Restricted trend						
0	109.4708	87.31	96.58	42.0629	37.52	42.36
1	67.4079	62.99	70.05	28.1659	31.46	36.65
2	39.2421	42.44	48.45	19.7355	25.54	30.34
3	19.5065	25.32	30.45	12.898	18.96	23.65
4	6.6086	12.25	16.26	6.6086	12.52	16.26
Unrestricted constant						
0	84.047	68.52	76.07	35.1109	33.46	38.77
1	48.9361	47.21	54.46	22.5264	27.07	32.24
2	26.4097	29.68	35.65	16.9598	20.97	25.52
3	9.4499	15.41	20.04	6.9043	14.07	18.63
4	2.5456	3.76	6.65	2.5456	3.76	6.65

Cointegrating Equation for Employment

The long run effects of government debt on employment demand are estimated by maximum likelihood, following the methods described in Johansen (1995). From the previous analyses, there is enough statistical evidence to believe that the variables have at the most one cointegrating vector. For this reason, the normalization of the cointegrating vector assumes that the coefficient on employment is equal to -1, so that the estimates can be interpreted as estimates of the long run employment demand function. According to Ewing and Payne (1999), this specification is common in monetary economics.

The normalized cointegrating vectors for the employment demand function are depicted in Table 2.6 for two specifications, restricted trend (model 1) and unrestricted constant (model 2). Both specifications produced the expected signs and the magnitudes for the effects of real interest rate and exchange rate varied slightly by 0.02% in absolute terms. The effects of GDP were not only significantly different from zero but also their magnitudes varied, in model 1 the effect was 33.06% higher than in model 2.

All the coefficients were statistically different from zero at 1% level of significance with the exception of the effects of debt when the specification of the model allowed for linear trends in the levels of the data. In the first specification, the magnitude of the trend was -0.003, such coefficient was very significantly different from zero; implying that in the long run, employment demand is decreasing although at a very slow rate.

The discussion and interpretation of the long run effects will focus on the first specification. The long-run debt elasticity was calculated at 0.03%, the effect is three times smaller than the long run interest rate elasticity and long run exchange rate elasticity. Additionally, for comparative purposes, the effect of debt is 29 times smaller than the effect of GDP. According to the

economic model, growth in productivity is detrimental to employment demand, since we assume that debt and exchange rate had effects on productivity, these variables are expected to have a negative effect on employment. However, the estimated long-run debt elasticity was small and positive. This result suggests that after controlling for growth in productivity, debt expands the use of labor in the economy. As the U.S. government expands its programs, the use of debt to finance deficits is slightly compatible with expansionary use of labor in the long run; specially, because governments are likely to use more debt during recessions when unemployment has risen and the employment level is in decline, counteracting the effects of debt on productivity that reduces labor demand in the economy.

According to the estimates, a decrease in the interest rates would have a negative effect on employment demand. This result would imply that as capital becomes cheaper, in the long run, the expansion of the economy will consume more of that factor. In this way, as the economy enters into a new equilibrium, the amount of utilized labor is reduced. Therefore, an increase in the interest rate is likely to have a positive effect on employment demand since the long run interest rate elasticity was estimated at 0.09% (Table 2.6).

The absolute effects of GDP on labor demand are greater than debt, interest rate and exchange rate. The long-run GDP elasticity was calculated at 0.88; suggesting that changes in the growth of GDP are matched almost completely by changes in the growth of labor demand in the long run. As such, I would suggest that for a stable employment demand in the economy, its growth should not exceed that of GDP; because a contraction in GDP will bring a proportional decrease in labor. The exchange rate had a similar effect than interest rate in absolute magnitude. A depreciation of the U.S. dollar, according to the exchange rate elasticity would increase the labor

demand in the long run. This is in accord with the conception that as exchange rate depreciates, exports growth would occur; and, as exports grow the demand for labor increases as well.

In conclusion, in the long run, labor demand is affected by government debt but not as much as by interest rates and the exchange rate; implying that labor markets react faster to changes in financial markets than fiscal policy. Furthermore, in reality, the effects of government debt may differ because increasing budget deficits are more likely to occur when there has been a contraction in either GDP or employment that have affected consumer demand negatively. Moreover, changes to fiscal rules are sluggish due to the legislation process, making fiscal policy more difficult to react to financial and labor markets.

Table 2.6 Normalized cointegrating vectors for employment demand.

Model*	Deflated Debt	Real Interest Rate	Exchange Rate	Deflated GDP	Trend
Model 1					
Parameter	0.0302	0.0905	-0.0930	0.8797	-0.003
Standard error	0.0115	0.0059	0.0166	0.0809	0.0006
Model 2					
Parameter	-0.0060**	0.1141	-0.1153	0.5491	
Standard error	0.0231	0.0116	0.0319	0.0413	

* All the coefficients were significantly different from zero at 1% level of significance.
** The coefficient was not significantly different from zero at 10% level of significance.

Cointegration Analysis of Unemployment
The analyses for cointegration included five variables, the unemployment rate, government debt, exchange rate, real interest rate and GDP. The final cointegration results are depicted in Table 2.7; following suit from the previous cointegrating analysis, two specifications of the trend are presented for the cointegration equation. The restricted trend specification produced unambiguous results for the number of cointegrating equations in the system.

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According to the trace test, the rank is zero at 1% and 5% levels of significance; same results were obtained by using the maximum eigenvalue test for cointegration. In the case of the unrestricted constant specification, the trace tests failed to reject the null of rank zero at 1% and 5% levels of significance. Moreover, the maximum eigenvalue statistic barely rejected the null of no cointegration at 5% level of significance, although at 1%, the null was not rejected. In conclusion, the variables in the analysis do not form cointegrating relations based on both tests with different specifications of the trend.

Table 2.7 Cointegration results for unemployment.

Rank	Trace statistic	Critical Values 5%	1%	Max Eigen. Statistic	Critical Values 5%	1%
Restricted trend						
0	86.9774	87.31	96.58	35.725	37.52	42.36
1	51.2524	62.99	70.05	22.7227	31.46	36.65
2	28.5296	42.44	48.45	14.5564	25.54	30.34
3	13.9732	25.32	30.45	9.0309	18.96	23.65
4	4.9423	12.25	16.26	4.9423	12.52	16.26
Unrestricted constant						
0	68.1937	68.52	76.07	33.7576	33.46	38.77
1	34.436	47.21	54.46	17.9335	27.07	32.24
2	16.5025	29.68	35.65	9.1687	20.97	25.52
3	7.3338	15.41	20.04	5.7082	14.07	18.63
4	1.6256	3.76	6.65	1.6256	3.76	6.65

VAR Analysis of the Effects of Debt on Unemployment
A VAR model was estimated for the analysis of the effects of government debt in the unemployment rate. From the previous analyses, given the lack of statistical evidence to believe that the variables in the system were cointegrated, the VAR model is estimated in first differences of the logarithmic transformation of the variables. This analysis included the unemployment rate, deflated debt, deflated GDP, real interest rate and the measure for the exchange rate. The model is estimated with four lags of each endogenous variable, the lag length

was determined by sequential likelihood ratio tests. However, information criteria such as the AIC and HQIC favored a lag length of two while the SBIC a lag length of one. Following either AIC, HQIC, or SBIC, the estimation of the systems produced autocorrelated residuals; thus, the results from these models were disregarded for further analyses.

Moreover, likelihood ratio tests were conducted to determine whether or not deterministic terms could improve the estimates so that residuals could conform to white noise processes. In a multivariate framework, the starting test evaluated the null hypothesis of exclusion of seasonal terms, i.e. quarterly dummy variables for removing remaining seasonality in the data; the null hypothesis was rejected at 1% level of significance. Therefore, the tests favored the inclusion of seasonal terms in the estimation (Table 2.8).

In addition to seasonal variables, likelihood ratio tests were conducted for evaluating the inclusion of structural breaks in a multivariate setting. Three dummy variables were created for representing structural changes that have occurred in the U.S. economy in the period 1973:1-2010:3. The variables represent major expansions on the accumulation of government debt to finance spending that may have effects on other indicators in the economy. The first dummy variable (sb1) takes the value of one for observations in the period 1982:1-2001:2, it represents the expansion of government debt during and after the administration of Ronald Reagan. The second dummy variable (sb2) takes the value of one for those observations after the 9/11 attacks and right before the 2008 financial crisis, covering the 2001:3-2007:4 period. The third dummy variable (sb3) takes the value of one for observations during the 2008:1-2010:3 period, corresponding to the fiscal expansion that emerged after the economic slowdown of the last recession in the United States.

The likelihood ratio test results for the evaluation of the inclusion of structural breaks are depicted in Table 2.8. The inclusion of seasonal terms and exclusion of either sb1 or sb3 was rejected at the 10% level of significance. The null hypothesis for including seasonal terms and simultaneous exclusion of structural breaks (sb1, sb2, and sb3) was rejected at the 1% level of significance; the test produced a likelihood ratio statistic of 32.64, which favored its rejection with a p-value of 0.0053 (Table 2.8). Furthermore, the null hypothesis of exclusion of seasonal terms and structural breaks (sb1, sb2, and, sb3) was also rejected at 1% level of significance; the corresponding likelihood ratio test statistic was 64.64 with a p-value of 0.0002 (Table 2.8).

Given previous likelihood ratio test results, estimation of the model with deterministic terms is favored. Estimation results of the VAR model with seasonal terms and structural breaks was evaluated. The residuals from these models had better quality in terms of normality and elimination of autocorrelation. Therefore, further results come from a VAR model estimated with 4 lags, seasonal terms and dummy variables (sb1, sb2, and sb3).

Table 2.8 Likelihood ratio tests for evaluating inclusion of deterministic terms.

Null hypotheses	Alternative hypotheses	df	LR statistic χ^2	P-value
No seasonals	Seasonals	15	32	0.0064
Seasonals, no sb1	Seasonals + sb1	5	9.89	0.0785
Seasonals, no sb2	Seasonals + sb2	5	5.17	0.3956
Seasonals, no sb3	Seasonals + sb3	5	13.43	0.0196
Seasonals, no sb2 only	Seasonals + sb1+sb2+sb3	5	10.01	0.0751
Seasonals, no sb1 and sb3	Seasonals + sb1+sb3	10	23.33	0.0096
No seasonals, just sb1-3	Seasonals + sb1+sb2+sb3	15	31.77	0.0069
Seasonals, no sb1-3	Seasonals + sb1+sb2+sb3	15	32.64	0.0053
No seasonals, no sb1-3	Seasonals + sb1+sb2+sb3	30	64.64	0.0002

Seasonals: equivalent term for seasonal terms. sb1: dummy variable for debt expansion that started during the administration of President Ronald Reagan. sb2: dummy variable for debt expansion after 9/11. sb3: dummy variable for debt expansion after the 2008 financial crisis.

Granger Causality Tests

According to Enders (2004), Granger-causality aims to evaluate if lags of one variable significantly contribute to the forecasting performance of another variable, in other words, evaluates the significance of the coefficients of lag variables into the equation of interest. For this purpose, if the system of equations has stationary variables, then either F-tests or Wald tests can evaluate the null hypothesis that the coefficients of the lag variable of interest are equal to zero in the equation of interest. In this way, if the test fails to reject the null hypothesis then it can be said in Granger-sense, that the test fails to reject the null hypothesis that the lagged values of an independent variable does not Granger-cause the dependent variable of interest.

In the system of equations, Granger-causality tests were performed by Wald tests and the results are depicted in Table 2.9. At the 5% level of significance, the null hypothesis that the unemployment rate does not Granger-cause government debt was rejected. This is in accord to the notion that increasing unemployment in the economy leads to greater dependence on fiscal policy to stimulate the economy. However, the tests fail to reject the null hypotheses that interest rate, GDP and exchange rate does not granger cause government debt (Table 2.9).

Separately, the Wald tests rejected the null hypotheses that government debt and the unemployment rate do not Granger-cause interest rate at 5% level of significance. Since there is causality from debt to interest rate, then it seems that changes in the growth of government debt ultimately have effects on the interest rate, this finding makes sense because supply and demand of debt would ultimately set its costs. Moreover, the nulls of non-Granger-causality of exchange rate and GDP were not rejected even at 32% level of significance.

The null hypothesis that government debt does not Granger-cause exchange rate was rejected at the 5% percent level of significance. Bidirectional Granger-causality was found between GDP

and the unemployment rate. At a 5% level of significance, the null that GDP does not Granger-cause the unemployment rate was rejected as well as the null that unemployment rate does not Granger-cause GDP. However, the null hypotheses that government debt does not Granger-cause employment and GDP can only be rejected at 15% and 20% levels of significance, respectively (Table 2.9). Lütkepohl (2004) emphasized that Granger-causality evaluates the relation between two variables and that ignores the remaining dynamic interactions in the system. For this reason, the estimation of impulse response functions is performed.

Table 2.9 Granger causality tests.

Equation	Excluded	χ^2	df	P-Value χ^2
Debt	Interest Rate	6.6894	4	0.153
Debt	Exchange Rate	5.0819	4	0.279
Debt	Unemployment Rate	11.068	4	0.026
Debt	GDP	5.6056	4	0.231
Interest Rate	Debt	10.397	4	0.034
Interest Rate	Exchange Rate	1.3228	4	0.857
Interest Rate	Unemployment Rate	11.325	4	0.023
Interest Rate	GDP	2.5022	4	0.644
Exchange Rate	Debt	15.7	4	0.003
Exchange Rate	Interest Rate	0.1833	4	0.996
Exchange Rate	Unemployment Rate	4.0803	4	0.395
Exchange Rate	GDP	3.9041	4	0.419
Unemployment Rate	Debt	6.6976	4	0.153
Unemployment Rate	Interest Rate	1.9046	4	0.753
Unemployment Rate	Exchange Rate	3.9738	4	0.41
Unemployment Rate	GDP	12.195	4	0.016
GDP	Debt	6.5243	4	0.163
GDP	Interest Rate	3.186	4	0.527
GDP	Exchange Rate	2.8927	4	0.576
GDP	Unemployment Rate	11.179	4	0.025

Analysis of the Impulse Response Functions

Orthogonalized impulse responses were estimated along with corresponding asymptotic standard errors for constructing the lower and upper bounds of the confidence intervals. The estimation required the imposition of a causal structure so that the responses of variables to shocks can be interpreted as close as possible to causal effects under the ceteris paribus condition. By doing so—unlike Granger causality tests— the responses to shocks take into consideration the dynamic structure of the variables in the system.

The responses of the variables to shocks of government debt are presented graphically in Figure 2.3, the lower and upper bounds correspond to the sixty-eight percent confidence intervals. After a shock to debt, the unemployment rate does not decrease immediately. In period four, changes to unemployment are at minimum. Between period four and ten, there are negative changes to unemployment. However, from period four, the unemployment tends to rise up in the negative side until the effects of the initial shock vanishes.

The response of the interest rate to a shock of government debt is significantly negative until periods two and three, at period four there is a positive and significant spike in interest rates; beginning at period five the effect starts to vanish. Yet, the effect at period four is lower than the cumulative effects from period two and three, which suggests that government debt shocks tend to have a transitory negative effect on interest rates before returning to equilibrium (Figure 2.3).

The immediate response of the exchange rate to a shock in government debt is positive. At period two, the exchange rate decreases to a minimum in the negative side. From there, it remains in the negative side until the effect is null at period thirteen. This result is in accord with previous findings that increasing government debt unambiguously depreciates the currency with

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a brief transitory period of exchange rate appreciation coming from increasing demand of the currency due to capital inflows that possibly finance government deficits (Figure 2.3).

The effects on gross domestic product by a shock in government debt are ambiguous in the first two periods. In the third period, however, the effect is positive and remains almost at the same level for two periods. From period six to nine, the effects decrease in the positive side. The effect on GDP is basically null beginning at period ten. Overall, the cumulative effects from periods three to nine is unambiguously positive as expected since increasing the growth of government debt is likely to generate greater aggregate demand (Figure 2.3).

The responses of the variables to shocks on the unemployment rate are presented along with their sixty-eight percent confidence intervals in Figure 2.4. The response of government debt to an unemployment rate shock is positive from the first period up until period nine, and then the effect is basically indistinguishable from zero. After the initial shock, changes to government debt reach a maximum at period two; basically, it remains at the same level until the sixth period, from then on decreases until it returns to normal levels before the initial shock.

The effects on the interest rate by an unemployment shock can be observed immediately. In period one, the interest rate tends to increase, from there decreases until it reaches a minimum in the negative side at period three. Before the dissipation of the effect, there is a positive spike at period four. In summary, an unemployment rate shock has a significantly and positive cumulative effect on the interest rate until the second period. The transitory ups and downs of the response of interest rate to unemployment shocks can be explained by market forces driven by economic agents that make adjustment to their portfolios after receiving information about increasing unemployment rate in the economy (Figure 2.4).

The effects of unemployment rate shocks to the exchange rate can be distinguished only after the seventh period. From period eight to the fourteenth, the exchange rate index decreases, from period ten to fourteen it increases in the negative side. Before the effect of the initial shock dies out, increasing unemployment unequivocally tends to decrease the exchange rate (Figure 2.4). Thus, it can be said that as an economy increases employment, it is likely that the underlying value of its currency will tend to be appreciated, *ceteris paribus*. Nevertheless, if the expansion in employment is driven mainly by increasing government debt, then, the currency is likely to have a transitory period of appreciation, but, eventually the currency is going to have a lower underlying value.

The effects on GDP by an unemployment rate shock are negative until period two. Yet, the effects are positive from period four up to period nine. Though, by period ten, the cumulative effect on GDP is unambiguously negative (Figure 2.4). The reaction of GDP is as expected since it is likely that increasing unemployment will reduce aggregate demand. Holding productivity constant, the positive changes of GDP after period four can be explained by the fiscal reaction of government policy makers with the aim to boost employment in the economy.

The effects of interest shocks have immediate effects in the variables considered in the analysis Figure 2.5. For instance, an interest rate shock tends to decrease government debt at periods three and four, thereafter the effect starts to dissipate very fast. In contrast, the response of the unemployment rate is ambiguous between period one and four; between period five and seven, the unemployment rate tend to rise up; thereafter, the effects are intrinsically zero (Figure 2.5). As capital becomes more expensive, labor is more likely to be employed in the economy; however, the empirical evidence shows a mild indication of this tradeoff. The effect of interest rate on the exchange rate is unambiguously positive at period one, the effect dies out very fast

thereafter; the effect at period one is in accord with the conception that as interest rates go up capital will flow, making higher demand for the currency until the market clears, ceteris paribus. Since the effect on exchange rate by an interest rate shock becomes insignificantly different from zero very fast, it is also evidence that financial markets react very fast to new information.

The responses of the variables to shocks on the exchange rate are presented along with their sixty-eight percent confidence intervals in Figure 2.6. Government debt tended to be increased by a shock in the exchange rate; significant effects to government debt can be observed in periods two, three, and six; thereafter the effect is not statistically different from zero. Even with insignificant effects on periods four and five, the cumulative effect is unambiguously positive at period six (Figure 2.6). The effect on unemployment rate by an exchange rate shock is positive and significant only at period two, thereafter, the effect cannot be distinguished from zero; however, the cumulative effect from period two up to five is positive. Holding other variables constant, this result implies that as the currency depreciates is likely that the unemployment rate will decrease (Figure 2.6).

The effects of gross domestic product shocks to the variables are displayed in Figure 2.7. A GDP shock tended to increase government debt, but, at periods two and three the effect becomes negative; thereafter, the effect vanishes. Other things being constant, it is coherent to think that as GDP grows the reliance on debt decreases. However, in the short run, the statistical evidence does not support that rational (Figure 2.7). The effects of a GDP shock on the unemployment rate are unambiguously negative from the first period until the fifth. The interest rate tends to decrease at periods two and three after a shock in GDP. In contrast, the exchange rate is appreciated by such a shock; however, the effect is distinguishable from zero only until the third period.
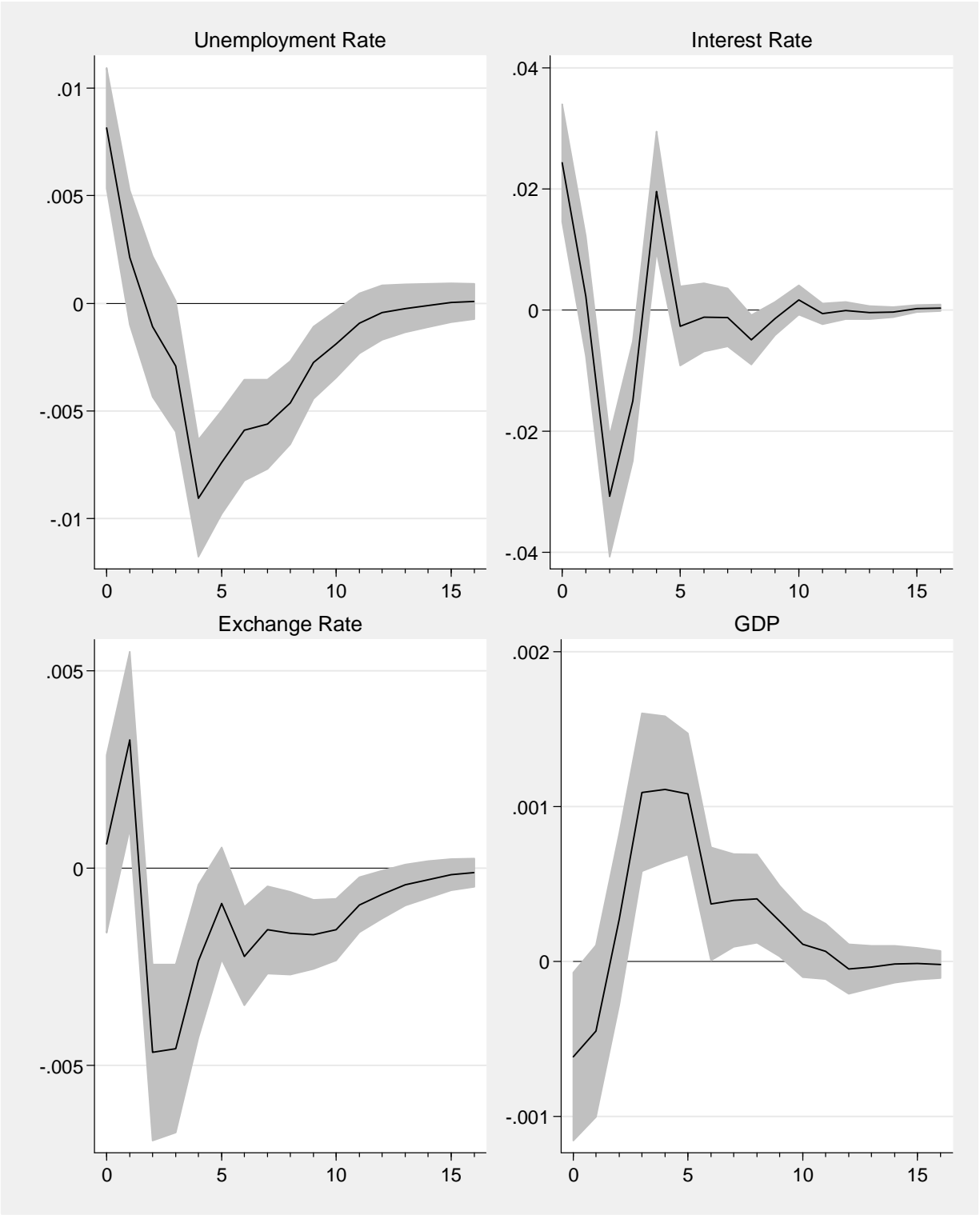
Figure 2.3 Orthogonalized impulse response functions to debt shocks.
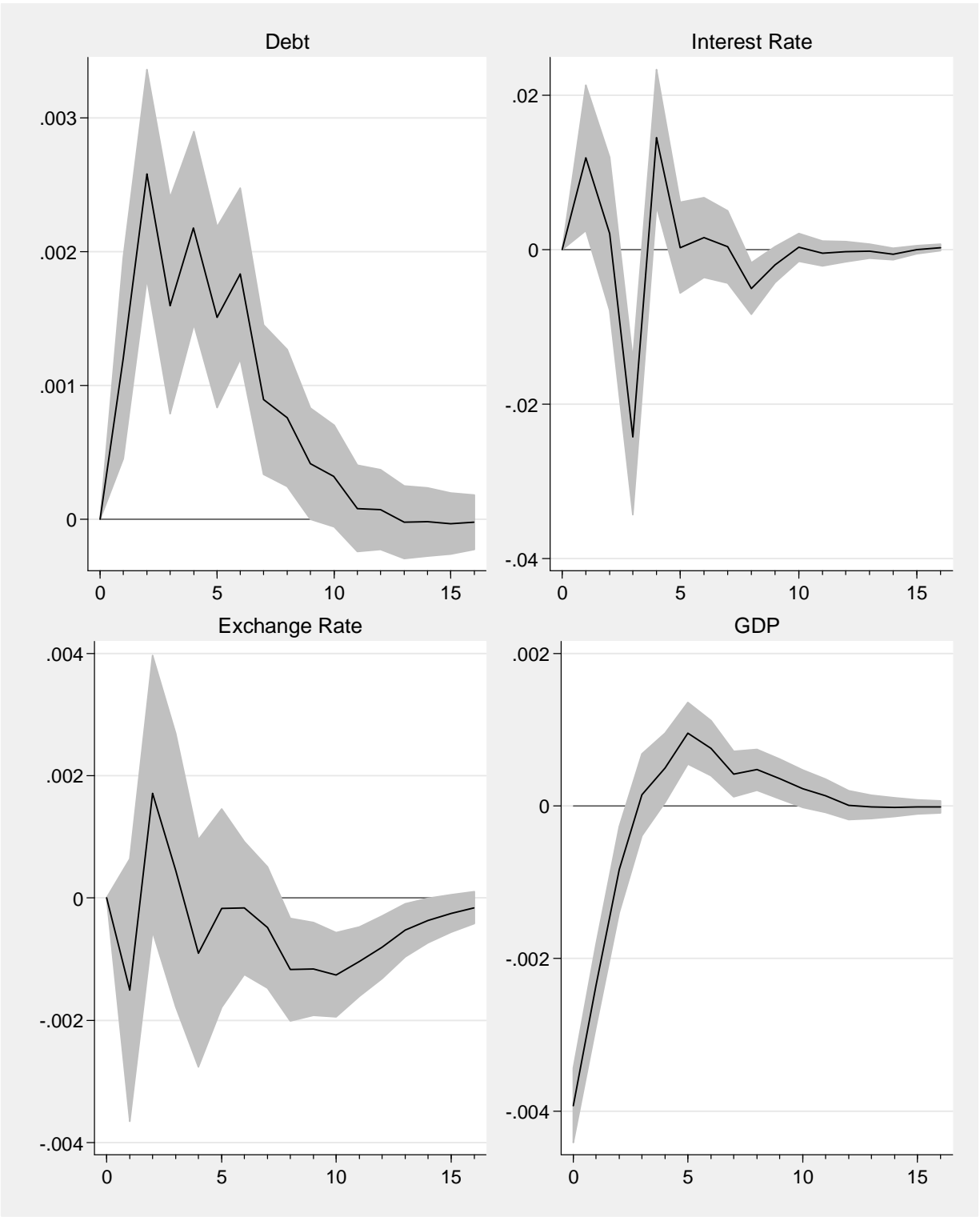
Figure 2.4 Orthogonalized impulse responses to unemployment shocks.

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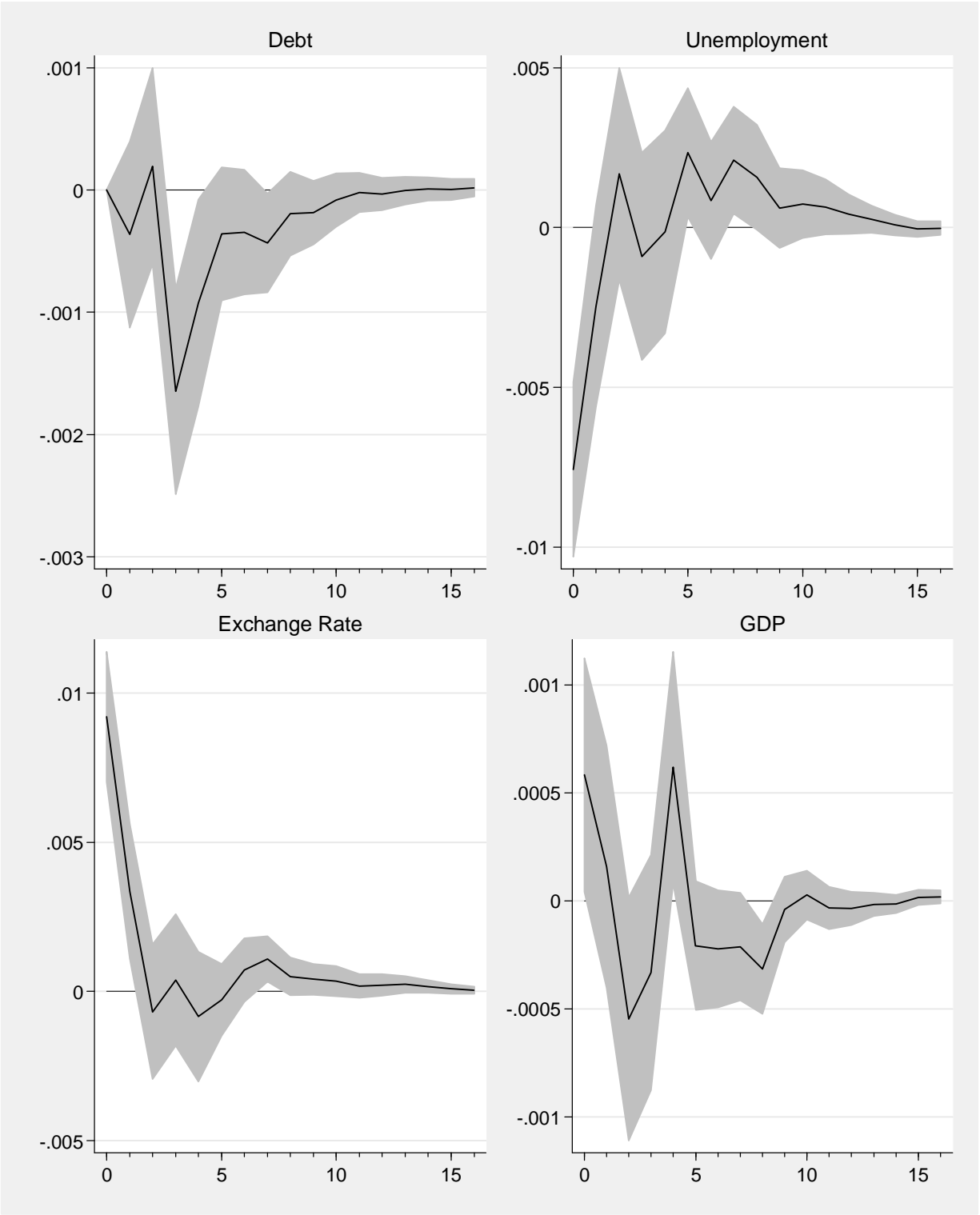
Figure 2.5 Orthogonalized impulse responses to interest rate shocks.

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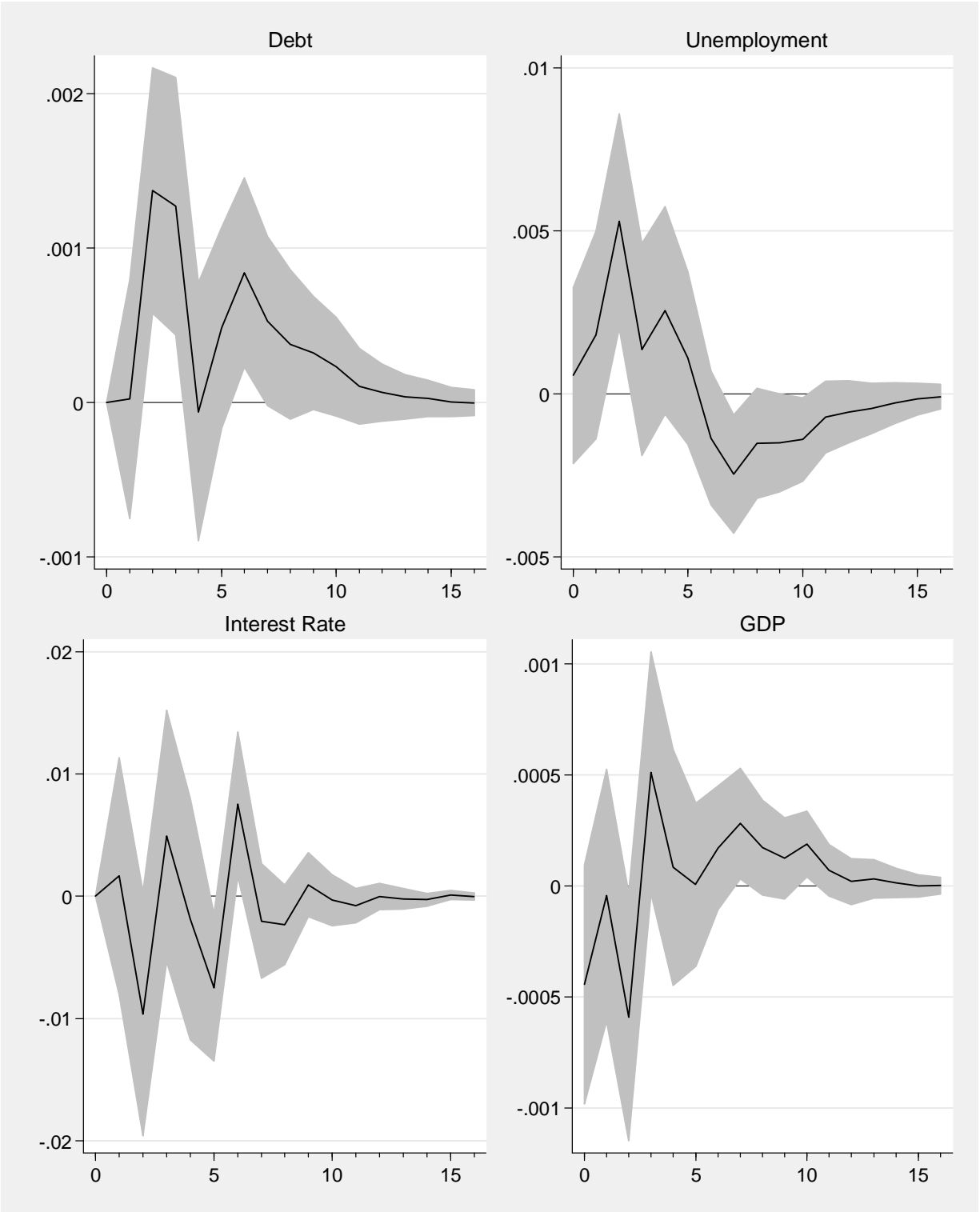
Figure 2.6 Orthogonalized impulse responses to exchange rate shocks.

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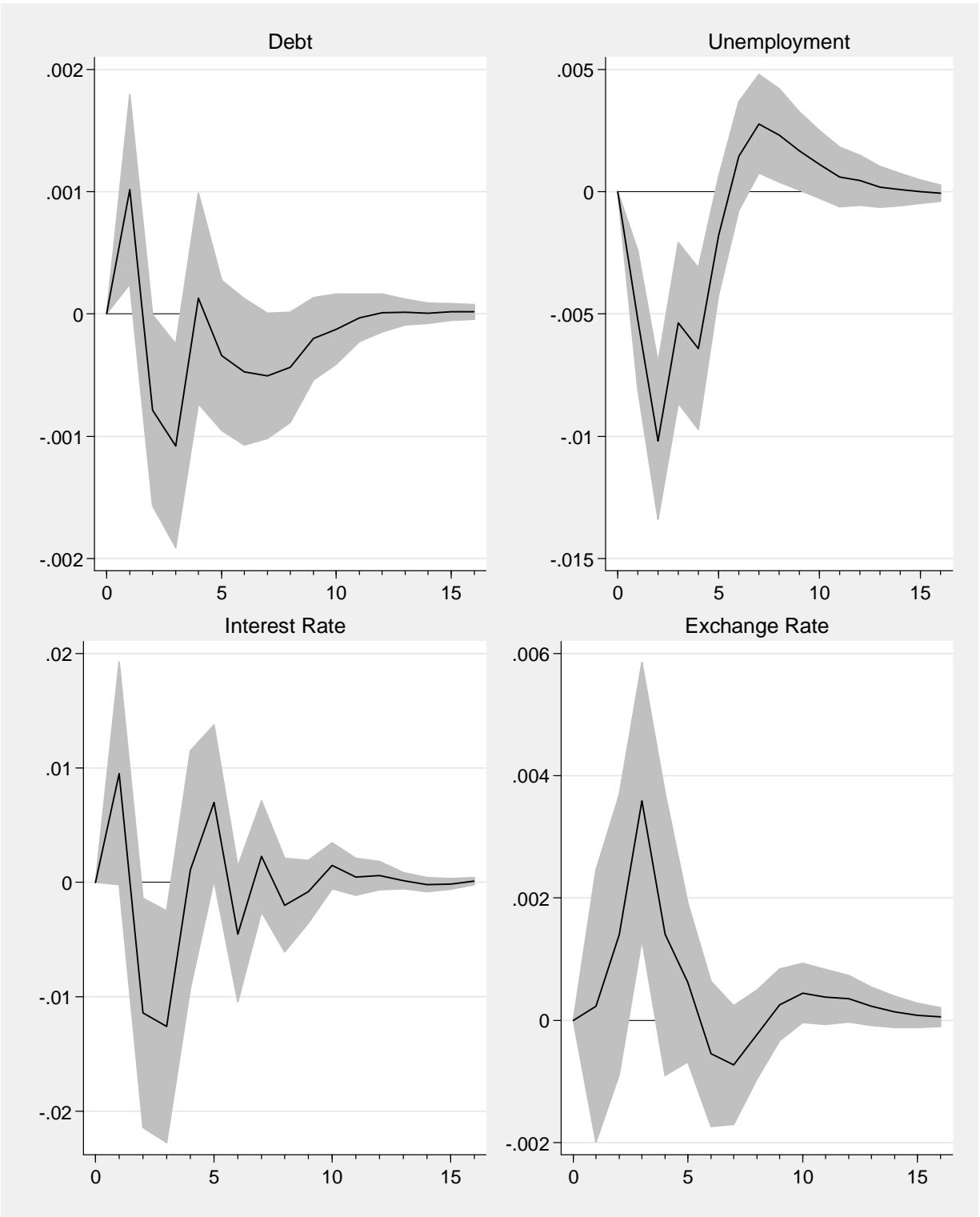
Figure 2.7 Orthogonalized impulse responses to GDP shocks.

Discussion and Concluding Remarks

In the last decade, the U.S. government has relied even more on public spending to stimulate the economy by aiming either to increase the level of employment or to de-accelerate the growth in the unemployment rate. The American Recovery and Reinvestment Act, the Emergency Economic Stabilization Act and the Economic Stimulus Package are salient examples of this reliance on accumulation of government debt for putting the economy out of a recessionary path and bringing it back into previous levels of economic activity.

If the accumulation of government debt tends to depreciate the currency, then, the prices of the factors of production are likely to change as well. Consequently, by assuming that economic agents maximize profits, they will tend to readjust the amount of capital and labor that is used in the economy as currency shocks arise. So, as the economy accumulates more debt to finance government spending, currency depreciation and the direct effects of new investments are likely to change the level of employment.

However, previous studies that deal with the effects of exchange rate on employment have neglected the role of government debt either through exchange rate or through direct effects on higher level of government spending. As such, this study bridges that gap by studying the effects of U.S. government debt accumulation on employment, at the same time, accounting for the effects of the foreign exchange value of the U.S. dollar.

The sample period of the study starts in 1973:1 and ends in 2010:3, far beyond the post Bretton Woods System of monetary management among industrialized countries. The effects of government debt accumulation on the labor market are studied from two different perspectives and corresponding indicators. The first approach studied the effects of government debt on the level of employment while the second approach considered the unemployment rate as the

indicator for the labor market. Both approaches had the same controlling variables, the exchange rate, interest rate, and gross domestic product. Giving the current debate on the efficacy of government debt accumulation to restore growth in the U.S. economy, dynamic labor demand functions are estimated using a system of equations.

After analyzing the properties of the data series, it was determined that the effects of government debt accumulation on employment were better assessed by a vector error correction model. In contrast, the effects of debt on the unemployment rate were analyzed by a vector auto regression model given that variables in the system fail to reject the null hypothesis of no cointegration.

A long-run-stable relation was found between employment, GDP, interest rate, exchange rate and government debt. The cointegrating equation was trend stationary. The long run effects of government debt in the level of employment were positive and smaller in comparison with the effects of interest rate, exchange rate and GDP. The sign of the coefficients on GDP and exchange rate conformed to economic theory. As such, the results implied that a depreciating currency increases the demand for labor while changes in GDP are accompanied by changes in the demand for labor. However, the greatest positive effect on employment was achieved by an increase in gross domestic product.

Given the formulation of the economic model, the accumulation of government debt is expected to have effects on productivity which in turn have negative effects on employment, *ceteris paribus*. However, the estimated long-run debt elasticity of labor demand was 0.03, it was statistically significantly different from zero at 1% level of significance. This result contradicts the expectation, however, when the trend is constrained to zero, the expected negative sign is obtained but it was not statistically different from zero at 10% level of significance. Then, these

results imply that government debt not only serves as an automatic stabilizer of the economy but also functions as a generator of employment through greater spending reflected on GDP; and, I would also suggest that government debt allows the financing of research & development that increases productivity, which expands consumption and new investments that are reflected in GDP and in turn have effects on business formation and subsequent expansion in the amount of labor being employed in the economy.

The inclusion of the foreign exchange value of the currency is very important for an economy that is highly integrated into global markets through financial activity and trade. In the long run, I find that a depreciating change of the currency had a positive effect on labor demand. This finding does not contradict previous research. For example, Hua (2007) found such relationship in China while Frenkel and Ros (2006) found it on 13 Latin American countries.

However, previous studies that focused on the relationship of exchange rate and labor demand have disregarded the effect of government debt accumulation either through exchange rate or directly through changes in GDP. Ngandu (2008) who made a thorough review of the literature, disregards government debt either as depreciating factor of the currency or as a channel of transmission of exchange rate. Thereby, this study analyzed the effects of government debt accumulation on employment demand, considering the role of exchange rate as a variable that changes the relative prices of output and the factors of production.

A second analysis was performed to understand the response of the unemployment rate to changes in government debt and the exchange rate, controlling for fluctuations in the interest rate and GDP. The sample period was the same as in the first analysis. From the impulse response analysis, it is found that decreasing unemployment rates are followed by greater expansion in the

use of debt, *ceteris paribus*. Moreover, as expected, financial variables reacted very fast to shocks in GDP and employment.

However, the decreasing effects of debt on the unemployment rate are only seen until the fourth period; thereafter, the effect remains negative until the tenth period. In contrast, the response of the exchange rate to shocks in debt is positive in the first period, thereafter the effects are significantly negative until the twelfth period. So, it seems that the response of the exchange rate can be divided in two stages; the first characterized by a short-lived appreciation followed by a more lasting period characterized by declines. These results contrast those found by McMillin and Koray (1990) who found that the real Canadian/U.S. exchange rate declines briefly after an unexpected shock in public debt.

A shock to the exchange rate caused the unemployment rate to rise from the first period up to the fifth; conforming to previous findings that employment tends to increase after the currency depreciates. However, only at period two, the effect was significantly different from zero. Nonetheless, the cumulative effect is significantly positive between periods two and five. Thereafter, the effects were not distinguishable from zero.

The effects of the exchange rate on the unemployment rate were short-lived, these results are in accordance with the findings of Branson and Love (1986), Frenkel and Ros (2006), Hua (2007), and Ngandu (2008) in that employment tends to decrease after the currency appreciates. VAR models were augmented in further chapters, and the effects of the exchange rate tended to last longer. However, the findings apply to an aggregated measure of employment—and as pointed by Campa and Goldberg (2001), the effects of the exchange rate may differ according to industry characteristics and the type of change in the exchange rate. Altogether, the discussed empirical

evidence provides support for the hypothesis that *U.S. government debt changes the foreign exchange value of the dollar, which leads to price fluctuations of output and labor; if there is an increase in the stock of debt, then, as the currency depreciates—more labor is likely to be employed.*

As for the response of employment to an increase in the real interest rate (10-year U.S. Treasuries), in the short run and the long run, the use of labor increased, *ceteris paribus*; VAR models were augmented in the fourth chapter, and the effects remained the same. As expected in the formulation of the employment demand function, holding other variables constant, if the cost of capital increases relative to the cost of labor, then, more labor is expected to be employed in the economy. However, this finding deserves more attention in future research as it contradicts the policy recommendation of low interest rate to boost GDP by increasing consumption, credit, and investments (Taylor, 1993; Gallmeyer et al., 2005; Bhamra et al., 2011).

Evidence from these results indicate that after the exchange rate depreciates as a result of increasing accumulation of government debt, it is expected that the demand for employment is likely to increase as it is shown that the unemployment rate decreases and the GDP increases after a positive debt shock. Moreover, in the short run and the long run, the level of employment was positively influenced by a depreciated exchange rate.

Furthermore, it can be inferred that movements in the exchange rate per se are not solely responsible for adjustments in labor demand as seen by the adjustment dynamics; accumulation of government debt plays a major role since it has direct influence on GDP as well. But, such effect is driven by the stimulus on domestic demand in contrast with the external supporting demand derived from a depreciated currency—the topic of the next chapter.

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CHAPTER 3.   ASSESSMENT OF THE CONSEQUENCES OF U.S. GOVERNMENT DEBT ON ECONOMIC GROWTH AND EXPORTS

Background Information

After the collapse of the Bretton Woods system of monetary management among industrialized nations in 1971, the world economy is more integrated through trade and financial markets. This was accomplished by improvements in transportation and telecommunications that has being accelerated in the post-world war II period, along with the creation of institutions with regulating power to influence the world economy, namely the World Bank, the International Monetary Fund, and the International Bank for Reconstruction and Development.

The aforementioned institutions have repeatedly been concerned with countries running large amounts of public debt which sometimes might put an economy in an unsustainable path of solvency. However, government debt may also be beneficial to developed nations with high levels of institutional development since they create conditions that allow efficient public administration that generate effective investments in education, infrastructure, science, technology and innovation that foster an escalation in business activity. Consequently, the accumulation of government debt may spur economic growth.

Government debt may be a source of inefficiency too, because it increases the size of the government and sub-optimal allocations of resources may occur since profits are not the main incentive. Nevertheless, if public debt increases the size of the government, due to economic growth favored by investments and spending by the government, then, we would observe a positive correlation between economic growth and government size. This argument is consistent with the supporters of the Wagner's hypothesis such as Kolluri, Panik and Wahab (2000), Mohammadi, Cak and Cak (2008), and Ziramba (2008).

When a country increases the level of government debt either because of lower taxation, lower revenue or increasing government spending, such information is immediately incorporated in the financial markets, causing movements in the exchange rates and interest rates that affect the overall value of the currency. For example, when news are spread out about a country strengthening the budget by cutting deficits, the domestic currency tends to appreciate. On the contrary, as indicated by McMillin and Koray (1990), the currency will tend to depreciate when the government announces larger budget deficits.

Feder and Just (1977) have suggested that depreciation of the currency occurs due to either the increasing possibility for a country to default its debt obligations or by simply signaling lack of debt servicing capacity. Thus, the demand for a country's debt and currency is reduced and the currency would tend to depreciate relative to other currencies. If capital flight is added to this scenario, then, the rate of depreciation is accelerated at a higher rate. This phenomenon has occurred during financial crises where high capital mobility and globalization of financial market activity affected the underlying value of the currency (Mexico in 1994, Russia in 1998, Argentina in 2001, and to a lesser degree in 2010/11 Greece, Ireland, Portugal, Spain and Italy).

A depreciated currency will have economic consequences in the form of intended outcomes, unanticipated outcomes and/or unintended outcomes; for instance, a depreciated currency will bring a competitive advantage in the tradable sector of the economy by stimulating exports growth due to the increasing ability of bringing cheaper goods to the international marketplace. In addition, a depreciated currency changes the relative prices of tradable and non-tradable goods, and favors a more efficient allocation of resources that occurs by increasing exports that help to shrink current account deficits. Moreover, according to Zhenhui (2008), a depreciated currency makes imports more expensive, as a result there are improvements in the trade balance.

Literature Review

In the trade literature, those who support the notion that exports bring economic growth to a particular country by increasing output have coined the exports lead growth hypothesis. It has being tested across different countries, at different time periods, with different methodologies, and variables in the analyses. For some countries, there is evidence that supports a causal effect of exports on economic growth. While for others, only the reverse relationship has been found. In some cases, the direction of causality is bidirectional.

The conception surrounding the exports lead growth hypothesis has led many economists to prescribe export promotion policies in developing and developed countries for fostering economic growth through the development of comparative advantages, specialization, economies of scale, increasing productivity, diffusion of technology, foreign investment, and effective reallocation of resources such as labor, capital investments, human capital and natural resources to the tradable sector of the economy.

But, exports are just one factor of a myriad of causes of economic growth. Therefore, any endeavor at explaining the functions of exports in economic growth would have to include all the causes of growth and exports in the analysis(Michaely (1977) and Weil (2009)). As such, in this dissertation, I have assumed that government debt is another factor conducive to economic growth. But then again, it is impractical to put all the sources of economic growth in one empirical analysis. However, we can strive to abstract the most important causes of economic growth and strive to present the most fundamental channels on how exports are conducive to economic growth. The majority of studies that test the export lead growth hypothesis include factors of production such as labor and capital. Economic growth is measured by including the gross domestic product or gross national product.

Other studies go a step further by controlling for the effects of other variables such as initial capital, imports, inflation, terms of trade, exchange rate, aggregate world supply (foreign output), money supply, savings, investment share of GDP, foreign and domestic investments, private consumption, manufacturing productivity, exports of fuel, non-fuel exports, level of country's openness (Riezman, Whiteman, and Summers (1996); Gutiérrez De Piñares (2007); Bahmani-Oskooee and Economidou (2009)). In what follows, some research endeavors that have emphasized the understanding of the effects of exports in the economy will be highlighted.

Emery (1967) presented the exports lead growth hypothesis as the "causal relationship between the two, that this relationship is one of interdependence rather than of unilateral causation, but that it is mainly a rise in exports that stimulates an increase in aggregate economic growth rather than vice versa." According to Emery (1967), exports allow imported goods, such as new technologies that support productivity, economies of scale, and foster investments, that lead to greater consumption. These arguments are Keynesian in nature.

Emery (1967) has argued that a country cannot sustain its economy without a strong trading sector, because the country can import more than it exports just temporarily. Assuming that capital flows are in balance, then the country will have an imbalance in the current account that could put downward pressure in the value of the currency-because it would have to adjust the financial account that would lead to sudden depreciations and possibly even debt overhang. Because of the potential financial dangers of not having a strong trading sector, Emery (1967) recommends promoting policies that fosters growth in exports such as having an undervalued currency. On the other hand, Emery (1967) recommends a realistic exchange rate that only originates from synchronized monetary and fiscal policies.

Michaely (1977) studied the relationship between exports and economic growth in less developed countries by analyzing the correlations among the variables in the period 1950-1973. He stated that "a positive association of growth with export expansion has thus been established;" though, Michaely did not control for other variables that would solve the spurious regression problem. Another problem that is not addressed in the estimation, is the simultaneous relationship between exports growth and economic growth as referenced by Lee and Cole (1996). Then, Michaely (1977) highlights that "if the growth process has no trade bias and exports remain a constant proportion of product, the correlation of the two variables will be very high," and thus, "has no indication of causal relationship and no explanatory value."

Michaely (1977) found a strong positive relationship between exports growth and economic growth among developed nations. But, such a relationship is mild among developing countries. He argues that "growth is affected by export performance only once countries achieve some minimum level of development," even after controlling for country size and proximity to a large country. Then, he concludes that countries would differ in export promotion policies.

Following Michaely (1977), Balassa (1978) studied the relationship between exports and economic growth as well as that between manufactured exports and manufacturing output for the period 1960-1973, the selected countries had an established industrialized base. Balassa concludes that different rates of growth in the exports sector of the economy will be related to differences in trade policies. Balassa (1978) also found that intercountry differences in economic growth (income increments) are due to lower investment costs favored by trade orientation.

In 1985, Balassa studied the export lead growth hypothesis for 43 countries in the 1960-79 period, finding that there was a significant effect of growth of exports on economic growth.

Furthermore, the effect was higher in the period 1973-79 in comparison with the 1960-73 period. Balassa (1985) acknowledged that "the introduction of an export variable in the production function-type framework aims at capturing the effects of exports on economic growth through improved resource allocation capacity utilization, economies of scale, and technical change." Balassa (1985) found that intercountry differences in the rate of economic growth is mainly due to differences in investment rates, labor force rate of growth, initial trade policy, adjustments to trade policies, level of economic development and composition of exports. Furthermore, he found that intercountry differences in export growth and exports to GDP ratio are the expression of the country's trade policies. These arguments are not so different to those found in Emery (1967) and Michaely (1977).

Using time series analysis, Hatemi-J and Irandoust (2000) studied the causal effects of exports on economic growth for Greece, Mexico, Portugal, Ireland, and Turkey. Using vector autoregression (VAR) models and annual data for the 1960-1997 period. They found that in the long run there was causality only for Ireland, Mexico and Portugal. Hatemi-J and Irandoust (2000) concluded that export promotion policies are fundamental to promote economic growth. They also found uni-directional Granger-causality-from export growth to economic growth in the cases of Ireland and Mexico, and causality from economic growth to export growth in the case of Portugal. The finding that Portugal's economic growth leads to growth in exports, may be due to the fact that economic growth directs a comparative advantage through human capital (skills and technological development) that increases the productivity of workers.

Giles and Williams (2000) made available an ample literature review on the relationship between exports and economic growth. More than 150 applied research papers were evaluated, and the

authors concluded that "extreme care should be exercised when interpreting much of the applied research on the exports lead growth hypothesis."

Trade orientation makes a country more capable of using external capital by not only allowing repaying debt obligations but also by increasing the debt servicing capacity. Giles and Williams (2000) suggest that export promotion policies may eliminate the controls that makes the currency of some countries be overvalued. They argue that economic growth can be achieved by export promotion policies. They compared Latin America and Africa with Hong Kong, Singapore, Korea and Taiwan and the newly industrializing countries of Malaysia and Thailand.

In the context of vector autoregressive (VAR) models for statistical analysis, Granger causality is referred to as a test of significance of a set of coefficients that correspond to the lags of a variable in question. Giles and Williams (2000) have demonstrated that the significance of the Granger causality test when evaluating the exports lead growth hypothesis is sensitive to variations in the degree of the deterministic trend and the implemented methods for testing nonstationarity. The authors considered VAR models in levels and first-differences of the data.

Ahmad (2001) reviewed thirty nine research papers written between 1985 and 1999, the authors employed time series analysis such as VAR models and vector error correction (VEC) models for testing the relationship between exports and economic growth. The author emphasized the concept of causality in the Granger sense. According to Ahmad (2001) there is not a strong empirical support for the export led growth hypothesis in both the developed and the developing countries, compared to previous studies that use correlations and production functions.

In the Latin America case, the exports lead growth hypothesis has been tested using different data and methodologies. For example, Gutiérrez De Piñares and Cantavella-Jordá (2007) in their

study concluded that there are contradictions in the test results by both choices, selection of data and estimation methodology. They state that the lack of strong support for the effectiveness of export promotion policies may put some countries to consider trade liberalization policies favored by developed nations.

Bahmani-Oskooee and Economidou (2009) evaluated the exports lead growth hypothesis and growth lead exports hypothesis. The authors studied 61 countries for the 1960-99 period, finding that not only the results of the exogeneity tests produced by Johansen were not only country specific, but, there was not a uniform pattern in the direction of causality. The authors suggested that "developing countries export promotion policies and growth oriented policies work together in making these countries grow and enjoy economic prosperity." They state that exports and imports (openness) represent international factors that have effects on productivity, but, they are not represented by production inputs such as labor and capital.

Thus far, I have discussed research papers that have described the theoretical and empirical fundamentals that outline the effects of exports on economic growth and vice versa, now I turn to the strand of literature that deals with the functions of government debt for fostering economic development and growth. The main argument for introducing government debt in the analysis in the context of development is that it fosters investments that increase not only the human capital but also strengthen the institutions and national infrastructure that facilitate economic growth and international competitiveness of the goods that are sold abroad. This is achieved by expected positive effects of government debt in total factor productivity that generates greater income.

Besides, exports are increased by direct effects of currency depreciation that arise from fiscal policies that set in motion a major role of government debt in improving the economy. In

theoretical grounds, the referred mechanism gives rise to a common critique for previous studies that did not account for either government debt and/or the effects of the currency when testing the validity of the exports lead growth hypothesis or growth lead exports in the empirical literature of trade and finance.

Love (1994) examined the causal relationship between income growth and exports growth as well as the causal effect of government expenditures and income growth, by using adjusted and unadjusted measures of income, the sample consisted of 20 countries in the period 1960-1990. Love concluded that such relationships are sensitive to the chosen measures of income, finding less evidence of support for the hypothesis that growth of government expenditures is positively and causally related to growth in income. Nevertheless, the results enforce the weakness of the export lead growth hypothesis, despite the fact that the author did not account for the correlation between growth of government expenditures and exports growth.

Considering the bias that may result from omission of variables in determining the causal effects among the variables of interest, Amoateng and Amoako-Adu (1996) augmented the bivariate relationship between exports growth and economic growth by adding external debt servicing, finding support for both the export lead GDP-growth and the GDP-growth lead exports hypotheses. The sample consisted of African countries in the period 1971-1990. Their empirical analysis was developed without a theoretical model that would have made assumptions of exogeneity of the external debt variable. The only justification for the inclusion of the external debt servicing variables relied on the fact that exports revenues are used to repay the debt obligations in foreign currency. Their rational is based on what happens to budget revenue after debt payments, economic development is hindered because less exports revenue implies less revenue for the private and public sector that may be intended for new investments.

Sen, Kasibhatla, and Stewart (2007) evaluated the debt overhang hypothesis for Latin American countries in the period 1970–2000 and a sample of Asian countries over the period 1982–2002. By means of panel data econometrics, they found that government debt has reduced economic growth in Asian countries but not as harshly as in Latin America. The variables (in log first differences) included in the analysis were the growth rate in per capita GDP, debt to GDP ratio, debt service ratio, debt to export ratio, gross capital formation and labor force.

Jayaraman and Lau (2009) have studied the effects of external debt, budget deficits, and export growth on GDP growth for six Asian-Pacific countries during the period 1988-2004, namely Samoa, Solomon Islands, Tonga and Vanuatu; a causal long run relationship among the variables was not found; in the short run, it was determined that there is a significant effect of GDP growth on growth of the debt. Surprisingly, in the long run they did not have enough statistical evidence supporting the significance of the effects of government budget deficits on external debt.

The risk of default of government bonds as a result of increasing reliance on debt is reflected, in part, on movements of capital markets that have effects on the relative values of a currency around the world. In that way, changes in increasing debt will set in motion a depreciating currency. If we assume the stronger version of the efficient markets hypothesis, then changes in the budget will be reflected immediately in the price of the currency; Mishkin (2009) has described different versions of the efficient markets hypothesis.

According to Starling (2008), the planning of the government budget starts at least a year and half before the fiscal year. In this budget cycle, the administration will incorporate new policies that will require either funding from tax revenues, debt and/or self-finance projects into the existing policies. Thus, I assume that the risk from approved policies in the budget will be

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already priced in the value of the currency, then giving support to the weak version of the efficient markets hypothesis. Therefore, approved public debt for new or improved government programs may be more informative about the state of fiscal policy, and thus, its effect can be captured in the exchange rate which in turn affects domestic economic activity and outward looking endeavors. Because of that, it is critical to investigate the effects of government debt on exports, and subsequent effects on economic growth.

Government debt in developed nations may directly foster a series of conditions that are advantageous for achieving greater competitiveness in the trading sector of the economy, the strand of literature that evaluates the validity of the notion that exports growth leads to economic growth have not included in their analysis the effects of government debt accumulation. This dissertation research project will pursue such understanding. Moreover, it will also consider the effects of debt on exchange rate because it determines the volume and value of exports.

Objective
The general goal of this research article is to empirically evaluate the effects of government debt on exports and economic growth in the United States for the period 1973:1-2010:3 by using quarterly data. As such, the hypothesis to be evaluated is that *U.S. government debt changes the foreign exchange value of the dollar; if there is an increase in the stock of debt—as the currency depreciates, and GDP and employment increase—then, the exports component of GDP is likely to increase*.

The chosen research period corresponds to the post-Bretton Woods System of monetary management among industrialized countries, far beyond the initial shock in 1971 for eliminating noise that arise from newly adopted policies for exchange rate and financial liberalization.

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The specific objectives of this research article are:

- To specify an economic model of output demand consistent with economic growth determinants, taking into account the effects of government debt on exports growth.

- To estimate a dynamic econometric model for the relationship between government debt with exports and economic growth, taking into consideration the effects of the foreign exchange value of the dollar.

- Determination of the causal effects between government debt and exports as well as government debt and economic growth.

- To investigate the relationship between exports and economic growth by considering two measures, adjusted and unadjusted GDP for exports.

- To obtain the dynamic responses of exports and GDP to shocks on government debt as well as the responses of employment to shocks on exports and government debt accumulation.

Theoretical Model

The output demand function was derived from a Cobb-Douglas production function, where Q is real output, K is the capital stock, and N represents the amount of labor input in the economy, equation (19). The coefficients α and β represent factor share coefficients, and, γ is a parameter that allows efficiency growth in the use of labor during the production process. This specification has been used by Greenaway, et al. (1999), Hua (2007), and, Fu and Balasubramanyam (2005).

$$Q = A^{\gamma} K^{\alpha} N^{\beta} \tag{19}$$

By assuming that economic agents maximize profit, then, labor and capital will be used up to a point where the marginal product of labor equalizes the wage (w) and the marginal product of capital equalizes the user cost of capital (c), respectively;

$$\frac{\partial Q}{\partial N} = \beta A^{\gamma} K^{\alpha} N^{\beta-1} = MPL \tag{20}$$

$$\frac{\partial Q}{\partial K} = \alpha A^{\gamma} K^{\alpha-1} N^{\beta} = MPK \tag{21}$$

then we aim to solve for K, thus,

$$\beta A^{\gamma} K^{\alpha} N^{\beta-1} = w \tag{22}$$

$$\alpha A^{\gamma} K^{\alpha-1} N^{\beta} = c \tag{23}$$

rearranging equations (20) and (21) for K^{α} and $K^{\alpha-1}$ we get

$$K^{\alpha} = \frac{w}{\beta A^{\gamma} N^{\beta-1}} \tag{24}$$

$$K^{\alpha-1} = \frac{c}{\alpha A^{\gamma} N^{\beta}} \tag{25}$$

and given that $\dfrac{K^{\alpha}}{K} = K^{\alpha-1}$ we get

$$\frac{\dfrac{w}{\beta A^{\gamma} N^{\beta-1}}}{\dfrac{K}{1}} = \frac{w}{K \beta A^{\gamma} N^{\beta-1}} \tag{26}$$

$$\frac{w}{K\beta A^{\gamma} N^{\beta-1}} = \frac{c}{\alpha A^{\gamma} N^{\beta}} \tag{27}$$

thus,

$$K = \frac{w\alpha N}{c\beta} \tag{28}$$

and by replacing K in equation (19) we get

$$Q = A^{\gamma} \left[\frac{w\alpha N}{c\beta} \right]^{\alpha} N^{\beta} \tag{29}$$

Applying logarithms and solving for the labor demand equation N (appendix II), we obtain

$$\ln N = \phi_0 + \phi_1 \ln Q + \phi_2 \ln(\frac{c}{w}) \tag{30}$$

where $\phi_0 = \dfrac{-\gamma \ln A}{\alpha + \beta}, \phi_1 = \dfrac{1}{\alpha + \beta}$, and $\phi_2 = \dfrac{\alpha[\ln b - \ln \alpha]}{\alpha + \beta}$. The efficiency parameter A is assumed

to be affected by government debt (Debt) and the exchange rate (ER), so that

$A = e^{\phi_3 T} Debt^{\phi_4} ER^{\phi_5}$; then, the extended labor demand function (appendix III) is described as

$$\ln N = \phi_1 \ln Q + \phi_2 \ln(\frac{c}{w}) + \phi_3 T + \phi_4 \ln Debt + \phi_5 \ln ER \tag{31}$$

Given that real output consists of consumption, investment, government spending plus net exports, we then subtract the value of exports from real output so that we can discern the effects of exports on labor demand as follow

$$\ln N = \phi_1 \ln Qx + \phi_2 \ln EX + \phi_3 \ln(\frac{c}{w}) + \phi_4 \ln ER + \phi_5 T + \phi_6 \ln Debt \tag{32}$$

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The majority of studies that evaluate the role of exports include a measure of the capital stock in their analysis. If we assume that the level of capital K depends proportionally on the ratio of the cost of capital and wages in a linear manner (i.e. $\ln K = \phi_k \ln(\frac{c}{w})$). Then, we obtain a labor demand function that also depends on capital, by assuming $\frac{\ln K}{\phi_k} = \ln(\frac{c}{w})$ and $\frac{1}{\phi_k} = \phi_3$ we get the following

$$\ln N = \phi_1 \ln Qx + \phi_2 \ln EX + \phi_3 \ln K + \phi_4 \ln ER + \phi_5 T + \phi_6 \ln Debt \qquad (33)$$

The econometric analysis for investigating the effects of government debt on exports can be performed under this specification by simply rearranging equation (33) and solving for output. In this way, we can evaluate the effects of exports on economic growth while accounting for the effects of government debt and exchange rate.

$$\ln Qx = \phi_1 \ln K + \phi_2 \ln N + \phi_3 \ln EX + \phi_4 \ln ER + \phi_5 T + \phi_6 \ln Debt \qquad (34)$$

If the stochastic variables described in the previous equation are considered as endogenous, as in any VAR model. Then, the model will be able to not only take into account the effects of government debt on output but also in the foreign exchange value of the dollar, consequently, the effects of debt on exports is accounted.

So, government debt is expected to have effects on exports through the exchange rate; because I assume that government debt has contemporaneous effects on the underlying value of the currency; and this in turn has contemporaneous effects on exports too. Under the proposed specification, in theory, government debt accumulation would tend to depreciate the currency, triggering growth in exports that may lead to economic growth.

Econometric Methods

The relationship between government debt, exchange rate, exports, and economic growth is investigated for the United States by using a dynamic specification of an economic model that not only takes government debt as an endogenous variable but also has exchange rate as a variable that directly has effects on exports that may lead to changes in economic growth, therein the problem is framed. According to the economic model, the variable capital is proportionally dependent upon the ratio of the cost of capital and the cost of labor; thereby, the variable of gross capital formation is used as a proxy for capital. Thus, the VAR model is estimated with the following variables: employment, gross capital formation, government debt, exports, GDP, and a measure for the foreign exchange value of the dollar.

The specification of the VAR model follows Arin and Koray (2009) as prescribed by Sims (1980) and Enders (2004). As such, equation (35) displays a VAR model that consists of ten endogenous variables, i.e. there is interdependence among all the variables included in the system such that the error terms conform to white noise processes.

$$Y_t = \alpha_o + C(L)Y_t + U_t \tag{35}$$

$Y_t = n*1$ vector of endogenous variables, $t = 1, 2, 3, \cdots t-2, t-1, T$

$\alpha_o = n*1$ vector of constants

$U_t = n*1$ vector of error terms

$C(L) = 6*6$ is a matrix compound of polynomials, L is the lag operator

$$C(L) = \begin{bmatrix} C_{1,1}(L) & \cdots & C_{1,6}(L) \\ \vdots & \ddots & \vdots \\ C_{6,1}(L) & \cdots & C_{6,6}(L) \end{bmatrix}$$

$C_{11}(L)Y = c_{11}Y_1 + c_{12}Y_1 + \cdots + c_{1k-1}Y_1 + c_{1k}Y_1$, i.e. k lags

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$$E(U_t) = 0, \quad E(U_t U_t') = \Sigma \quad \text{where} \quad \Sigma = n * n \quad \text{and} \quad E(U_{1t} U_{2s}) = \sigma_{12} \quad \text{for t=s}$$

$$E(U_t U_t') = 0 \quad \text{and} \quad E(Y_t U_t') = 0 \text{ for } t \neq s$$

The choice in the number of lags of each endogenous variable was guided by information criteria

such as AIC $[-2(\frac{LL}{T}) + \frac{2t_p}{T}]$, SBIC $[-2(\frac{LL}{T}) + \frac{\ln(T)}{T} t_p]$ and HQIC $[-2(\frac{LL}{T}) + \frac{2\ln(\ln(T))}{T} t_p]$;

where LL is the log-likelihood value linked to a particular model, T corresponds to the number

of observations and t_p corresponds to the number of parameters in the model. In addition to

likelihood ratio tests, the modified AIC, SBIC and HQIC suggested by Lütkepohl (2005) were

considered as well.

The inclusion of deterministic terms such as structural breaks and deterministic trends, was

evaluated by likelihood ratio tests as in equation (36); where Ll_0 and Ll_1 are the log-likelihood

values related to the estimated models under the null and alternative hypotheses, respectively.

The null hypothesis of the test assumes that the evaluated deterministic terms equal to zero.

$$LR = -2(Ll_o - Ll_1) \tag{36}$$

The statistic follows a χ^2 distribution with the degrees of freedom equal to the number of

deterministic terms being evaluated. However, the final decision lies on whether the estimated

parameters are statistically significantly different from zero and/or the residuals conform to white

noise process. Moreover, the parameter estimates should result in a stable VAR model to ensure

that is invertible and consequently it has an infinite-order vector moving-average representation.

Empirical Results

Description of the Dataset

A dynamic econometric model is estimated with the following variables: deflated gross domestic product (GDP) adjusted for exports, deflated gross capital formation (GCF), employed labor (Employment), deflated government debt (Debt), deflated exports (Exports), and the trade weighted exchange rate index of major currencies (Exchange Rate). The dataset was constructed with observations for the period 1973:1- 2010:3, the graphical representation of the variables in levels is displayed in Figure 2.2.

The chosen measure for exchange rate is the trade weighted exchange rate index of major currencies. It measures the relative value of the U.S. dollar against the currencies of the Euro Area, Canada, Japan, United Kingdom, Switzerland, Australia, and Sweden. The index uses 1973 prices as the benchmark for comparisons across years, the data was obtained from the Federal Reserve Bank of St. Louis; an appreciation (depreciation) of the U.S. dollar is captured by an increase (decrease) of the index. On average, the trade weighted exchange rate index showed a decline of 0.19% per quarter.

The nominal gross domestic product was obtained from the Bureau of Economic Analysis and it measures the economy's output in billions of U.S. dollars. The GDP measure was adjusted for exports and then deflated by the GDP deflator that is released by the same bureau; such a deflator uses 2005 prices as benchmark for comparisons. In the system of equations, the labor market is characterized by employed labor, such variable represents the total number of individuals that are employed in the economy (16 years and over), measured in thousands. The data was obtained from the Bureau of Labor Statistics. On average, employed individuals grew 0.372% per quarter.

Data for the total federal government debt was obtained through the Federal Reserve Bank of St. Louis, it is compiled from the Financial Management Service Office of the U.S. Department of the Treasury. It is measured in billions of U.S. Dollars, and it was deflated using the GDP deflator previously described. The gross total federal government debt had an average growth rate of 2.21% per quarter; in real terms, the growth rate was 1.37% per quarter. Total government debt is defined as the sum of debt held by the public and government borrowings from federal trust funds such as Social Security and Medicare.

The nominal value of exports was obtained from the Bureau of Economic Analysis, measured in billions of U.S. dollars. The real value of exports was obtained by using the exports deflator which is released by the same bureau. The exports deflator uses 2005 prices for comparisons, just as the GDP deflator does. Gross fixed capital formation was used as a proxy for capital, estimates are provided by the Bureau of Economic Analysis in the national accounts. However, data for this variable was obtained from the International Monetary Fund, it is measured in billions of U.S. dollars and real values were obtained by using the GDP deflator given the lack of an appropriate price deflator for the analyzed period.

In the period 1973:1-2010:3, 151 observations were obtained. The descriptive statistics of the variables in levels are displayed in Table 2.1. In terms of the coefficient of variation, the exchange rate index and employed labor had the lowest values, 14.15% and 16.02%, respectively. In contrast, the highest values were found on deflated gross debt and deflated exports, 54.69% and 59.5%, correspondingly. The correlation coefficients among the six variables are different from zero at 1% level of significance (Table 2.2).
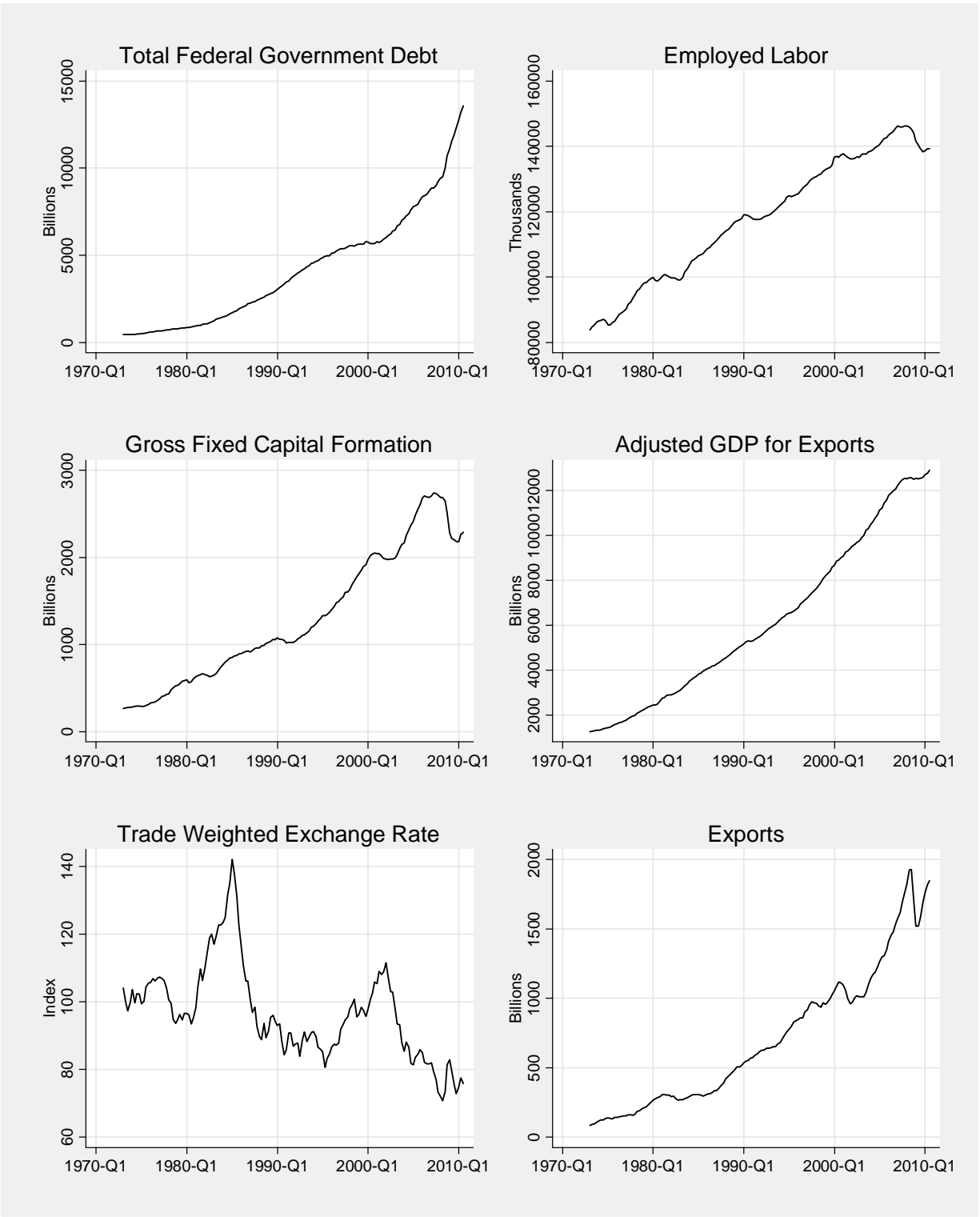
Figure 3.1 Graphs of variables in levels and nominal values, 1973:1 – 2010:3.

Table 3.1 Descriptive statistics of the observations in levels, 1973:1 – 2010:3.

Variable	Mean	Std. Dev.	Min	Max
Total Federal Government Debt	4169	3237.64	457.32	13561.62
Adjusted Gross Domestic Product	6202	3627.85	1251.10	12896.20
Exports	709	499.63	84.00	1927.30
Gross Fixed Capital Formation	1302	751.79	269.50	2737.10
Employment	117971	18904.17	83841.66	146264.30
Exchange Rate	97	13.69	70.83	142.06
Deflated Debt	4931	2697.26	1540.20	12212.73
Deflated Adj. GDP	7829.14	2412.20	4363.10	11716.05
Deflated Exports	755	449.04	217.08	1696.60
Deflated GFCF	1653	503.10	869.46	2628.94

Table 3.2 Correlation structure of the variables, 1973:1 – 2010:3.

	ER	GDPx	Exports	GFCF	EMLA	DEBT
Exchange Rate	1.000					
Deflated Adj. GDP	-0.564	1.000				
Deflated Exports	-0.631	0.978	1.000			
Deflated GFCF	-0.483	0.969	0.938	1.000		
Employment	-0.556	0.980	0.949	0.957	1.000	
Deflated Debt	-0.654	0.959	0.970	0.872	0.937	1

Tests for Unit Roots

The dynamic econometric model was estimated using first logarithmic differences of the variables, i.e. the growth rate of the variables. These transformed variables were tested for unit roots in levels and its respective first difference by means of the generalized least-squares Dickey–Fuller test for unit roots (DF-GLS) and the augmented Dickey-Fuller test for unit roots, the results are displayed in Table 3.3 and Table 3.4, respectively. In each table, two sets of results are displayed. The first set corresponds to the test results of the variables in levels while the second set corresponds to test results of variables in first differences.

Table 3.3 DF-GLS unit root test results for the growth rates of the variables.

Lags	Debt	Adj. GDP	Exports	GFCF	Employment	Exchange Rate
Variables in levels with trend						
7	-1.815	-5.095	-2.942	-4.447	-4.875	-2.579
6	-2.091	-4.601	-3.016	-4.157	-4.542	-2.644
5	-2.154	-4.805	-3.084	-4.355	-4.795	-2.861
4	-2.122	-5.361	-4.001	-3.951	-5.227	-3.428
3	-1.727	-5.518	-4.568	-4.206	-5.471	-3.830
2	-2.542	-5.945	-4.603	-5.347	-5.329	-4.362
1	-3.184	-6.478	-5.823	-5.427	-6.605	-6.366
Variables in first differences without trend						
3	-4.410	-1.535	-2.010	-4.741	-2.526	-5.444
2	-8.693	-2.289	-2.802	-6.720	-3.369	-7.439
1	-10.405	-3.561	-4.503	-7.909	-6.077	-11.725

Note: For tests with trend, the critical values for 1%, 5% and 10% levels of significance are -3.519, -2.979 and -2.689, respectively. For tests without trend, the critical values for 1%, 5% and 10% levels of significance are -2.593, -1.95 and -1.613, respectively.

Table 3.4 Results from Augmented Dickey–Fuller unit root tests.

Variables	ADF Statistic*	Critical Values		
		1%	5%	10%
Variables in levels with trend				
Debt	-3.352	-4.025	-3.444	-3.144
Adj. GDP	-4.694	-4.025	-3.444	-3.144
Exports	-5.446	-4.025	-3.444	-3.144
GFCF	-3.798	-4.025	-3.444	-3.144
Employment	-4.679	-4.025	-3.444	-3.144
Exchange Rate	-4.912	-4.025	-3.444	-3.144
Variables in first differences without trend				
Debt	-7.305	-2.594	-1.95	-1.613
Adj. GDP	-8.441	-2.594	-1.95	-1.613
Exports	-8.659	-2.594	-1.95	-1.613
GFCF	-8.895	-2.594	-1.95	-1.613
Employment	-7.647	-2.594	-1.95	-1.613
Exchange Rate	-9.287	-2.594	-1.95	-1.613

*Note: Dickey-Fuller tests were augmented with 3 lags.

The generalized least-squares Dickey–Fuller test for unit root tests (DF-GLS) rejected the null hypothesis of non-stationarity for all the variables in levels at the 5% level of significance (Table 3.3); with the exception of deflated debt since only at lag one, the null was rejected; the interpolated critical values came from those calculated by Elliott, Rothenberg, and Stock (1996). In the second set of results depicted in Table 3.3, the DF-GLS tests also rejected the null hypothesis of non-stationarity for all variables at the 5% level of significance.

Augmented Dickey–Fuller (1979) tests were also conducted, they are depicted in Table 3.4, all the variables in levels were tested under the alternative of stationarity around a linear time trend; the tests rejected the null hypotheses of unit root at 5% level of significance for all variables. The tests on first differences of the variables resulted in rejection of the null hypothesis of non-stationarity of all variables at the 5% level of significance. The exception was for the variable total deflated federal government debt. Therefore, further analyses were conducted for this variable. In conclusion, since the variables (growth rates) appear to be stationary in levels and first differences, their corresponding order of integration is 0, i.e. I(0).

Additional tests were conducted for the variable deflated debt. The Phillips and Perron (1988) , which is robust to autocorrelation and heteroskedasticity rejected the null hypothesis of non-stationarity at the 5% level of significance (critical value = -2.887), the statistic was estimated at a value equal to -6.788. In addition to Phillips and Perron tests, the KPSS test by Kapetanios, Shin, and Snell (2003) was conducted. The estimated statistic was 0.26598, in this way the null hypothesis of stationarity was not rejected at the 5% level of significance since the corresponding critical value was 0.464. Therefore, by using multiple tests, it is concluded that the growth rate of government debt is in fact a stationary variable.

VAR Analysis

A vector autoregressive model was estimated for understanding the dynamic effects of government debt on exports and GDP growth. The system of equations consists of six variables. The lag length of the VAR model was determined by sequential likelihood ratio tests, it was found that three lags of each endogenous variable was the best choice. In addition, other information criteria such as AIC, HQIC, and SBIC were considered as well. The AIC criteria coincided with the likelihood ratio tests. In contrast, the HQIC and SBIC criteria favored a more parsimonious model with a lag length of one. However, after estimation, such lag length produced autocorrelated residuals. Therefore, the lag length of three was favored given that it produced residuals that were close to white noise processes.

After determining the lag length of the VAR model, the inclusion of deterministic terms was evaluated by likelihood ratio tests. Their inclusion is necessary for improving the final estimates so that residuals can get closer to white noise processes. Among the deterministic terms that were considered were constant terms, structural breaks, trends, and seasonal terms within a multivariate setting. The first likelihood ratio test evaluated the exclusion of constant terms, i.e., it evaluated the null hypothesis that the constant terms were equal to zero. Overwhelmingly, the test rejected the null hypothesis at 1% level of significance (Table 3.5). The null hypothesis that quarterly dummy seasonal terms were equal to zero was rejected at 1% level of significance. As such, the tests favored the inclusion of seasonal terms in the final estimation (Table 3.5).

Similarly, the inclusion of structural breaks was evaluated separately and jointly in a multivariate setting. Three dummy variables were created for representing structural changes that have occurred in the U.S. economy in the period 1973:1-2010:3. The variables represent major

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expansions on the accumulation of debt to finance spending that may have effects on other aggregate indicators in the economy such as exports and capital formation.

The first dummy variable (sb1) takes the value of one for observations in the period 1982:1-2001:2, it represents the expansion of government debt during and after the administration of Ronald Reagan. The second dummy variable (sb2) takes the value of one for those observations after the 9/11 attacks and right before the 2008 financial crisis, covering the 2001:3-2007:4 period. The third dummy variable (sb3) takes the value of one for observations during the 2008:1-2010:3 period, corresponding to the fiscal expansion that emerged after the economic slowdown of the last recession in the United States.

Three separate tests were conducted to evaluate structural breaks. The null hypothesis that variable sb1 is equal to zero was rejected only at 10% level of significance. In contrast, the test failed to reject the null hypothesis that variable sb2 is equal to zero at 10% level of significance. Finally, the null hypothesis that variable sb3 was equal to zero was overwhelmingly rejected at 5% level of significance. A final test was performed to evaluate the simultaneous inclusion of sb1, sb2, and sb3; the null that such variables were equal to zero was rejected at 1% level of significance (Table 3.5).

Finally, the inclusion of a deterministic trend was evaluated. The null hypothesis that the trend terms were equal to zero was overwhelmingly rejected at 1% level of significance. In conclusion, through the evidence compiled by likelihood ratio tests, the addition of deterministic terms was analyzed. After considering the inclusion of deterministic terms, their significance was evaluated by t-tests from the estimation of parameters by ordinary least squares. If the terms were not significantly different from zero at 90% level of confidence, then, such parameters were

constrained to zero. Thereafter, the final estimation used iterated seemingly unrelated regression. The significance and signs of included deterministic terms are displayed in Table 3.6.

Notice that structural break sb1 was positive and significantly different from zero only in the equation that represents government debt, while structural break sb3 was significantly different from zero for government debt, GDP, GFCF and employment equations; whereas the trend term was significantly different from zero only on government debt and GDP.

Table 3.5 Likelihood ratio tests for evaluating inclusion of deterministic terms.

Null hypotheses	Alternative hypotheses	df	LR statistic χ^2	P-value
No constants	Constants	6	35.79	0
No seasonals	Seasonals	18	58.37	0
Seasonals, no sb1	Seasonals + sb1	6	11.61	0.0713
Seasonals, no sb2	Seasonals + sb2	6	7.01	0.3196
Seasonals, no sb3	Seasonals + sb3	6	16.68	0.0105
Seasonals, no sb1-3	Seasonals + sb1+sb2+sb3	18	37.88	0.004
No trend	Trend	6	40.61	0

Seasonals: equivalent term for seasonal terms. sb1: dummy variable for debt expansion that started during the administration of President Ronald Reagan. sb2: dummy variable for debt expansion after 9/11. sb3: dummy variable for debt expansion after the 2008 financial crisis.

Table 3.6 Deterministic terms included in the system of equations.

Terms	Variables					
	Debt	GDP	Exports	GFCF	Employment	Exchange Rate
sb1	+					
sb2	+	-				
sb3	+	-		-	-	
q1	-					
q2	-					
q3	-					
Trend	-	+				
Constant						

Note: The terms q1-q3 correspond to seasonality. The terms sb1-sb3 correspond to structural breaks. sb1: dummy variable for debt expansion that started during the administration of President Ronald Reagan. sb2: dummy variable for debt expansion after 9/11. sb3: dummy variable for debt expansion after the 2008 financial crisis. All the included deterministic terms were significant at 95% confidence level.

Granger Causality Tests

In what follows, the causes and effects of government debt growth are discussed by means of granger causality commonly used in applied macroeconomic research. Such concept refers to the statistical evaluation of lags of one variable being differently from zero in the forecasting performance of another variable (Enders, 2004); i.e., granger causality evaluates the significance of the coefficients of lag variables into the equation of interest. Three questions arise for consideration. First, what causes growth in government debt? Secondly, what are the effects of government debt in the economy? And finally, is the direction of causality among the variables one way or bi-directional?

For this purpose, if the system of equations has stationary variables, then either Wald tests or F tests can evaluate the null hypothesis that the coefficients of the lag variable of interest are equal to zero in a particular equation. In this way, if the test fails to reject the null hypothesis then it can be said in Granger-sense, that the test fails to reject the null hypothesis that the lagged values of an independent variable does not Granger-cause the dependent variable of interest.

In the system of six equations, Granger-causality tests were performed by Wald tests and the results are depicted in Table 3.7. The null hypothesis that employment does not Granger-cause growth in government debt was rejected at 1% level of significance. This result is in agreement with the justification that many policy makers provide when justifying rising government debt levels. Moreover, when the U.S. economy has faced increasing unemployment, it seems that there is more reliance on fiscal policy instruments to stimulate the economy; specially, when real interest rates are either declining or stagnant at low levels.

Table 3.7 Granger causality tests.

Equation	Excluded	χ^2	df	Prob > χ^2
Debt	GDP	7.245	3	0.064
Debt	GFCF	12.928	3	0.005
Debt	Exchange rate	2.1875	3	0.534
Debt	Exports	1.6842	3	0.64
Debt	Employment	12.596	3	0.006
GDP	GFCF	16.081	3	0.001
GDP	Debt	14.64	3	0.002
GDP	Exchange rate	2.4244	3	0.489
GDP	Exports	10.225	3	0.017
GDP	Employment	3.2776	3	0.351
Exports	GDP	3.3839	3	0.336
Exports	GFCF	8.2695	3	0.041
Exports	Debt	3.5978	3	0.308
Exports	Exchange rate	9.6929	3	0.021
Exports	Employment	5.4461	3	0.142
GFCF	GDP	6.2986	3	0.098
GFCF	Debt	7.3633	3	0.061
GFCF	Exchange rate	2.8679	3	0.412
GFCF	Exports	1.7216	3	0.632
GFCF	Employment	2.5263	3	0.471
Employment	GDP	11.006	3	0.012
Employment	GFCF	8.3936	3	0.039
Employment	Debt	6.9671	3	0.073
Employment	Exchange rate	3.9854	3	0.263
Employment	Exports	2.174	3	0.537
Exchange rate	GDP	2.3432	3	0.504
Exchange rate	GFCF	1.55	3	0.671
Exchange rate	Debt	7.7058	3	0.050
Exchange rate	Exports	2.7312	3	0.435
Exchange rate	Employment	7.1439	3	0.067

The null hypothesis that growth in GDP does not Granger-cause government debt can only be rejected at 10% level of significance whereas the null hypothesis that gross-fixed capital formation does not granger-cause government debt was rejected at 1% level of significance. Moreover, separately, Wald tests fail to reject the null hypotheses that exports and exchange rate does not Granger-cause government debt (Table 3.7).

Although granger causality cannot provide the magnitudes of the effects, it can be inferred that growth in GDP has had an effect on government debt accumulation; mainly, due to lower taxation regimes in the sample period. Moreover, increasing GFCF is expected to produce less reliance on government debt accumulation because as more private capital is invested, the government will have fewer incentives to improve the state of the economy.

The null hypothesis that accumulation of government debt does not Granger-cause GDP growth was rejected at 1% level of significance. Moreover, the null hypotheses that debt does not Granger-cause either employment or GFCF were rejected at 10% level of significance. As expected, the accumulation of government debt Granger-causes the exchange rate; moreover, the null hypothesis that debt does not Granger-cause the exchange rate was rejected at 5% level of significance (Table 3.7).

The null hypothesis that GDP growth does not Granger-cause exports was not rejected. In contrast, the null hypothesis that exports does not Granger-cause GDP growth was rejected at 5% level of significance (Table 3.7). This result provides statistical evidence that U.S. exports have being compatible with GDP growth, giving stronger support to the exports lead growth hypothesis. However, Granger-causality does not provide statistical evidence about whether the effect of exports on GDP growth is either positive, negative or null.

Even though the Wald test fail to reject the null that government debt accumulation does not Granger-cause exports, it seems that the accumulation of government debt have more profound effects in the economy. Based on the tests, it seems that there is bi-directional causality between government debt and GDP, GFCF, and employment (Table 3.8). Hence, Granger-causality tests did not support the hypothesis that *U.S. government debt changes the foreign exchange value of the dollar; if there is an increase in the stock of debt—as the currency depreciates, and GDP and employment increase—then, the exports component of GDP is likely to increase.* Furthermore, government debt seems to have effects on the exchange rate but the opposite relationship was not statistically significant (Table 3.8). Similarly, GDP was found to Granger-cause employment but the opposite effect was not significant. the exchange rate was Granger-caused by debt and employment, however, the exchange rate only Granger-caused exports.

Table 3.8 Direction of causality among variables.

	Debt	GDP	Exports	GFCF	Employment	Exchange Rate
Debt	na	B		B	B	O
GDP	B	na		B	O	
Exports		O	na			
GFCF	B	B	O	na	O	
Employment	B				na	O
Exchange Rate			O			na

Read from row to column. O: one direction. B: bidirectional. na: not applicable.

Although, exports were not Granger-caused by government debt accumulation, such effects will be studied further. Lütkepohl and Krätzig (2004) has emphasized that Granger-causality tests only evaluates the relation between two variables and that ignores the remaining dynamic interactions in the system of equations. For this reason, the estimation of orthogonalized impulse response functions is performed.

Analysis of the Impulse Response Functions

The orthogonalized impulse responses were estimated along with corresponding asymptotic standard errors for constructing the lower and upper bound of the sixty-eight percent confidence intervals. The estimation required the imposition of a causal structure so that the responses of variables to shocks can be interpreted as close as possible to causal effects under the ceteris paribus condition. In this way, the responses to shocks take into consideration the dynamic structure of the variables in the system (Figure 3.2 - Figure 3.7).

Government debt shocks are applied to the variables in the system; the responses are displayed in Figure 3.2 along with the sixty-eight percent confidence intervals. As for the immediate effects (periods:1-3), it appears that there is appreciation of the exchange rate, decline in exports and gross-fixed capital formation, as well as increase in gross domestic product whereas the growth in employment appears not to be affected, ceteris paribus.

A one-time shock to government debt appears to have positive effects in the growth of debt accumulation; the effect is significantly positive until period eight, before it becomes statistically negligible from zero (Figure 3.2). In comparison to the reaction of the other variables, self-shocks to government debt were the most persistent since they lasted for longer periods of time. For example, significant responses by GDP and GFCF to their own shocks lasted for four quarters before the effects vanished whereas the effects of exchange rate and exports to own shocks were distinguishable from zero only until the first and second period, respectively.

The exchange rate was immediately appreciated after a positive shock to government debt, but, such positive and significant reaction lasted for only one period. Thereafter, the exchange rate tended to depreciate. The lowest change occurred in the third period (depreciation of the currency), from there the currency remained depreciated and it tended to appreciate from period

three onwards. The effect of government debt shocks on the exchange rate was not significantly different from zero after the fifth period from the initial shock (Figure 3.2).

In summary, the currency tended to appreciate temporarily and then remained depreciated for a longer period. This result may be due to higher international demand for the currency as the government increases the debt level, and afterwards, the market re-asses the value of the currency which will tend to be lower. At this point, higher risk of holding government securities and interest rate risk, altogether, may not only drive the price of the currency to lower values but also to remain depreciated.

Exports, after a government debt shock, tended to decrease in the first two periods; thereafter, the effect was unambiguously positive up until the fifth period where the maximum effect was reached. From there, exports tended to increase at a lower rate until period nine, thereafter, the effect was statistically insignificant different from zero. After period six, the cumulative effect of debt on exports is unambiguously positive (Figure 3.2). This result might be explained by increasing favorable conditions to export; these conditions are created by increasing government spending and the undervalue currency that follows. As such, this empirical evidence gives support to the hypothesis that *U.S. government debt changes the foreign exchange value of the dollar; if there is an increase in the stock of debt—as the currency depreciates, and GDP and employment increase—then, the exports component of GDP is likely to increase.*

In contrast to exports, the reaction of Gross Domestic Product to increasing government debt is unequivocally positive until period six from the initial shock. Although, the effect is positive from period seven to nine, the effect is not statistically significantly different from zero. From period ten onwards, the effect dies out (Figure 3.2). From this result, it can be inferred that fiscal

policy in the United States had been compatible with economic growth in the last 37 years; even at period six-teen, the cumulative effects of debt on GDP growth is unquestionably positive.

The response of gross-fixed capital formation to a government debt shock is more alike to the reaction of exports; GFCF tended to decline in the first two periods, from there it increased until reaching a maximum at the fifth period. After that, GFCF declined until period eight, thereafter, the effect was not statistically significantly different from zero (Figure 3.2). Consequently, the reaction of GFCF has a transitory contractionary stage as well as one that is expansionary. As for the effects of debt on employment growth, it can be said that such responses were the most delayed in comparison to other macroeconomic variables because the effect was positive and significantly different from zero until the third period. There was a maximum effect at period five, from there it started to vanish until period ten; thereafter, the effects were not distinguishable from zero even though the responses were positive (Figure 3.2).

In the previous section, the Wald test failed to reject the null hypothesis that GDP Granger-cause exports even at 68% confidence level; thus, there was not enough statistical evidence to support the growth-lead exports hypothesis, since the test cannot account for the dynamics that occur in the system. Nevertheless, the dynamic responses to GDP shocks provide contrasting evidence, significant exports growth occurs between periods two and four; thereafter, the effect remains positive but insignificant until it dies out (Figure 3.3).

Shocks to gross domestic product had an immediate appreciating effect in the currency, yet, it is statistically insignificantly different from zero. At period two, the currency is depreciated and such effect is significant (Figure 3.3). This effect coincides with the exports response to the same GDP shock, ceteris paribus. The effect of gross domestic product in the exchange rate is

insignificant from period three onwards and it may be due to fast incorporation of this type of information in the financial markets.

Unlike the responses of the exchange rate and exports to GDP shocks, employment and gross-fixed capital formation reacted significantly positive until period five and four, respectively. The remaining responses were positive but not statistically significantly different from zero (Figure 3.3). The reaction of government debt to GDP shocks was positive and significantly different from zero at period one, and from period two onwards the cumulative effect was positive. This evidence shows a transitory increase in government spending after a shock in GDP.

I expected to find negative effect of GDP on government debt accumulation, consistent with less reliance on fiscal policy as the economy faces greater economic growth. Different from previous responses, shocks to exports produce temporary reactions in the economic variables (Figure 3.4). The effects of an exports shock on the growth of government debt accumulation were basically null since every response was illegible from zero. An exports shock had short-lived positive effects on employment and exchange rate that lasted for only one and two periods, respectively.

In contrast, exports had a negative effect on the growth of GDP and GFCF. In the first two periods the effect was insignificant on GFCF, thereafter, the effect was statistically significantly negative until period six (Figure 3.4). The reaction of GDP to a shock in exports was significantly negative from the first period until the third; after that, the effect was not distinguishable from zero (Figure 3.4). Yet, the cumulative response was significantly negative from period one until the sixteenth. Besides granger-causality tests, this evidence showed that exports in the U.S. economy may have a detrimental effect on economic growth, ceteris paribus.

Shocks on gross-fixed capital formation had a negative impact on government debt accumulation; the effect was significant between periods one and four (Figure 3.5), thereafter, it diminished until it was vanished. The responses of exchange rate and GDP were temporarily positive, differing from the reaction of employment and exports which lasted longer. Employment had an immediate positive response to a GFCF shock that lasted for three periods, thereafter the effect was significantly negative for five periods; after the ninth period, the effect vanished out. Therefore, this result indicates that capital is first complementary and then substitute for labor.

An exchange rate shock had an expected negative and significant effect on exports growth (Figure 3.6). Such a shock had an immediate positive impact on debt accumulation and GDP growth, at the end of period 16, the cumulative effects were unambiguously positive; contrasting the response of employment which responded negatively from the first to the third period, and then positive responses were observed between periods six and ten.

VAR Model with Unadjusted GDP
An additional VAR model is estimated to evaluate the response of GDP to an exports shock; but, in this case, exports were not subtracted from GDP. The orthogonalized impulse response of GDP to an unexpected exports shock is depicted in Figure 3.8 (the remaining OIRF's can be found in appendix IV); the response was negative for six periods, however, it was distinguishable from zero only from the second to the fourth period. The response of GDP to an exports shock was basically the same as the response of adjusted GDP for exports (Figure 3.4). The response of the exchange rate to an exports shock was also similar as it appreciated for about two periods.
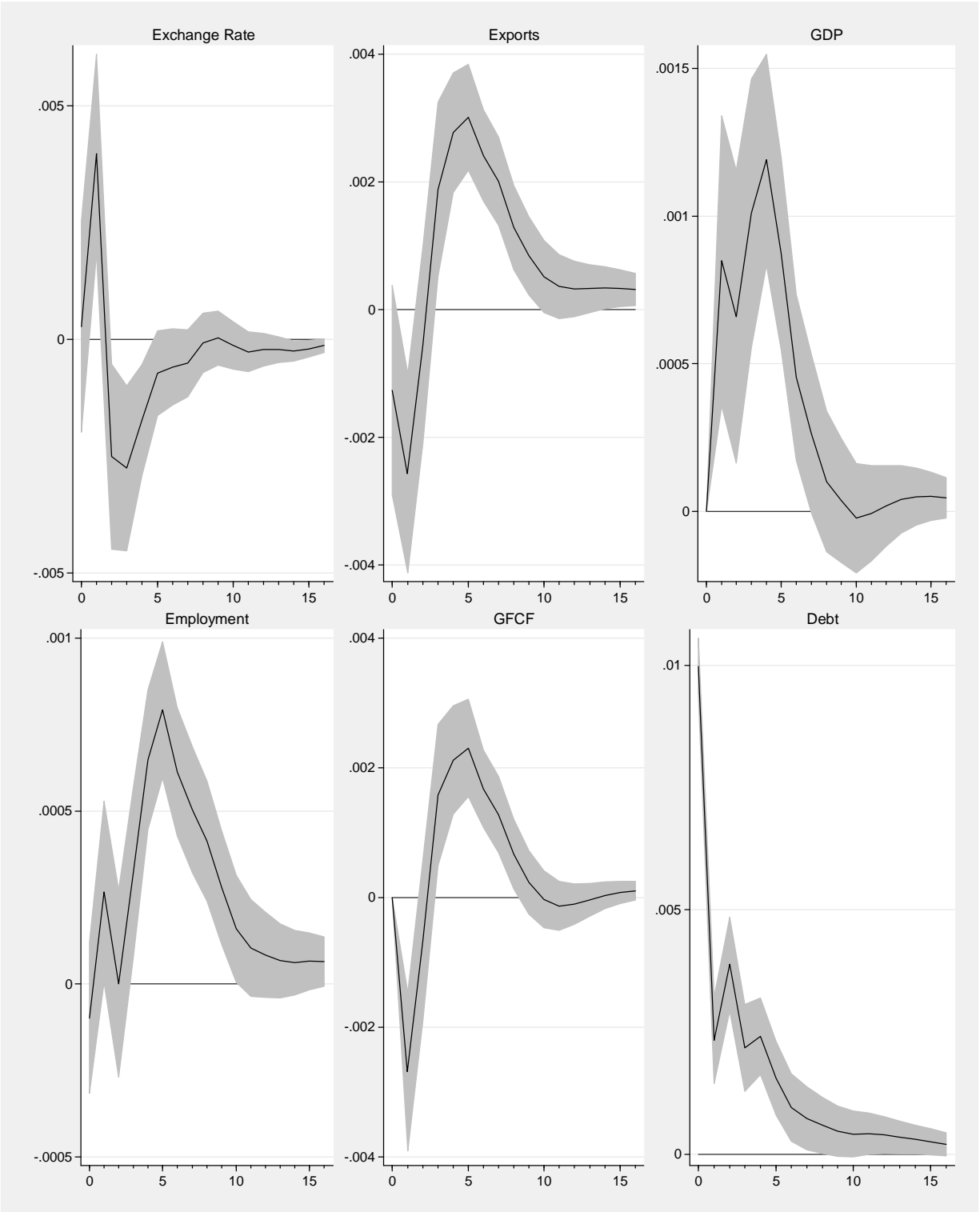
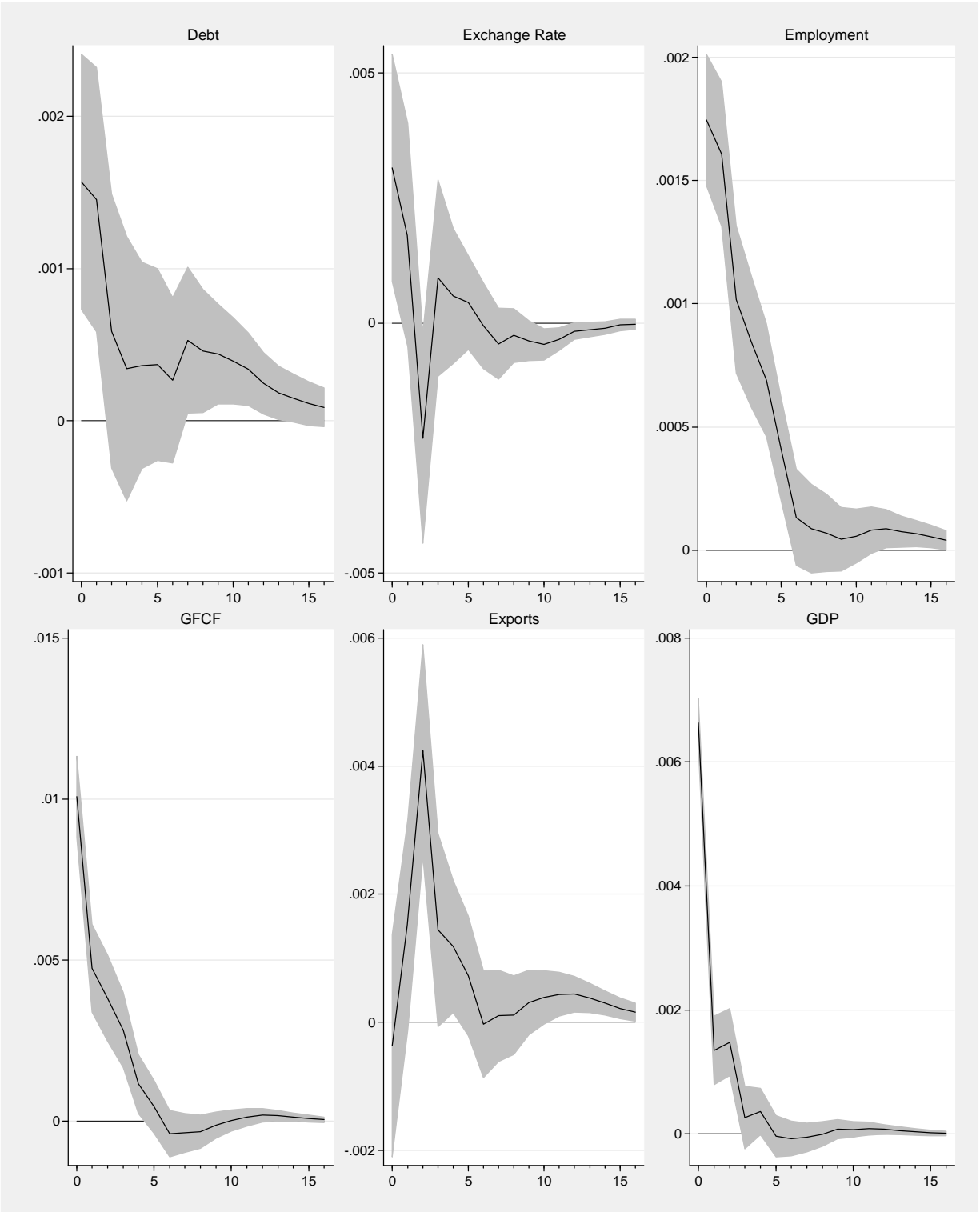Figure 3.2 Orthogonalized impulse responses to government debt shocks.

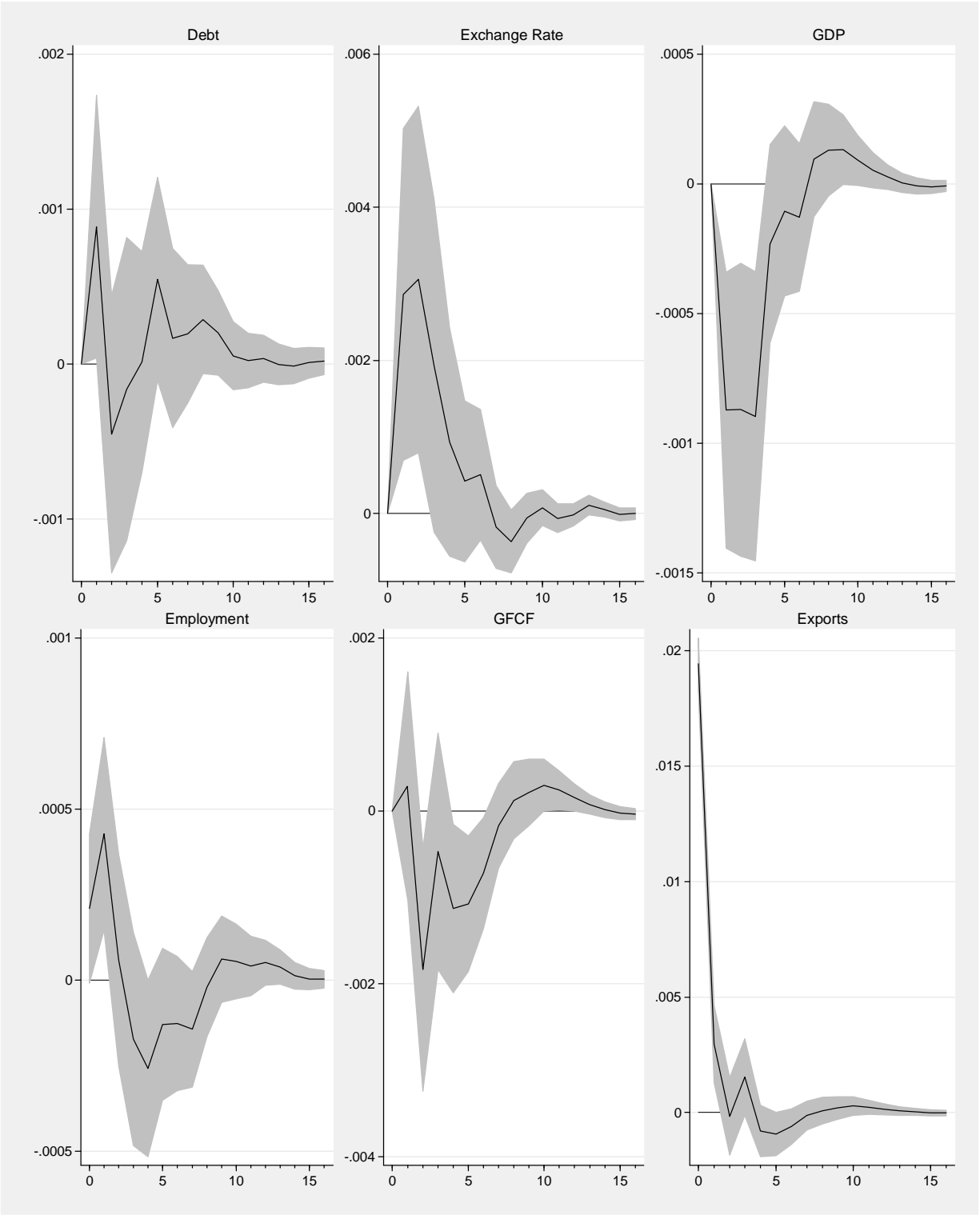Figure 3.3 Orthogonalized impulse responses to GDP shocks.

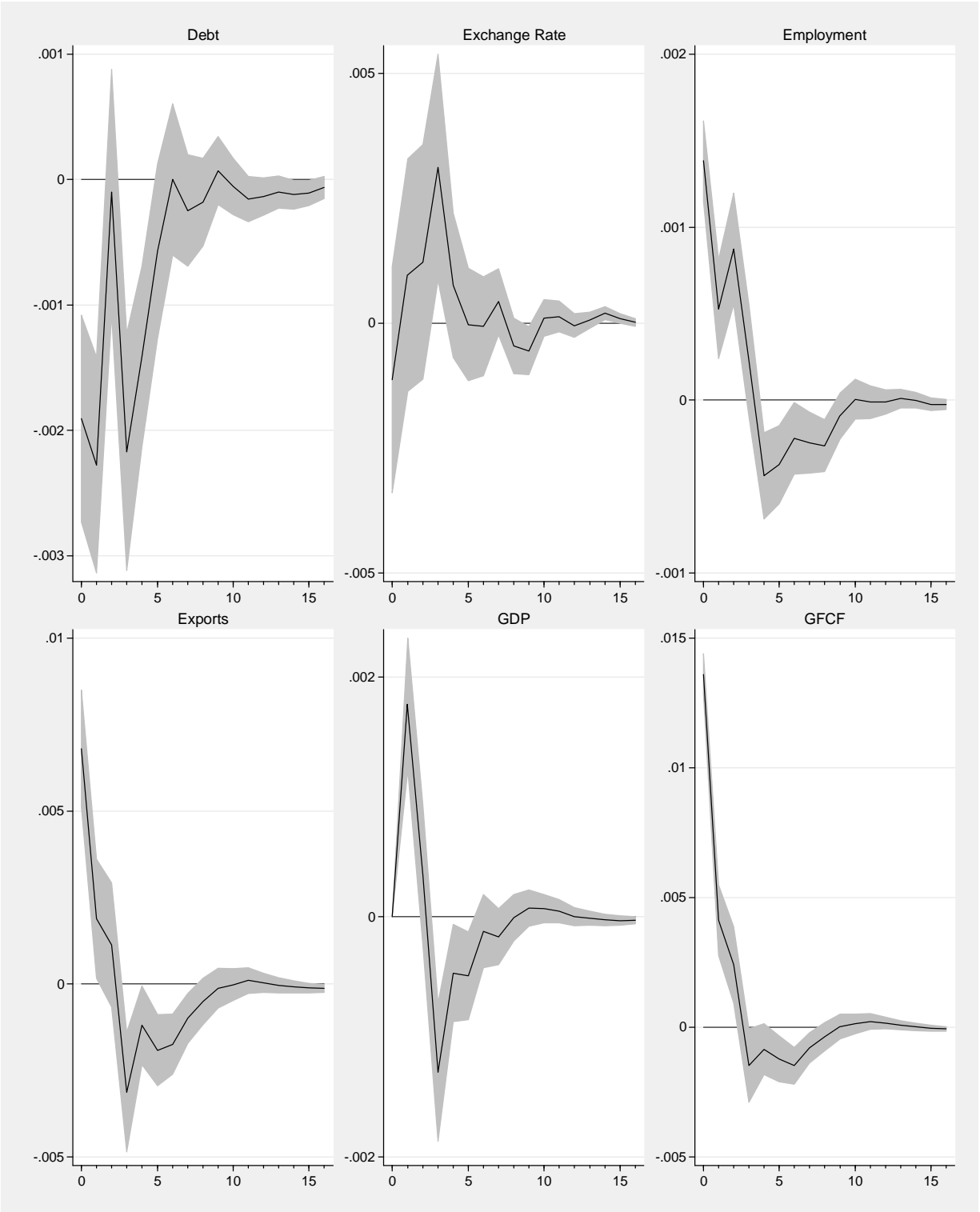Figure 3.4 Orthogonalized impulse responses to export shocks.

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Figure 3.5 Orthogonalized impulse responses to GFCF shocks.
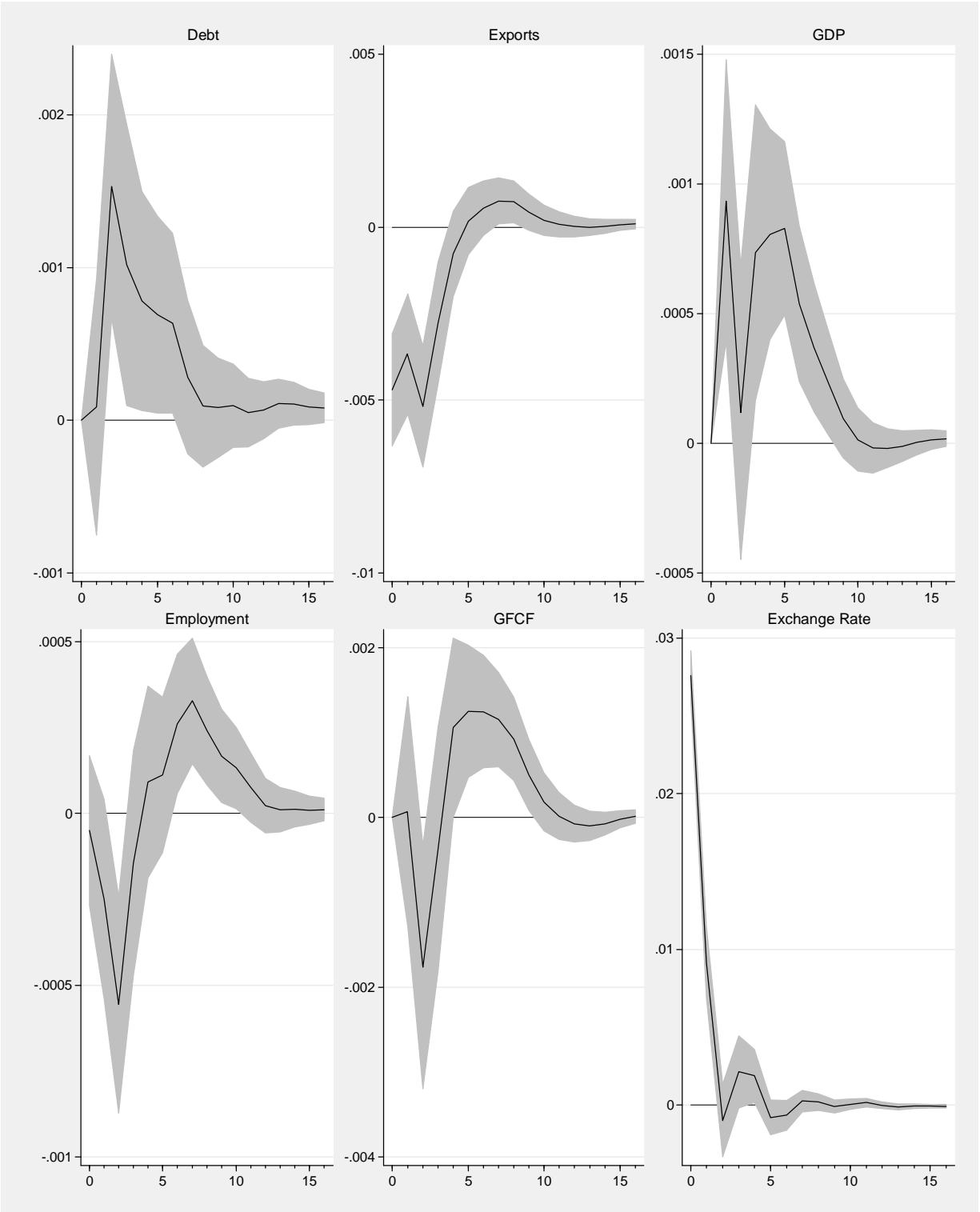
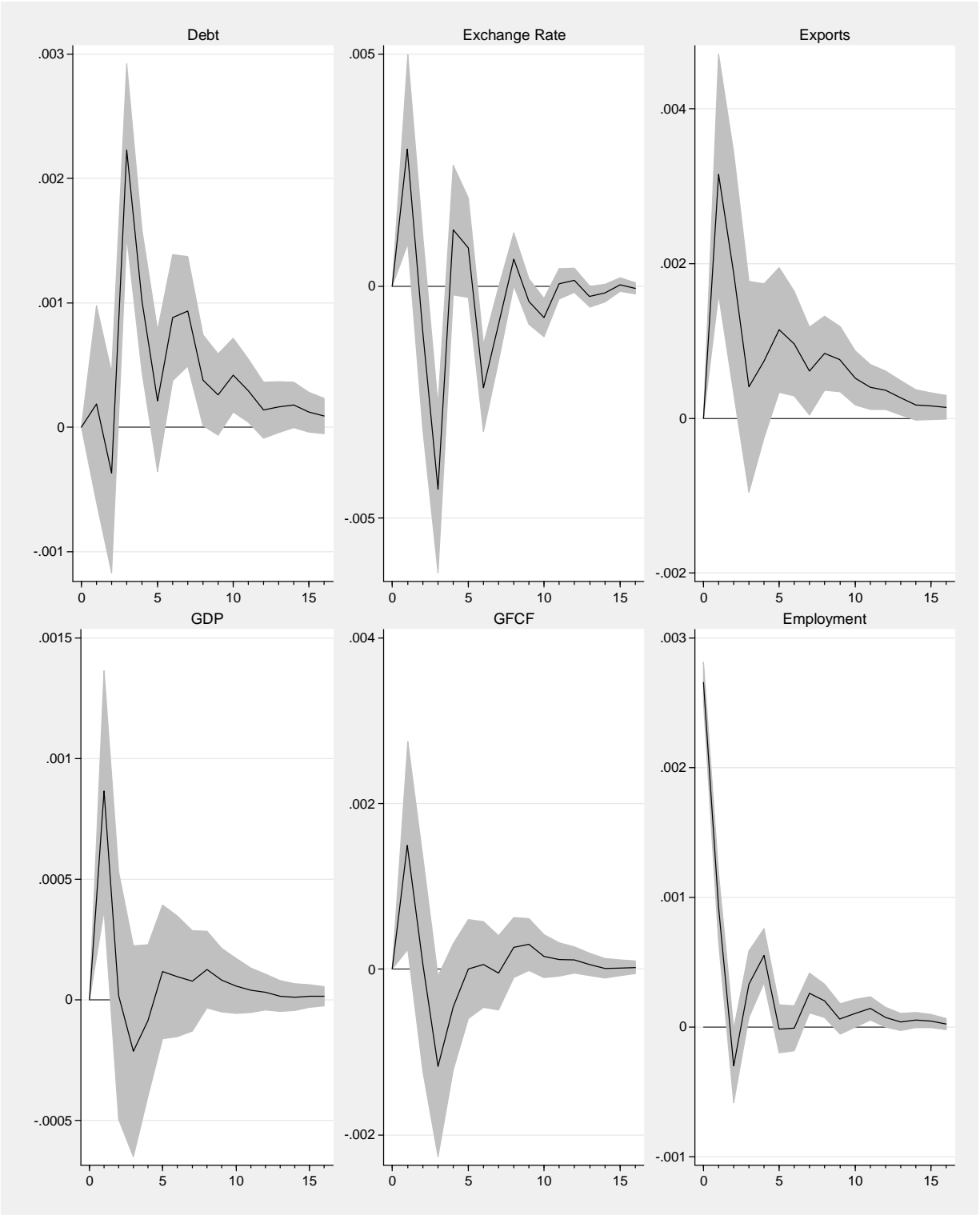Figure 3.6 Orthogonalized impulse responses to exchange rate shocks.

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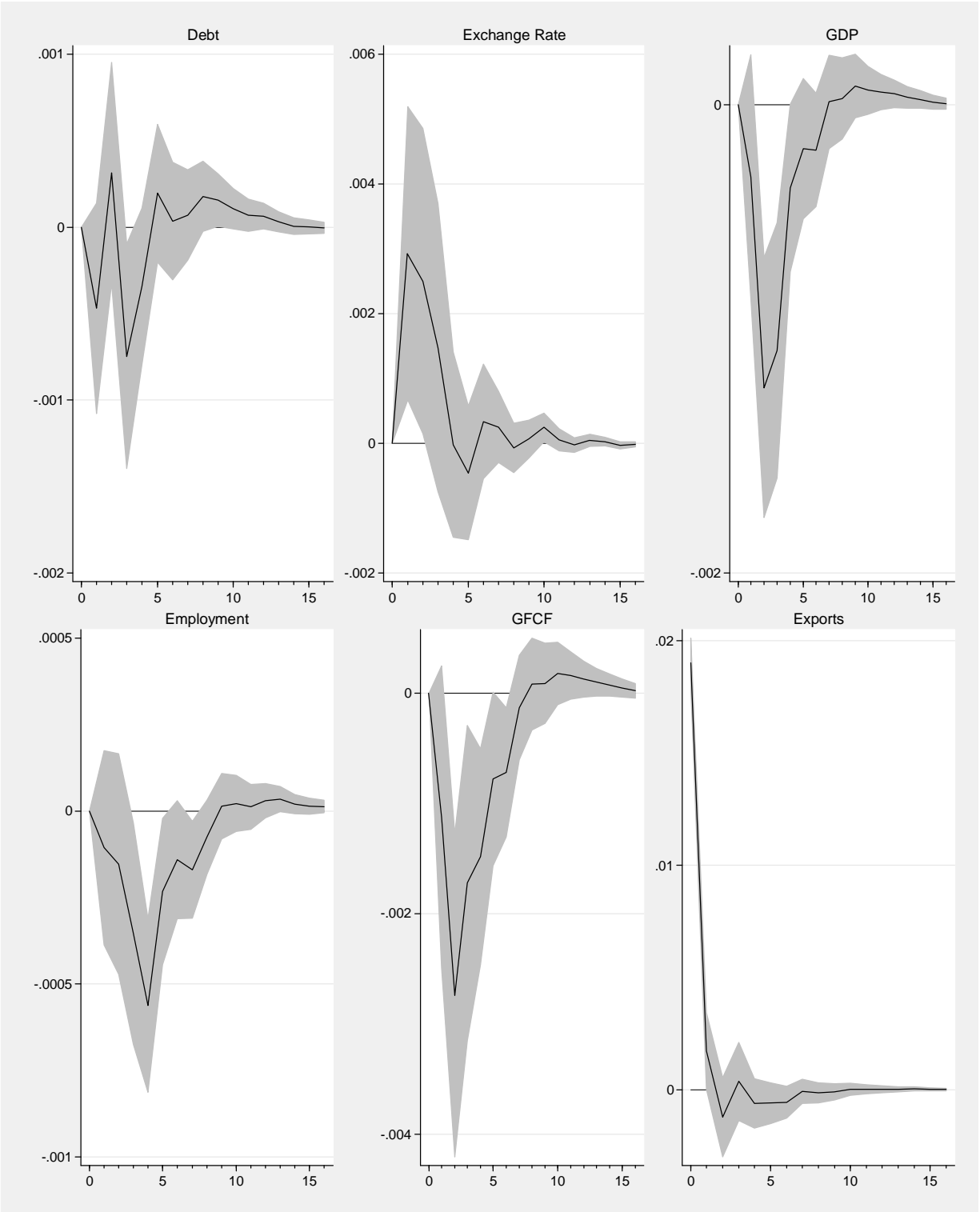Figure 3.7 Orthogonalized impulse responses to employment shocks.

Figure 3.8 Orthogonalized impulse responses to export shocks, unadjusted GDP in the model.

Discussion and Concluding Remarks

After World War II, economies have become more integrated and cooperative than ever before through the Bretton Woods system of monetary management that provided an extraordinary role to the U.S. dollar; by the early 70's, the currency was not convertible to gold anymore, thereafter, the relative value of the dollar is being set in the marketplace. Thus, economic agents and the forces of demand and supply for the currency have determined foreign exchange rates.

These major changes have had implications for international trade and capital flows, e.g., a persistent depreciated currency would tend to increase exports over the long run. As such, a country has the incentive to preserve a depreciated currency with the aim of achieving higher economic growth by means of the development of a thriving exports sector. In the 60's and 70's, many economists strongly believed that exports could be a strong source of economic growth, among those were Emery (1967), Michaely (1977) and Balassa (1978). However, as pointed by Weil (2009), economic growth is the result of many contributing factors and circumstances that work together for making a society more prosperous.

In the trade literature, previous analyses of the effects of exports on economic growth have disregarded the effects of government debt accumulation (Riezman, Whiteman, and Summers (1996); Gutiérrez De Piñares (2007); Bahmani-Oskooee and Economidou (2009)). Government debt is an important factor to consider because the currency will tend to depreciate as it increases, in turn, a surge in the exports sector may occur; generating and establishing more favorable conditions for faster economic growth and development. Moreover, increasing government debt accumulation may have positive effects on infrastructure, human capital, research and development, and stronger institutions that promote greater accumulation of capital that fosters economic development and exports growth.

I aimed to understand the effects of U.S. government debt accumulation on exports and GDP by including the effects on/by the currency in the sample period 1973:Q1 - 2010:3, corresponding to the post Bretton Woods system of monetary management among industrialized countries, the sample starts far beyond the end of gold convertibility of the dollar in 1971. The analysis encompassed the estimation of vector auto-regression models that serve to perform Wald tests as well as the evaluation of the orthogonalized impulse responses that allowed the imposition of a recursive causal structure.

According to the Wald tests, government debt accumulation and exports growth seemingly appear not to be related since there was no evidence of Granger-causation. Nevertheless, the impulse response functions provided a more intriguing relationship. After a debt shock, exports tended to decrease, and right after the third period they increased until period nine, thereafter the effect was not distinguishable from zero.

Therefore, this empirical evidence supports the hypothesis that *U.S. government debt changes the foreign exchange value of the dollar; if there is an increase in the stock of debt—as the currency depreciates, and GDP and employment increase—then, the exports component of GDP is likely to increase*. Furthermore, increasing government debt may also produce positive conditions for a more export-oriented economy either through institutional development, human capital or increasing supporting infrastructure.

The hump-shaped behavior of exports to government debt shocks can be partially attributed at the initial appreciation and lasting depreciation of the exchange rate imposed in the recursive causal structure, *ceteris paribus.* Comparatively, the impulse response functions found by Blanchard and Quah (1989) showed the same hump-shaped reaction of output after positive

shocks to aggregate demand and aggregate supply, corresponding to increasing employment and gross national product, respectively.

The Wald tests rejected the null hypothesis of no causation between government debt and gross-fixed capital formation which suggest that there is a strong bi-directional relationship. From the impulse responses, the effects of debt shocks on gross-fixed capital formation can be divided in two stages. A stage defined by a temporary contraction and another characterized by an expansion. The decreasing stage of GFCF to a government spending shock may be explained by increasing competition of funds between private and public sector, while the increasing second stage could be the result of positive externalities created by government shocks that stimulate growth in new investments in response to increasing expected demand for goods and services.

Although, the present analysis assumes that the stock of government debt is spent on a myriad of alternatives, Greiner and Semmler (2000) have pointed out that specific government expenditures may be more productive than others; as Greiner (2008) exemplifies that public debt may have effects on human capital formation and investments when it is in a stable path. But even temporarily, government debt may be utilized to achieve goals that not necessarily are motivated by economic reasons. Still, based on the results, an unexpected change in government debt leads to increasing gross fixed capital formation that contributes to the capital stock of the economy.

Exports were found to Granger-cause the growth of adjusted GDP for exports but the reverse relationship was not statistically significant; these findings are in opposition to those of Jin and Yu (1996) who concluded that in the United States such relationship was neutral. However, the responses of GDP and adjusted GDP for exports were negative after a shock in exports which

adds to the evidence on the nature of causation between those variables, ceteris paribus. Furthermore, based on the evidence is concluded that exports will tend to decrease the non-exports components of GDP for a brief period of time, *ceteris paribus*.

The response of exports was dissimilar since they tended to grow after a shock in adjusted GDP for exports. A possible explanation for these findings is that exports will tend to have higher growth when the currency is depreciated and that state is more likely during a recessionary period or when the economy presents low levels of economic activity and GDP is growing at low rates. Moreover, another factor to consider is that in the U.S. relative to other countries, exports contribute marginally to GDP compared to the influence of consumption, investment, and government spending—even when the exports to GDP ratio has risen from 6.3% in 1973:1 to 12.5% in 2010:3 (Figure 3.9).
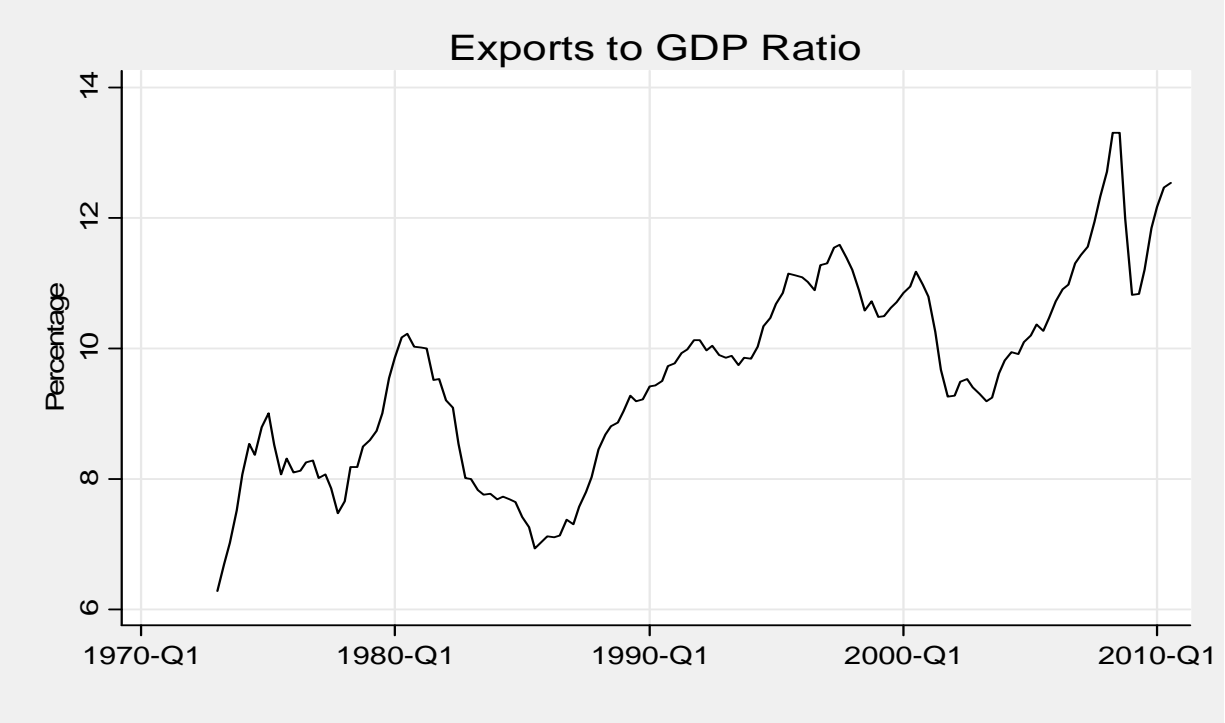

Figure 3.9 U.S. Exports to GDP ratio, 1973:1-2010:3.

So, it seems that the evidence for the export-lead growth hypothesis in the United States is weaker as suggested by Ahmad (2001) and Love (1994) for the case of developing countries. As for Canada, a U.S. neighbor, Awokuse (2003) suggested that is likely that exports leads to economic growth because of the declining Canadian dollar, however, the exchange rate was disregarded in the analysis.

Unlike a GDP shock, the growth of government debt accumulation declined after a shock in gross-fixed capital formation. In addition to GFCF, GDP also had a bi-directional causal relationship with government debt in Granger sense. Unlike the response of GFCF, the responses of GDP and employment to debt shocks were unambiguously positive. The presented evidence contradicts the findings of Sen, Kasibhatla, and Stewart (2007) who found that increasing debt was detrimental to economic growth in Asian and Latin American countries during the period 1970–2000. The reaction of employment to a government debt shock was statistically distinguishable from zero between periods three and ten whereas that of GDP between periods one and six. Accordingly, it can be said that the effect of debt on employment is delayed while that on GDP is spontaneous.

In conclusion, the growth of government debt accumulation in the United States during the 1973-2010 period was found to have been compatible with economic growth and exports growth. Hence, it can be said that effective management of fiscal policies constitutes another factor for development. Moreover, the results suggest that capital accumulation is likely to occur as government debt increases; but, this implication might not be applicable to countries with underdeveloped financial markets, incipient institutional development, and meager prospects for economic growth that undermines the terms and conditions of credit prescribed by institutional lenders and investors.

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CHAPTER 4.   TRANSMISSION OF U.S. GOVERNMENT DEBT SHOCKS TO THE ECONOMY OF MEXICO

Background Information

Mexico and the United States have a long history of economic cooperation ranging from trade liberalization to foreign investment, and labor market agreements. In the early 90's, such cooperation has given light to stronger coordination of the trading sector of both economies through the ratification of the North American Free Trade Agreement (NAFTA).

As the demand for exports and imports in both countries depend on the conditions of their economies, it becomes relevant to elucidate the most relevant economic changes that happen in one country because eventually they will have spillover effects in the other economy. Thus, economic conditions in the U.S. are leading indicators on how the Mexican economy is likely to perform; these are more pivotal for Mexico as a neighboring and emerging country. Thereby, it is imperative to understand the transmission of effects from U.S. macroeconomic variables into the Mexican economy. Especially, it is of interest to understand the effects of fiscal and monetary changes as both economies pursue stronger integration. In particular, the study of the economic effects of government debt accumulation becomes more relevant.

In a globalized economy, information about the financial conditions of countries are transmitted almost immediately as it becomes available. Such information triggers either excess demand or excess supply of domestic and international financial assets until the market clears; so that as Mishkin (2009) suggests, prices would eventually contain the available information. Governments would also take a series of actions that prevent them from negative spillovers from abroad. Dooley and Hutchison (2009) mentioned Mexico as an example, where government officials at the beginning of the recent U.S. financial crisis were very optimistic about not having negative spillovers, but their expectations changed as the recession deepened. According to the

authors, the majority of emerging countries responded by having stricter control over public debt and lower exposure to exchange rate risk by rebalancing foreign currency holdings.

Dooley and Hutchison (2009) estimated a bivariate VAR model of U.S. equity prices (S&P 500) and Mexican equity prices, finding that U.S. financial asset prices are leading indicators of Mexican financial asset prices. The outcomes are rooted on expectations about future industrial production, retail sales and economic growth. Their results provide support to the idea that Mexican equity prices are integrated with the U.S. economy. The authors suggest that after the 2008 financial crisis there is evidence to support the idea of stronger financial integration between the two economies. Notwithstanding the mention of bank recapitalization news, the authors did not state whether increasing U.S. government spending to recapitalize the banks or the stimulus plan to stabilize the economy in 2009 had effects in the Mexican equity market.

Literature Review

According to the International Monetary Fund (2008) there are two mechanisms by which fiscal policy can achieve stabilization of the business cycle. The first mechanism is what they call automatic stabilizers that vary according to the economic conditions. The second is discretionary fiscal policy that entails the formulation of policies that have effects on the spending levels, taxation, and income transfers which are independent of achieving goals, e.g. the fiscal stimulus package in 2009 that was enacted after the U.S. financial crisis.

Fiscal expansions can be observed overtime in the United States which can be financed either by raising taxes, increasing government debt, or a mix of both means. According to Galí (1994) both taxes and government purchases effectively work as automatic stabilizers. On the other hand, public debt can generate a financial crisis as Bratsiotis and Robinson (2004) have demonstrated in the analysis of the Mexican case in 1994.

Fatás and Mihov (2001) analyzed the effects of fiscal policy on consumption and employment, finding that positive innovations in government spending are followed by strong and persistent increments in consumption and employment. That is in accordance to the consensus at the IMF (2008), in that fiscal stimulus in emerging and advanced economies may have positive effects, although in some cases, the effects could be mild depending upon the rigidities of labor and credit markets, monetary policy, openness, and financial innovations in the capital markets. But, the IMF recommends emphatically that fiscal stimulus be executed as needed without increasing alarms about the sustainability of the debt and economic growth patterns.

Using data from OECD countries, Alesina and Ardagna (1998) find that the effects of fiscal expansions on the labor market are not clear compared to fiscal adjustments. They argued that at least in the short run, a monetary contraction creates a recession; but, the contractionary effects should be larger with a spending cut compared to tax cuts, the opposite occurs with fiscal expansions.

Blanchard and Perotti (2002) analyzed the effects of tax and spending shocks on output. In general, they find that output responds positively to a spending shock and becomes persistent. The multipliers according to the model specification were larger or smaller than the tax multiplier. The authors state that the results were inconsistent with Keynesian theory given that the spending multiplier should be larger than the tax multiplier. No connections were made with the labor market, as Killingsworth (1983), Hamermesh (1993), and Polachek and Sieber (1993) have indicated, taxes have effects on demand and supply of labor.

Burnside, Eichenbaum, and Fisher (2004) researched the effects of fiscal policy shocks on macroeconomic variables, allowing for movements in capital, labor tax rates and government

purchases. They found that after ten quarters from a spending shock, hours worked peaked at 9.7% higher; while, after-tax real wages declined 9 quarters after the spending shock with a peak decline of 7.5%. The authors omitted debt dynamics in fiscal expansions, as Favero and Giavazzi (2007) have argued that such omission results in incorrect estimates of the dynamic effects of fiscal shocks. According to Favero and Giavazzi, long term interest rates appear not to respond to fiscal shocks due to failure to account for the effects from the stock of debt and its dynamics.

Unlike monetary policy, according to Fatás and Mihov (2001), Blanchard and Perotti (2002), International Monetary Fund (2008), the transmission mechanisms of fiscal policy are still on debate. Moreover, it's also important to understand the transmission of fiscal policy shocks from one country to another; in open economies, such connection is reflected on the exchange rate due to the trading activities of goods, services, and, financial assets.

For instance, Koray and McMillin (1999) researched the responsiveness of the trade balance and exchange rate due to monetary shocks using a vector autoregression (VAR) model based on an open economy model. The included variables in their model were industrial production, personal consumption deflator, commodity prices, a short-term interest rate, total reserves, non-borrowed reserves, foreign industrial production, foreign CPI, a foreign short-term interest rate measure, a nominal exchange rate measure, and a measure for real trade balance.

Koray and McMillin (1999) find that after a negative shock to non-borrowed reserves the nominal exchange rate depreciates, reaching the peak after six months; similar response is found when the real exchange rate is replaced with the nominal exchange rate. During the first 20 months, the trade balance responded positively to a negative shock to nonborrowed reserves, the effect became negative after 24 months, although, in that period the confidence band spanned

zero. In contrast, when the monetary instrument was the federal funds rate, they also found that positive shocks made the nominal exchange rate to respond immediately by appreciating it, but then it returned to the original level. Given that the effect of the contractionary monetary shock is transitory, the authors determined that such exchange rate appreciation was consistent with the market approach to exchange rate determination.

Kim (2001) argues that U.S. expansionary monetary policy has little effect on the trade balance. Although he found that there exists an important decrease on the world interest rate. The author states that a U.S. monetary expansion worsens the trade balance in the short-run, but improves it persistently in the medium and long run. Additionally, U.S. expansionary monetary policy shocks lead to increases in real GDP and industrial production of foreign countries. Kim (2001) found that the output in foreign countries (G-6 countries) was between 25% and 50% of the increment in U.S. output, in part, due to the effects of lower world interest rates rather than improvements in the trade balance after expansionary monetary shocks.

Arin and Jolly (2005) investigated the transmission effects of monetary policy shocks between Australia and New Zealand, small open economies that have experienced a high level of integration in the goods and financial markets. Although, Australia's GDP is many times greater than that of New Zealand. For both countries, the contractionary monetary shocks reduced GDP before returning to its trend while the effect on CPI was initially positive and then it declined. When there was a contractionary Australian monetary shock, the exchange rate appreciated and then returned to its original level. Such contractionary policy increased the interest rate, leading to higher demand of financial assets from countries experiencing lower interest rates. Thus, such demand would cause higher demand for Australian dollars, and in this way, the currency is appreciated as a result.

According to Arin and Jolly (2005), the positive monetary shocks were applied to the Australian cash rate of the Reserve Bank and the New Zealand interbank rate; these shocks corresponded to a contractionary monetary policy. Bernanke and Blinder (1992) have stated that the interest rate is a good indicator of monetary policy because is less contaminated by endogenous responses to contemporaneous economic conditions than money growth.

Monetary and fiscal policies have simultaneous effects on the economy, relations of complementarity and substitutability can be found. According to van Aarle, Garretsen, and Gobbi (2003) complementarity exists when a restrictive monetary policy is accompanied by a restrictive fiscal policy and vice versa; while substitutability arise when a restrictive monetary policy is accompanied by an expansionary fiscal policy response and vice versa. Monetary policy is not isolated from fiscal policy, e.g Jacobs, Kuper, and Verlinden (2007) mentioned that in the creation of the European Monetary Union under the Masstritch Treaty, the states agreed to keep government deficits below 3% of the GDP and the government debt below 60% of GDP. Those conditions set the budgetary discipline necessary for convergence in the union.

Jacobs, Kuper, and Verlinden (2007) set up a VAR model comprised of output, prices, the long-term interest rate, and the effective exchange rate, plus the short-term interest rate to model monetary policy, and the variables for fiscal policy were primary surplus to GDP ratio and the nominal public debt. In the case of the 3% deficit rule, its presence in the model affected the volatility and the speed of transmission of the shocks. The imposition of the deficit rule seems to have increased output mainly through the effect of the real exchange rate. The authors concluded that the imposition of the aforementioned rules seemed to have effects on monetary policy in the Euro area; on average, GDP reached a peak after two years from an interest rate shock.

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Arin and Koray (2009) investigated the effects of U.S. fiscal policy on the Canadian economy by using vector autoregressions. The government expenditures decisions were assumed to have a contemporaneous effect on income taxes, but, government expenditures were affected by income taxes with a lag. Transmission effects of U.S. tax disturbances were not as important as government expenditure shocks. They also found that 1% rise in U.S. government expenditures raises the output by 0.13%, but such shock decreased Canadian output by 0.32%; thus, in absolute values the effect of rising government expenditures in U.S. output is one third of the effect on Canadian output. The other variables included in the VAR model were inflation rates, the 3 months Treasury bill rate and the exchange rate.

Souki (2008) found that U.S. output shocks to Canadian output is augmented during expansions, but, during recessions the shock was even more detrimental, even though inflation seemed to have decreased. The analysis was based on the Sims-Bernake decomposition of the errors from vector autoregressions that use GDP and CPI for both countries in the period 1973-2002, disregarding common shocks that could be reflected in the real exchange rate as in Voss and Willard (2009) and Arin and Koray (2009). In addition, the level of employment plus money growth shocks and fiscal policy shocks were disregarded as well. When we compare these results with those of Arin and Koray (2009) seems puzzling due to possible divergent effects when we consider that part of government expenditures is a component of the GDP equation.

Voss and Willard (2009) used the exchange rate and commodity prices in vector autoregressions for linking the U.S. and Australian economies in the analysis of transmission of monetary shocks in the 1984-2007 period. Voss and Willard found that output contributed little to variations of exchange rate; and, this in turn had slow effects in the price level. In contrast, increasing U.S. interest rates had significant effects on Australian interest rates and insignificant effects on

Australian output, prices, exchange rate and U.S. unemployment; however, commodity prices may be less important for the U.S than Australia.

The interconnection between exchange rate and the transmission channel of fiscal shocks among countries has been investigated recently for Latin America. Caporale, Ciferri, and Girardi (2008) included in their study Argentina, Bolivia, Brazil, Chile, Mexico and Peru. For all countries the exchange rate with the U.S. was used. They concluded that there is a close relationship between fiscal shocks and real exchange rate fluctuations and thus unanticipated fiscal shocks have effects on the level of international competitiveness of Latin American economies due to currency depreciation. The authors did not analyze the transmission of fiscal shocks between countries since their analyses assumed open economies and used a two country economic model where productivity, employment and government expenditures were relative measures; the country for comparison was the United States. Now, the questions that naturally arise are: how fiscal shocks are transmitted from the United States to Latin America? And also, how Latin American countries respond to fiscal shocks from their neighbors?

Blecker (2009) studied the effect of external shocks in Mexican economic growth in the 1980-2007 period, by estimating an equation of growth by dynamic ordinary least squares. The variables included in the model were financial inflows, real oil prices, U.S. GDP growth and exchange rate; controlling for structural shocks as a result of financial liberalization in 1988 and stronger trade liberalization in 1994 after the signing of NAFTA. It was found that U.S. GDP growth affected significantly Mexican economic growth, the effect was stronger after NAFTA. Real appreciation of the Mexican peso was detrimental to economic growth, the effect was stronger after the period of liberalization and NAFTA. Oil prices had a significant and positive effect on economic growth, but the effect was not as strong as the effect of U.S. GDP growth.

Blecker (2009) also estimated an investment function, finding that appreciation of the Mexican peso had a positive effect as well as oil prices and economic growth, but the public investment rate had a negative effect on total investments. Curiously, although FDI had a positive sign, the authors did not find a significant effect on investments. Thus, it did not affect capital accumulation of the economy.

The finding that U.S. GDP growth has a positive and significant effect on growth of the Mexican economy is very interesting because research by Dooley and Hutchison (2009) has confirmed that after NAFTA both countries have integrated even more in terms of financial markets. Therefore, if U.S. fiscal expansions are more likely when either employment and/or GDP is decreasing, then, we would expect that increasing government debt would increase U.S. GDP and have spillover effects in the growth of the Mexican economy.

Under those assumptions, the relation is expected to hold but the need to empirically assess such prediction exists. It is unlikely that there exists a *Beggar thy Neighbour effect* due to higher economic cooperation and historic relations between both countries. But, the results of Arin and Koray (2009) are noteworthy because they have found that fiscal expansions in the United States are disadvantageous to GDP growth of Canada. Perhaps, the U.S. economy has more flexibility and competence on counteracting external effects than Canada. A caution on the results needs to be made since the VAR model did not control for world output, employment, weighted foreign exchange, and/or world systemic risks that put downward pressure on GDP of both countries.

Barry and Devereux (2003) constructed a general equilibrium model for determining the effects of fiscal contractions. Given the previous results, we would expect that output would decline, but they found the contrary since output was expanded. The authors determined that output increased

due to increasing capital stock favored by greater investments as a result of lower interests. The interest rate was suspected to decline due to lower government consumption and greater accumulation of inventories. According to the authors, the explained mechanism is alleged to have occurred in Ireland (1987-90) and Denmark (1983-86).

If government spending does not keep up with the tax receipts, then a budget deficit occurs and needs to be funded by either internal or external debt. The twin deficit hypothesis asserts that when a country experienced fiscal deficits is likely to incur in trade imbalances. This notion according to Erceg, Guerrieri, and Gust(2005) is unlikely to be true because fiscal shocks (increasing spending or tax cuts) do not have strong effects on the trade balance. They found that a 1% of GDP increase in fiscal deficits worsens the trade balance by .2 % of GDP. The authors state that some effects of increasing fiscal deficits are compensated by the expansion of aggregate demand, savings and declines in investments.

Ghosh and Ramakrishnan (2006) maintain the opinion that the effects of current account deficits depend upon the financial conditions of a country; if there is excess of investments, then, it might be due to an economic expansion. But, according to Lin (2002), the deficit can also arise from rising consumption that could lead to abrupt corrections; specially, if there are not institutions that regulate capital markets or control the size of the government and persistent increasing government expenditures.

Kearney (1990) estimated VAR models for Australia, Britain, Canada, France, Germany, Ireland, Italy and the United States during the 1972:1-1987:4 period. The models included variables such as government expenditures, taxes, money supply, exchange rate and the current account. They found that exchange rate and the current account had significant effects on

government expenditures and tax collections, but the appearance of the twin deficits seems plausible in the short run although governments can independently alter the process of financing the deficits (taxes, bonds, and, seigniorage).

Overall, by the impulse response functions obtained by Kearney (1990) it was determined that fiscal expansions improve the current account, as a result the current account and fiscal deficits diverged. This finding is in accordance with the results of Kim and Roubini (2008), they used the same methodology but controlled for real GDP growth and monetary policy disturbances were controlled by employing the 3-months real interest rate. In contrast, Ahmed (1986) has realized that during periods of war in the United Kingdom (1908-1980), temporary fiscal deficits are accompanied with higher deficits in the trade balance. In the 70's the same happen due to oil price shocks during the OPEC embargo; they considered interest rates as exogenous—finding that government spending and money growth increased output; even though, there was crowding out of private investments, money growth had negative effects on the trade balance.

Mexico is not integrated into a common currency area with the United States and Canada, they also have neither a common fiscal policy nor a common monetary policy. In spite of that, after signing NAFTA it seems that is becoming more relevant the understanding of the inter-dependence and transmission of fiscal and monetary shocks from one country to the other. In the case of the Euro area, in theory, policies from the European Central Bank are independent from fiscal policies of the members of the union. Nevertheless, that could be set under inquiry after the public debt issues triggered by Greece in 2010. Semmler and Zhang (2004) have established such relation of independence in the period 1967-1998 in Germany and France. Furthermore, as stated by Lombardo and Sutherland (2004) and Ferrero (2009), cooperative inter-dependence of fiscal and monetary policy may stabilize the economy of an economic union.

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After the Mexican financial crisis in 1994, GDP growth has being recovered. In 1995, GDP fall by 6.2%, but five years before the crisis the GDP growth trended negatively with an average growth of 3.86%; 5 years after the crisis, GDP growth trended positively averaging 5.18%, based on data presented by Giugale et al. (2001). After the crisis, Giugale et al. (2001) pointed out that the Mexican economy has experienced substantial decrease of current account deficits. Moreover, politicians have also become intolerant to increasing public debt and escalating inflation that affects the purchasing power of nominal wages.

Mexico and the United States have shown strong cooperation in the trading sector of their economies. And given that Mexico is an emerging country, it is plausible to assume that the health of the U.S. economy has tremendous effects in Mexico channeled through trade and financial investments favored by capital mobility. When the economy faces strong prospects of declining GDP growth and rising unemployment, the U.S. seems to react quickly by operating monetary policy with a combination of inflation targets, interest rate targets and control of the money supply. Profound shocks to the economy give rise to scenarios of deep recessions. Then, the U.S. have reacted by implementing fiscal policy to restore the economy to a path of positive growth by relying on debt accumulation; e.g. the declining prices of houses troubled the mortgage market that in turn threatened the collapse of financial markets and institutions, these events triggered Bailouts of Banks 2007-2008, the Economic Stimulus Package in 2008, and the American Recovery and Reinvestment Act of 2009.

The monetary and fiscal policies implemented in the U.S. are likely to be transmitted to other countries. The cases of Canada and Australia have already being studied, but we know little about how the U.S. government debt shocks are transmitted into the Mexican economy, comprehension of this issue will be obtained by studying the dynamic responses of GDP.

Objective

The general goal of this research article is to empirically assess the transmission of direct and indirect effects of U.S. government debt on economic growth of Mexico for the 1973:1-2010:3 period. As such, the main hypothesis to be evaluated is that *U.S. government debt influences the Mexican economy through trade; if there is an increase in the stock of debt—as GDP and employment increase, and the Peso depreciates—then, Mexican GDP will grow since U.S. imports from Mexico will increase*.

The chosen research period corresponds to the post-Bretton Woods System of monetary management among industrialized countries, far beyond the initial shock in 1971 for eliminating noise that arise from newly adopted policies for exchange rate, financial liberalization and policies that have promoted freer trade and economic cooperation.

The specific objectives of this research article are:

- To specify an economic model of output demand consistent with determinants of economic growth, taking into consideration the direct and indirect effects of U.S. government debt on the U.S. trade balance with Mexico.

- To estimate a dynamic econometric model that relates the U.S. and Mexican economies, considering the transmission of U.S. government debt shocks into Mexico, particularly on the trade balance and Mexican GDP.

- To investigate the impulse responses of Mexican GDP to U.S. government debt shocks as well as shocks to U.S. GDP, U.S. trade balance with Mexico, and U.S. M2 money stock.

- To obtain the responses of the chosen variables to shocks in the U.S./Mexico bilateral real exchange rate and the trade weighted exchange rate index of major currencies.

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Theoretical Model

The employment demand function was derived from a Cobb-Douglas production function, where Q is real output, K is the capital stock, and N represents the amount of labor input in the economy, equation (37). The coefficients α and β represent factor share coefficients, and, γ is a parameter that allows efficiency growth in the use of labor during the production process. This specification has been used by Greenaway, et al. (1999), Hua (2007), and, Fu and Balasubramanyam (2005).

$$Q = A^\gamma K^\alpha N^\beta \tag{37}$$

By assuming that economic agents maximize profits, then, labor and capital will be used up to a point where the marginal product of labor equalizes the wage (w) and the marginal product of capital equalizes the user cost of capital (c), respectively;

$$\frac{\partial Q}{\partial N} = \beta A^\gamma K^\alpha N^{\beta-1} = MPL \tag{38}$$

$$\frac{\partial Q}{\partial K} = \alpha A^\gamma K^{\alpha-1} N^\beta = MPK \tag{39}$$

then we aim to solve for K, thus,

$$\beta A^\gamma K^\alpha N^{\beta-1} = w \tag{40}$$

$$\alpha A^\gamma K^{\alpha-1} N^\beta = c \tag{41}$$

rearranging equations (38) and (39) for K^α and $K^{\alpha-1}$ we get

$$K^\alpha = \frac{w}{\beta A^\gamma N^{\beta-1}} \tag{42}$$

$$K^{\alpha-1} = \frac{c}{\alpha A^{\gamma} N^{\beta}} \tag{43}$$

and given that $\dfrac{K^{\alpha}}{K} = K^{\alpha-1}$ we get

$$\frac{\dfrac{w}{\beta A^{\gamma} N^{\beta-1}}}{\dfrac{K}{1}} = \frac{w}{K\beta A^{\gamma} N^{\beta-1}} \tag{44}$$

$$\frac{w}{K\beta A^{\gamma} N^{\beta-1}} = \frac{c}{\alpha A^{\gamma} N^{\beta}} \tag{45}$$

thus, $K = \dfrac{w\alpha N}{c\beta}$ and by replacing K in equation (37) we get

$$Q = A^{\gamma} \left[\frac{w\alpha N}{c\beta} \right]^{\alpha} N^{\beta} \tag{46}$$

Applying logarithms and solving for the labor demand equation N (appendix II), we obtain

$$\ln N = \phi_0 + \phi_1 \ln Q + \phi_2 \ln(\frac{c}{w}) \tag{47}$$

where $\phi_0 = \dfrac{-\gamma \ln A}{\alpha + \beta}, \phi_1 = \dfrac{1}{\alpha + \beta}$, and $\phi_2 = \dfrac{\alpha[\ln b - \ln \alpha]}{\alpha + \beta}$. The efficiency parameter A is assumed

to be affected by government debt (Debt) and the exchange rate (ER), so that

$A = e^{\phi_3 T} Debt^{\phi_4} ER^{\phi_5}$. Then, the extended labor demand function (appendix III) is described as

$$\ln N = \phi_1 \ln Q + \phi_2 \ln(\frac{c}{w}) + \phi_3 T + \phi_4 \ln Debt + \phi_5 \ln ER \tag{48}$$

Given that real output consists of consumption, investment, government spending plus net exports, we then subtract the value of real exports from real output so that we can obtain the effects of exports on labor demand as follow

$$\ln N = \phi_1 \ln Qx + \phi_2 \ln(\frac{c}{w}) + \phi_3 T + \phi_4 \ln Debt + \phi_5 \ln ER + \phi_6 \ln EX \qquad (49)$$

If we assume that the level of capital K depends proportionally on the ratio of the cost of capital and wages in a linear manner (i.e. $K = \phi_k(\frac{c}{w})$). Then, we obtain a labor demand function in the economy that depends also on capital, by assuming $\frac{K}{\phi_k} = \frac{c}{w}$ and $\frac{1}{\phi_k} = \phi_2$ we get the following

$$\ln N = \phi_1 \ln Qx + \phi_2 \ln K + \phi_3 T + \phi_4 \ln Debt + \phi_5 \ln ER + \phi_6 \ln EX \qquad (50)$$

The econometric analysis for investigating the effects of government debt on exports can be performed under this specification by simply rearranging equation (50) and solving for real output as in equation (51), the model now includes the standard variables used in empirical analysis. In this way, the effects of exports on economic growth can be evaluated while accounting for the effects of government debt and exchange rate.

$$\ln Qx = \phi_1 \ln K + \phi_2 \ln N + \phi_3 \ln ER + \phi_4 T + \phi_5 \ln Debt + \phi_6 \ln EX \qquad (51)$$

Departing from equation (51), let's ignore logarithmic transformations and assume that U.S. total exports (EX) can be subdivided between exports to Mexico (EXm) and exports to the rest of the world (EXw). Moreover, exports to Mexico will depend upon their level of income (Qmex). Such income (Qmex) also depends upon the level of exports to the United States (IMm, U.S.

imports from Mexico). Next, we adjust Mexican income (Qmexi) for exports to the U.S. and imports from the U.S. and then equation (51) becomes

$$Qx = \phi_1 K + \phi_2 N + \phi_3 EXw + \phi_4 EXm + \phi_5 ER + \phi_6 T + \phi_7 Debt + \phi_8 Qmexi + \phi_9 IMm \qquad (52)$$

Previous studies have pointed out the role of monetary shocks on exchange rate in studies of transmission of macroeconomic shocks from one country to another, because trade and capital mobility favors their economic integration (McMillin (1980); Kearney (1990); Koray and McMillin (1999); Arin and Jolly (2005); Caporale, Ciferri, and Girardi (2008); Souki (2008); Arin and Koray (2009); and, Voss and Willard (2009)). As such, a measure of M2 money stock is added to equation (52).

Subsequently, we assume that the capital stock depends primarily upon the interest rate, r, since it is well known that there exists a negative relationship with investments which in turn determines the capital stock. As such, real labor costs are assumed to be primarily determined by inflation, to the extent that nominal wages are more influenced by the supply of output. Lastly, real interest rates are obtained by adjusting for the inflation rate. The model is then extended by including inflation, since it affects the real trade balance, real money stock, real exports, real government debt, and real GDP.

$$Qx = \phi_1 ri + \phi_2 N + \phi_3 EXw + \phi_4 EXm + \phi_5 ER + \phi_6 T + \phi_7 Debt + \phi_8 Qmexi + \phi_9 IMm + \phi_{10} \pi + \phi_{11} M \qquad (53)$$

where M stands for money growth, equation (53) can be simplified by aggregating EXm and IMm into the U.S. trade balance with Mexico. And then we finally obtain

$$Qx = \phi_1 ri + \phi_2 N + \phi_3 EXw + \phi_4 TB_{mus} + \phi_5 ER + \phi_6 T + \phi_7 Debt + \phi_8 Qmexi + \phi_9 \pi + \phi_{10} M \qquad (54)$$

Econometric Methods

The transmission of U.S. government debt shocks into the Mexican economy is investigated by estimating vector autoregressive models (VAR) which endogenizes all variables prescribed by the economic model. In accordance with the economic model, the variables to be included in the econometric model are U.S. gross domestic product, real interest rate, level of employment, inflation, the U.S. trade balance with Mexico, U.S. government debt, exchange rate, Mexican gross domestic product and U.S. M2 money stock.

The specification of the VAR model follows Arin and Koray (2009) as prescribed by Sims (1980) and Enders (2004). As such, equation (55) displays a VAR model that consists of ten endogenous variables, i.e. there is interdependence among all the variables included in the system such that the error terms conform to white noise processes.

$$Y_t = \alpha_o + C(L)Y_t + U_t \tag{55}$$

$Y_t = n*1$ vector of endogenous variables, $t = 1,2,3,\cdots t-2, t-1, T$

$\alpha_o = n*1$ vector of constants

$U_t = n*1$ vector of error terms

$C(L) = 10*10$ is a matrix compound of polynomials, L is the lag operator

$$C(L) = \begin{bmatrix} C_{1,1}(L) & \cdots & C_{1,10}(L) \\ \vdots & \ddots & \vdots \\ C_{10,1}(L) & \cdots & C_{10,10}(L) \end{bmatrix}$$

$C_{11}(L)Y = c_{11}Y_1 + c_{12}Y_1 + \cdots + c_{1k-1}Y_1 + c_{1k}Y_1$, i.e. k lags

$E(U_t) = 0$, $E(U_t U_t^{'}) = \Sigma$ where $\Sigma = n*n$ and $E(U_{1t}U_{2s}) = \sigma_{12}$ for t=s

$E(U_t U_t^{'}) = 0$ and $E(Y_t U_t^{'}) = 0$ for $t \neq s$

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The choice in the number of lags of each endogenous variable was guided by information criteria

such as AIC $[-2(\frac{LL}{T})+\frac{2t_p}{T}]$, SBIC $[-2(\frac{LL}{T})+\frac{\ln(T)}{T}t_p]$ and HQIC $[-2(\frac{LL}{T})+\frac{2\ln(\ln(T))}{T}t_p]$;

where LL is the log-likelihood value linked to a particular model, T corresponds to the number

of observations and t_p corresponds to the number of parameters in the model. In addition to

likelihood ratio tests, the modified AIC, SBIC and HQIC suggested by Lütkepohl (2005) were

considered as well.

The inclusion of deterministic terms such as structural breaks and deterministic trends, was

evaluated by likelihood ratio tests as in equation (56); where Ll_0 and Ll_1 are the log-likelihood

values related to the estimated models under the null and alternative hypotheses, respectively.

The null hypothesis of the test assumes that the evaluated deterministic terms equal to zero.

$$LR = -2(Ll_o - Ll_1) \tag{56}$$

The statistic follows a χ^2 distribution with the degrees of freedom equal to the number of

deterministic terms being evaluated. However, the final decision lies on whether the estimated

parameters are statistically significantly different from zero and/or the residuals conform to white

noise process. Moreover, the parameter estimates should result in a stable VAR model to ensure

that is invertible and consequently it has an infinite-order vector moving-average representation.

Once the estimated residuals were evaluated for whine noise by Portmanteau Q tests, then, the

estimation of orthogonalized impulse responses is performed so that they conform to economic

theory. The chosen ordering assumes that U.S. macroeconomic variables have contemporaneous

effects in Mexican GDP and the bilateral real exchange rate while Mexican GDP and the

bilateral real exchange rate are assumed to affect U.S. macroeconomic variables with a lag.

Empirical Results

Description of the Dataset

A dynamic econometric model is estimated with the following variables: inflation, gross domestic product, real interest rate, employment, deflated debt, deflated M2 money stock (M2), the bilateral real exchange rate between U.S. and Mexico, U.S. trade balance with Mexico, GDP of the Mexican economy, and finally, exports to the rest of the world. The variables are graphically represented in Figure 4.1 and Figure 4.2.

The cost of capital, the interest rate, is characterized by the nominal yield on treasuries; in the model the interest rate is represented by real yields on 10 years Treasury bonds. Data was obtained from the Federal Reserve Bank of Saint Louis. Real interest rates were obtained by subtracting inflation from nominal yields. Inflation was calculated from the Consumer Price Index (CPI). The CPI is benchmarked with an average value equal to 100 for the 1982-84 years, it measures overall prices changes for all items and all urban consumers. CPI data is produced by the Bureau of Labor Statistics and was obtained from the Federal Reserve Bank of Saint Louis.

The M2 money stock variable was deflated by the GDP deflator, the unit of measurement is billions of U.S. dollars. The components of M2 are savings deposits, small-denomination time deposits less than $100,000, balances in retail money market mutual funds and M1 money stock; data for this variable was obtained from the Federal Reserve Bank of Saint Louis.

The labor market is characterized by the employed labor in the economy, such variable represents the total number of individuals that are employed in the economy (16 years and over, measured in millions); data was obtained from the Bureau of Labor Statistics. The nominal gross domestic product was obtained from the Bureau of Economic Analysis and it measures the economy's output in billions of U.S. dollars. Since total exports are a component of GDP, the

U.S. GDP variable was adjusted by subtracting total exports. Then, it was deflated by the GDP deflator which uses 2005 prices for measuring price movements. As such, the adjusted GDP measure will not reflect any effect coming from exports growth.

Total government debt is defined as the sum of debt held by the public and government borrowings from federal trust funds such as Social Security and Medicare. Data for this variable was obtained from the Federal Reserve Bank of Saint Louis (measured in billions of U.S. Dollars), it is compiled from the Financial Management Service Office of the U.S. Department of the Treasury. Real government debt was obtained by deflating the nominal values by the GDP deflator that uses 2005 prices as benchmark.

The nominal values for total exports were obtained from the Bureau of Economic Analysis, measured in billions of U.S. dollars. Then, total exports were divided between exports to Mexico and exports to the rest of the world. As for exports to the rest of the world, they were calculated by subtracting U.S. exports to Mexico from total U.S. exports; then, the obtained values were deflated by the exports deflator. Data for the variable total exports was obtained from the national accounts produced by the Bureau of Economic Analysis. The exports deflator uses 2005 prices for comparisons just as the GDP deflator does.

The measure for the bilateral (U.S. - Mexico) real exchange rate was constructed by multiplying the nominal exchange rate (Mexican Pesos per U.S. dollar) by the factor of proportionality between U.S. and Mexican consumer price indexes. Both indexes corresponded to all items and urban consumers. The quarterly nominal exchange rate variable was calculated by averaging monthly values. Data for constructing this measure was obtained from the Federal Reserve Bank of Saint Louis. An increase in the real bilateral exchange rate corresponds to either a real

appreciation of the U.S. dollar or real depreciation of the Mexican Peso. Refer to Calvo and Mendoza (1996), De La Cruz Martínez (1999), Carstens and Werner (2000) and Epstein and Yeldan (2009) for details about Mexico's exchange rate policy.

The trade balance between U.S. and Mexico was obtained by subtracting U.S. Imports from Mexico from U.S. exports to Mexico. The measure used in the final estimation corresponded to the ratio of the real trade balance and total trade between Mexico and the United States. Total trade was measured as the sum of real exports and real imports. Real exports and real imports were obtained by deflating the nominal variables by the corresponding price deflators, i.e., the export deflator and the import deflator. Both deflators were obtained from the Bureau of Economic Analysis while trade data was obtained from the Direction of Trade Statistics-International Monetary Fund.

Mexican GDP was obtained from the Federal Reserve Bank of Saint Louis (1980-2010) and the Instituto of Nacional de Estadística y Geografía (INEGI, 1973-1979), the data is measured in billions of local currency, Mexican Peso. Mexican real GDP was obtained in similar fashion as for the United States, the GDP deflator uses 2005 prices and was obtained from the International Financial Statistics-IMF (1981-2010) and INEGI (1973-1980).

In the period 1973:1-2010:3, 151 observations were obtained. The descriptive statistics of the variables in levels are displayed in Table 2.1. In terms of the coefficient of variation, employed labor and the bilateral real exchange rate index had the lowest values, 16.02% and 18.51%, respectively. In contrast, the highest values were found on real U.S. exports (excluding Mexico) and deflated gross debt, 59.02% and 54.69 correspondingly. The correlation coefficients among

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the ten variables are different from zero at 1% level of significance (Table 4.2) with the exception of eight pairs.
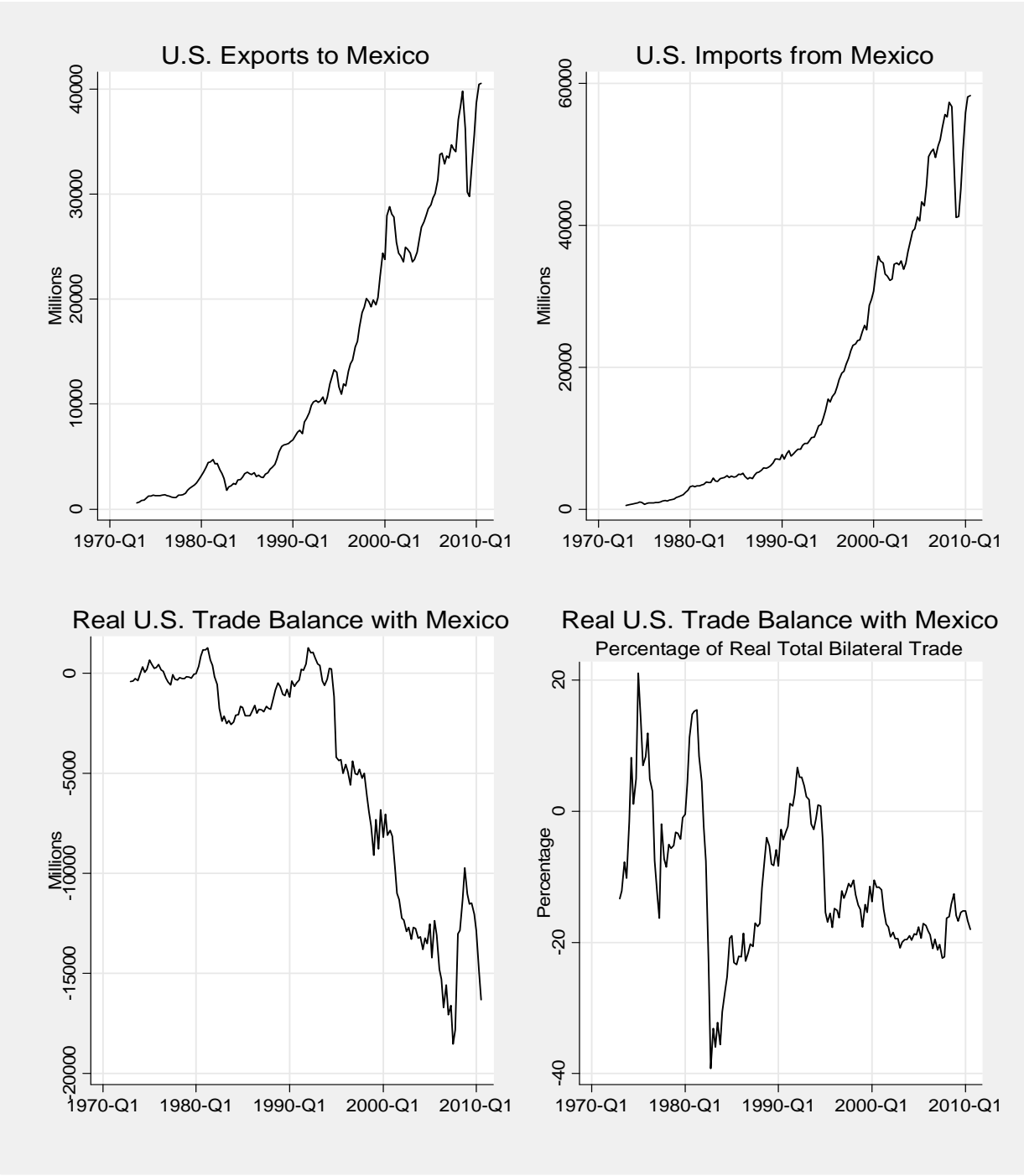
Figure 4.1 U.S. trade with Mexico in the period 1973:1–2010:3.
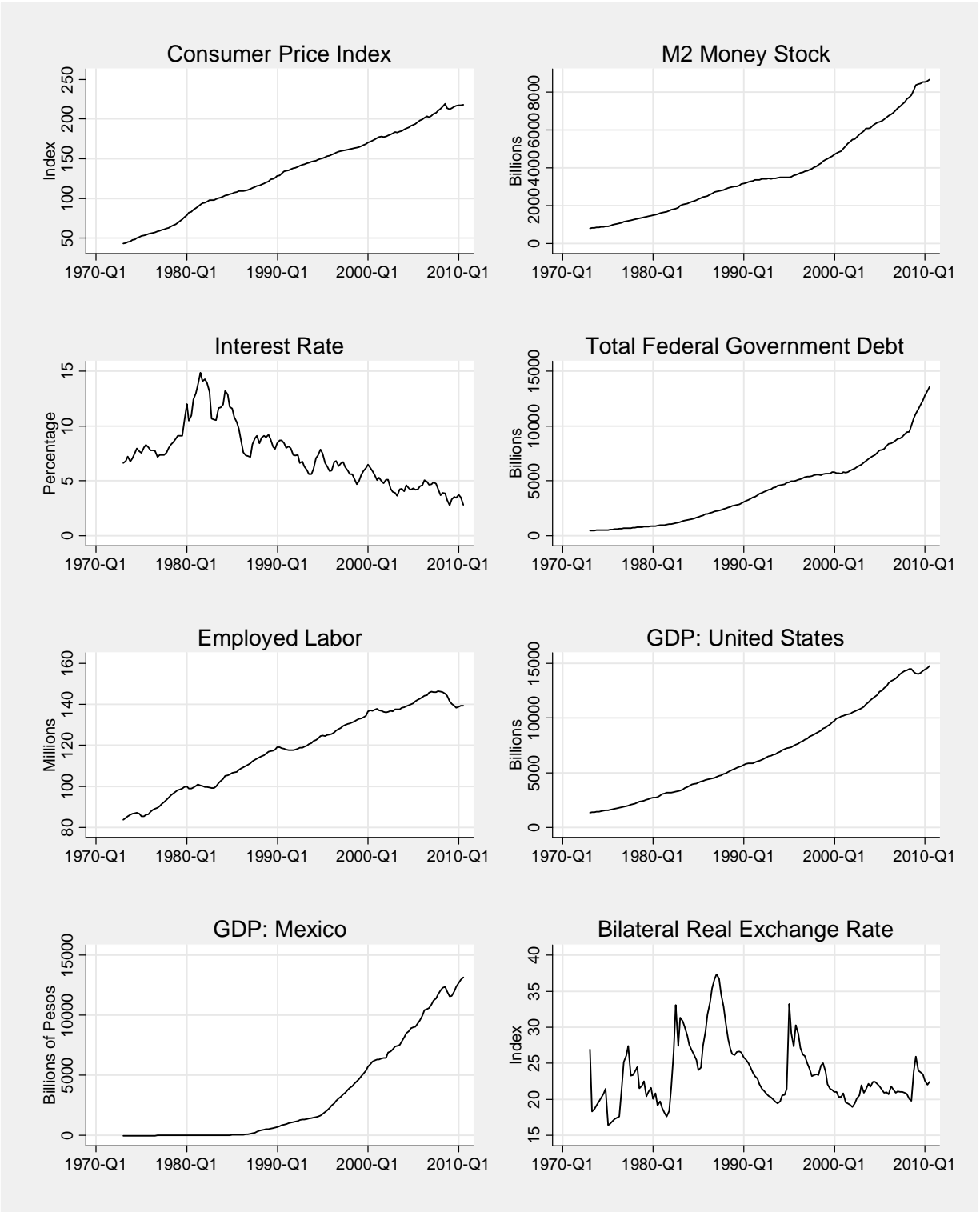
Figure 4.2 Graphs of variables in levels and nominal values, 1973:1 – 2010:3.

Table 4.1 Descriptive statistics of the observations in levels, 1973:1 – 2010:3.

Variable	Mean	Std. Dev.	Min	Max
U.S. Exports to Mexico	13452.93	12166.04	598.19	40535.48
U.S. Imports from Mexico	17833.18	17825.59	517.87	58270.93
Real U.S. Trade Balance with Mexico	-4721.26	5635.66	-18516.4	1261.57
Real Trade Balance as percentage of Total Trade.	-10.77	11.20	-39.22	21.08
Consumer Price Index	133.72	51.22	43.03	218.92
M2 Money Stock	3680.32	2177.89	813.20	8663.40
Interest Rate: 10 years Treasury Bonds	7.28	2.72	2.74	14.85
Total Federal Government Debt	4168.58	3237.64	457.32	13561.62
Employment	117.97	18.90	83.84	146.26
GDP: U.S.	6911.25	4119.49	1335.10	14745.10
GDP: Mexico	3314.82	4168.83	0.56	13139.20
Bilateral Real Exchange Rate	23.51	4.35	16.43	37.31
Deflated M2 Money Stock	4670.83	1392.55	2795.99	7801.70
Real Interest Rate: 10 year Treasury Bonds	6.19	2.42	2.30	13.40
Deflated Debt	4931.30	2697.26	1540.20	12212.73
Deflated Adj. GDP: U.S.	7829.14	2412.20	4363.10	11716.05
Deflated GDP: Mexico	7016.34	2104.61	2540.67	10264.41
Deflated U.S. Exports (excluding Mexico)	741.04	437.43	215.72	1663.08

Table 4.2 Correlation structure of the variables, 1973:1 – 2010:3.

	CPI	M2	RI	Debt	Emp.	GDPx	Adj. Exp.	TB	GDPMX
M2***	0.93	1.00							
RIRATE	-0.42	-0.62	1.00						
Debt***	0.96	0.95	-0.61	1.00					
Employment**	0.98	0.95	-0.53	0.97	1.00				
USGDPx***	0.96	0.98	-0.61	0.98	0.99	1.00			
Adj. Exp.***	0.95	0.95	-0.62	0.98	0.98	0.98	1.00		
TBUSMX	-0.44	-0.46	0.09*	-0.38	-0.42	-0.44	-0.34	1.00	
GDPMX***	0.96	0.86	-0.28	0.87	0.93	0.90	0.89	-0.41	1.00
RER**	0.06*	-.03*	0.30	0.0*	0.0*	-0.05*	-0.12*	-0.56	0.05*

*** Logarithmic transformation to deflated values of variables.
** Logarithmic transformation to variables.
* Coefficients were not statistically different from zero at 1% level of significance.

VAR Analysis

Following the approach of Arin and Koray (2009), a vector autoregressive model was estimated for understanding the dynamic effects of government debt on the Mexican economy; based on likelihood ratio tests and information criteria such as AIC, HQIC, and SBIC, the ten variables VAR model was estimated with a lag length of two. Then, the inclusion of deterministic terms was evaluated by likelihood ratio tests (Table 3.5) with the intention of refining the final estimates so that residuals can get closer to white noise processes. In addition to seasonality and deterministic trends, three structural breaks were considered within a multivariate setting.

Three dummy variables were created for representing major expansions on the accumulation of debt in the economy of the United States in the period 1973:1-2010:3; they may have effects on other aggregate indicators in the economy such as employment and exports that subsequently affects the Mexican economy. The first dummy variable (sb1) takes the value of one for observations in the period 1982:1-2001:2, it represents the expansion of government debt during and after the administration of Ronald Reagan. The second dummy variable (sb2) takes the value of one for those observations after the 9/11 attacks and right before the 2008 financial crisis, covering the 2001:3-2007:4 period. The third dummy variable (sb3) takes the value of one for observations during the 2008:1-2010:3 period, corresponding to the fiscal expansion that emerged after the economic slowdown of the last recession in the United States.

Overwhelmingly, multiple likelihood ratio tests rejected the null hypotheses that the deterministic terms were simultaneously equal to zero (Table 3.5). However, after obtaining the estimates by ordinary least squares, the insignificant deterministic terms were either constrained to zero or eliminated such as in the case of seasonal terms (Table 3.6). The final estimation used iterated seemingly unrelated regression. Then, the estimated series of residuals were evaluated to

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discern whether or not they corresponded to White noise processes, using 95% confidence levels

for evaluating the significance of the Portmanteau Q statistic; moreover, 63% of 45 correlation

coefficients were statistically significantly different from zero at 5% level of significance.

Table 4.3 Likelihood ratio tests for evaluating inclusion of deterministic terms.

Null hypotheses	Alternative hypotheses	df	LR χ^2 statistic	P-value
No constants	Constants	10	27.34	0.0023
No seasonals	Seasonals	30	57.85	0.0017
No trends	Trends	10	16.95	0.0756
No sb1, sb2, sb3	sb1, sb2, sb3	30	101.15	0.0000
No sb1, sb2, sb3, trends	sb1, sb2, sb3, trends	40	138.96	0.0000
No trends (model includes sb1, sb2, sb3)	Trends (model includes sb1, sb2, sb3)	10	37.81	0.0000
No sb1, sb2, sb3, trends, constants	sb1, sb2, sb3, trends, constants	50	166.30	0.0000

The null hypotheses are such that tests evaluate whether the deterministic terms are equal to zero. Seasonals: equivalent term for seasonal terms. sb1: dummy variable for debt expansion that started during the administration of President Ronald Reagan. sb2: dummy variable for debt expansion after 9/11. sb3: dummy variable for debt expansion after the 2008 financial crisis.

Table 4.4 Deterministic terms included in the system of equations.

Variables	Constant	Trend	sb1	sb2	sb3
Inflation	0	-	-		
M2 Money Stock	0	0	-	-	-
Real Interest Rate	0	+	+		
Government Debt	0	0	+	+	+
Employment	+	0			-
U.S. GDP (adj. for total exports)	0	+	-	-	-
U.S. Exports (adj. for exports to Mexico)	0	0	-	-	-
U.S. Trade Balance with Mexico	-	-			
Mexican GDP	-	0	-	-	
Bilateral Real Exchange Rate	0	0			

Note: The terms sb1-sb3 correspond to structural breaks. sb1: dummy variable for debt expansion that started during the administration of President Ronald Reagan. sb2: dummy variable for debt expansion after 9/11. sb3: dummy variable for debt expansion after the 2008 financial crisis. All the included deterministic terms were significant at 95% confidence level.

Analysis of the Impulse Response Functions

From the estimated VAR model, the residuals were assessed for autocorrelation as well as tested for determining whether or not they corresponded to a White noise process by implementing the Portmanteau (Q) test for 3, 5, 9, 15 and 40 lags. Once corroborated that the ten series of residuals were White noise, the orthogonalized impulse responses and corresponding asymptotic standard errors were estimated and represented graphically from Figure 4.3 to Figure 4.11, the graphs include the lower and upper bound of the sixty-eight percent confidence intervals.

GDP of Mexico tended to increase after a shock in U.S. government debt (Figure 4.3). The responses of Mexican GDP were not distinguished from zero in the first and second periods as the confidence interval spanned to negative values; in contrast, the responses from the third to the seventh period were positive and significant. So, it seems that increasing debt by the United States government tends to have a positive effect on the Mexican economy; but, as expected, such effect is delayed as it becomes significant only after the second period.

This finding gives strong support to the hypothesis that *U.S. government debt influences the Mexican economy through trade; if there is an increase in the stock of debt—as GDP and employment increase, and the Peso depreciates—then, Mexican GDP will grow since U.S. imports from Mexico will increase*.

A shock to U.S. government debt had immediate effects on U.S. GDP (Figure 4.3), given that the orthogonalized response was positive from the first to the seventh period; thereafter, even though the effect was positive, it was not distinguishable from zero. The response of U.S. GDP and Mexican GDP are similar in that the last period where the effect vanishes is the same; the responses differ in the initial response where they are discernible from zero. As expected,

increasing government debt accumulation is more likely to have immediate effects in the United States than in other economies; specially, when spending is restricted to national goods.

A U.S. government debt shock had a positive effect on the trade balance with Mexico. Although, the effect is not distinguishable from zero in the fourth and fifth periods, the remaining responses were significantly positive. The response of employment to a U.S. government debt shock was strictly positive, but, the effect was significant only from the first to the tenth period from the initial shock, the effect peaked in the fifth period, contrasting the response of U.S. GDP that peaked in the third period.

After a shock to U. S. government debt, inflation tended to decrease from the first to the second period, thereafter it increased (Figure 4.3). The response was not distinctive from zero from the third to the fifth period; thereafter, the responses were significantly positive until the tenth period. However, the cumulative effect of debt on inflation was negative and significantly different from zero until the sixth period.

In contrast to the previously described responses to U.S. government debt shocks, the responses of M2 money stock and interest rate followed similar patterns, in that debt had immediate positive effects in the first period that was followed by a continuous decline; M2 had a negative response starting at period 9 until period 16, while interest rate from period 5 to 10. The positive response of M2 indicates that expansionary fiscal policy may be accommodated in the short run by an expansionary monetary policy. And as inflation tends to increase with increasing debt, the monetary authorities are likely to decrease the money supply.

A shock to U.S. GDP tended to have positive effects on the GDP of Mexico (Figure 4.4), the effect was significantly positive until the fifth period from the initial shock, then the effect was

not distinguishable from zero from period 6 to 10; thereafter, the effect was negative. Yet, the cumulative effect of U.S. GDP on Mexican GDP was positive only until the tenth period. As expected, these results indicate that the economy of Mexico is affected by the performance of the U.S. economy; moreover, an unexpected change in U.S. GDP had positive effects on the trade balance with Mexico. Yet, such effects were significantly different from zero from the ninth period until the sixteenth period.

A shock to U.S. GDP had a negative effect on the bilateral real exchange rate between Mexico and the United States (Figure 4.4). The response reached the lowest point in the first period, thereafter, it increased rapidly until the seventh period; then, it remained negative but it increased at a slower pace. Such a response contrasted that from a U.S. government debt shock which did not have a clear effect on the bilateral real exchange rate.

The response of employment to a U.S. GDP shock was very similar to a shock in U.S. government debt, the effects remained positive and distinguishable from zero from the first period until the tenth period of the initial shock; the response of employment to a GDP shock peaked in the fourth period. As expected, increasing GDP had a negative effect on U.S. government debt accumulation. Yet, the response of debt to GDP shocks is significantly positive in the first period, followed by negative responses until the fourteenth period. These results point to less reliance on debt by the government as the economy expands.

Similarly, the effect of GDP on interest rate was positive in the first period, followed by negative responses; suggesting that as the economy expands, temporarily the economy may increase its debt which may briefly drive the yields up. But, as the debt level decreases couple with higher demand for Treasury bonds, yields will tend to go down. These effects are likely to occur, since

increasing GDP is associated with higher repayment capacity and lower chances of default; thus, yields will tend to decrease.

Both, U.S. government debt and U.S. GDP shocks had positive effects on the trade balance with Mexico, ceteris paribus. Now, we focus our attention on the effects of the trade balance on both economies. A shock on the U.S. trade balance with Mexico, had negative effects on U.S. GDP and Mexican GDP, the responses of the former were mild relatively to the latter (Figure 4.5).

Mexican GDP tended to decrease in the first period, followed by insignificant responses from the second to the fifth period, thereafter the effect is unambiguously negative. In contrast, the effect on U.S. GDP was negative and distinguishable from zero only in the fifth period; subsequently, the effect remained negative until the eleventh period. These results suggest that the Mexican economy depends on strong exports growth to the United States; the opposite cannot be stated.

The responses of the U.S. trade balance to self-shocks are positive for about eight periods (Figure 4.5), suggesting that these shocks tend to be more persistent in comparison with the responses of U.S. government debt to self-shocks which were significantly positive only from the first to the third period from the initial shock (Figure 4.3). The response of the bilateral exchange rate to a trade balance shock was negative; the response was similar to a shock in U.S. GDP. In this case, the response was significantly negative from the first to the sixth period from the initial shock to the U.S. trade balance with Mexico whereas the effect of U.S. GDP was persistently negative on the exchange rate.

Inflation and M2 money stock tended to decrease after a shock in the U.S. trade balance with Mexico. Persistently and significantly, inflation decreased at the start of the fourth period; while M2 decreased temporarily until the third period. So, under this specification, an increase in the

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trade balance with Mexico exerts a deflationary force in the U.S. economy coupled with a temporary reduction of M2. Furthermore, employment in the United States decreases after the initial shock in the trade balance, the effect becomes distinguishable from zero after the fifth period; from there forward, the effect remains negative (Figure 4.5).

A shock to U.S. employment had positive effects on U.S. GDP, Mexican GDP, the U.S. trade balance with Mexico, and U.S. inflation (Figure 4.6). The response of U.S. GDP was unambiguously positive from the first to the ninth period from the initial shock. Similarly, the effect of employment on Mexican GDP was positive in the first period; suggesting that employment shocks are transmitted very fast into the neighboring country; the effect reaches a maximum in the ninth period.

This result suggests that the performance of the U.S. labor market is a very important indicator about how the Mexican economy is likely to perform. Moreover, the effect of U.S. employment tends to be more persistent in Mexico than at home, possibly due to different sizes of the economies. So, it seems that as the United States government debt increase, the labor market absorbs more people into employment and the market for goods and services also improves; and, as income change, the effects are transmitted into the Mexican economy through trade since a trade deficit is also associated with positive changes of Mexican GDP.

Therefore, this empirical evidence also supports the hypothesis that "U.S. government debt may influence the Mexican economy positively through trade. If there is an increase in the stock of debt, then, the effects will spill over into Mexico as the U.S. economic conditions change; as a result, Mexican gross domestic product is likely to increase."

Furthermore, the U.S. trade balance with Mexico responded positively from the fourth to the sixteenth period from the initial shock to employment; reaching the highest response in the ninth period. Thus, as the U.S. labor market absorbs more people into employment, the economy is able to produce and consume goods not only for the domestic market but also for the Mexican market which in turn improves its own economy (Figure 4.6).

As for the response of inflation to an employment shock, the effect was distinguishable from zero starting in the third period until the fifteenth period, reaching a peak in the fourth period (Figure 4.6). Employment was negatively associated with M2 money stock as it decreased for about eleven periods after a positive shock to employment; implying that monetary authorities are likely to decrease M2 as higher employment levels would produce higher aggregate demand and in turn higher inflation is expected, ceteris paribus. An employment shock had a negative transitory effect in the interest rate and a positive transitory effect on the bilateral real exchange rate; indicating that the bilateral real exchange rate is appreciated as higher demand for treasuries (due to lower chances of default and higher payment capacity) puts downward pressure in yields.

Inflation shocks had the expected effect of reducing real M2 money stock in the first period, thereafter the effect was ambiguous until the seventh period. Thereafter, the response of M2 was unambiguously positive. However, at period 16, the cumulative effect of inflation on M2 was negative (Figure 4.6). As such, the model is able to discern the negative effects of inflation on M2 money stock. Accordingly, as expected, monetary authorities are likely to decrease the growth of the stock of money for fears of higher levels of inflation.

After a shock in inflation, U.S. GDP and employment responded negatively at all periods; the lowest responses occurred at the fourth and seventh period, respectively (Figure 4.7). The

bilateral real exchange rate declined, the effect was unambiguously negative from the first to the seventh period. Furthermore, inflation shocks are likely to produce favorable conditions for the U.S. trade balance with Mexico, since the response was unambiguously positive until the fifth period from the initial shock. Thus, as expected, inflation depreciates the dollar and appreciates the Mexican Peso; which in turn may have positive effects on U.S. exports, ceteris paribus.

The effects of inflation on interest rates are dissimilar to previously described responses. In the first period, the interest rate on treasuries decreased to the lowest point; from there, it increased so much that the response of yields was positive in the second period. The interest rate responses remained unequivocally positive until the fifteenth period from the inflation shock. Nonetheless, the cumulative response of interest rate was negative until the fifteenth period. As inflation rises, U.S. government debt tended to decreased temporarily (Figure 4.7) in the second period, and then it increased, the effects were unambiguously positive from the fifth period until the thirteenth period from the original shock. Consequently, inflation shocks are likely to reduce yields on Treasuries; in turn, as new debt offerings increase, yields will tend to increase too. But, due to inflation, yields will still remain at lower real levels.

A shock to M2 increased U.S. GDP from the first period until the sixteenth period from the original shock; the effect peaked in the seventh period (Figure 4.8). Employment also increased due to an M2 shock, but, the effects were ambiguous between the first and fifth periods, thereafter the effects were unequivocally positive until the sixteenth period. As such, it seems that actions from the Federal Reserve not only are likely to promote economic growth but also stimulate the economic conditions for greater employment in the U.S. economy.

The bilateral real exchange rate tended to increase from the second period until the sixth period from the M2 money stock shock (Figure 4.8); the effect corresponds to a real depreciation of the Peso or appreciation of the U.S. dollar. An M2 shock tends to produce a trade deficit with Mexico, the responses of the trade balance were negative even at the ninth period; the lowest response occurred in the third period. As such, it seems that an increase in M2 will spur growth in the exports sector of the Mexican economy, ceteris paribus. However, an M2 shock was detrimental to Mexican GDP, as it can be seen in Figure 4.8, the responses were negative until the fifth period from the shock.

Finally, M2 shocks were associated with higher yields on treasuries and higher levels of debt. The interest rate on treasuries increased significantly in the second and third periods, thereafter, the effects were unambiguously negative between the eight and sixteenth periods. However, the cumulative effects were positive by the end of the eighth period. Similar responses were obtained on debt accumulation by the M2 money stock shock; U.S. government debt increased after the shock for only a period; thereafter the responses were negative between the sixth and the sixteenth periods. In spite of that, the cumulative effects were positive by the end of the seventh period. By way of comparison, M2 and government debt shocks seem to produce symmetrical responses in each other; in Figure 4.3 can be seen that a U.S. government debt shock increased M2 in the first period and declining responses followed.

A shock in interest rate produced a negative and transitory response of government debt, since the effect was discernible from zero only in the first period after the shock (Figure 4.9). The response of M2 was dissimilar to the response of government debt. M2 declined in the first and second period, thereafter, it increased permanently until the sixteenth period. In contrast,

inflation and U.S. GDP increased only in the first period; afterwards, the effects of rising interest rates vanished.

Curiously, the shock on interest rate did not have an effect on the bilateral real exchange rate; however, the U.S. trade balance with Mexico worsened while Mexican GDP increased after a shock in the interest rate. This result could be explained by assuming a possible rise in capital investments in Mexico that have positive effects in interest rates, in turn, on Mexican GDP, ceteris paribus.

A shock to the bilateral real reach exchange rate had negative effects on the U.S. trade balance with Mexico, as it declined immediately; the responses remained negative until the ninth period, although they rise up from the lowest point in the first period (Figure 4.10). Both, U.S. GDP and Mexican GDP declined after a shock in the exchange rate; however, the effect lasted only for three and six periods, respectively. As expected, the appreciation of the currency had adverse effects on the labor market, as employment declined temporarily for about three periods after a shock in the bilateral reach exchange rate.

A shock to Mexican GDP resulted in rising inflation in the United States (Figure 4.12), the responses were positive until the sixth period. However, U.S. GDP declined from the third period until the sixteenth period after the initial shock to U.S. government debt. These results suggest that there are asymmetrical responses of GDP due to GDP growth in both economies. Moreover, U.S. trade balance with Mexico decreases after a shock in Mexican GDP, but, such effects are not negligible only after the tenth period until the sixteenth period.

Furthermore, a Mexican GDP shock had negative effects on M2 money stock; up until the fourth period from the shock the effect was negative, then M2 rise-up until the sixteenth period.

However, the cumulative effect at the eleventh period after the shock was unambiguously negative. This result suggest that as monetary authorities realized that there is economic growth in other nations, since such demand pressure is likely to have an inflationary impact at home; then, M2 money stock is likely to be reduced to contain imported inflation at acceptable levels, ceteris paribus.

The reaction of the interest rate to a Mexican GDP shock is similar to that of M2 (Figure 4.12), in that there was an initial decline for three periods, then interest rates rise-up until a higher level was reached. The responses of interest rates were unmistakably positive from the sixth to the sixteenth period; however, the cumulative responses were negative until the eighth period; and by the end of the sixteenth period, the cumulative response was unambiguously positive.

A possible explanation for these results lies on diversification of portfolios, as the Mexican economy expands, investors are likely to diversify their investments. As such, more investors increase their holdings of U.S. Treasuries, prices increase and yields decrease. Then, as the Mexican economy expands, the interest rate is likely to increase as more capital investments are needed; and once investors realized this new information—then, a sell-off of treasuries is likely to occur. Consequently, yields are likely to increase over a longer period of time to an unexpected change in Mexican GDP.
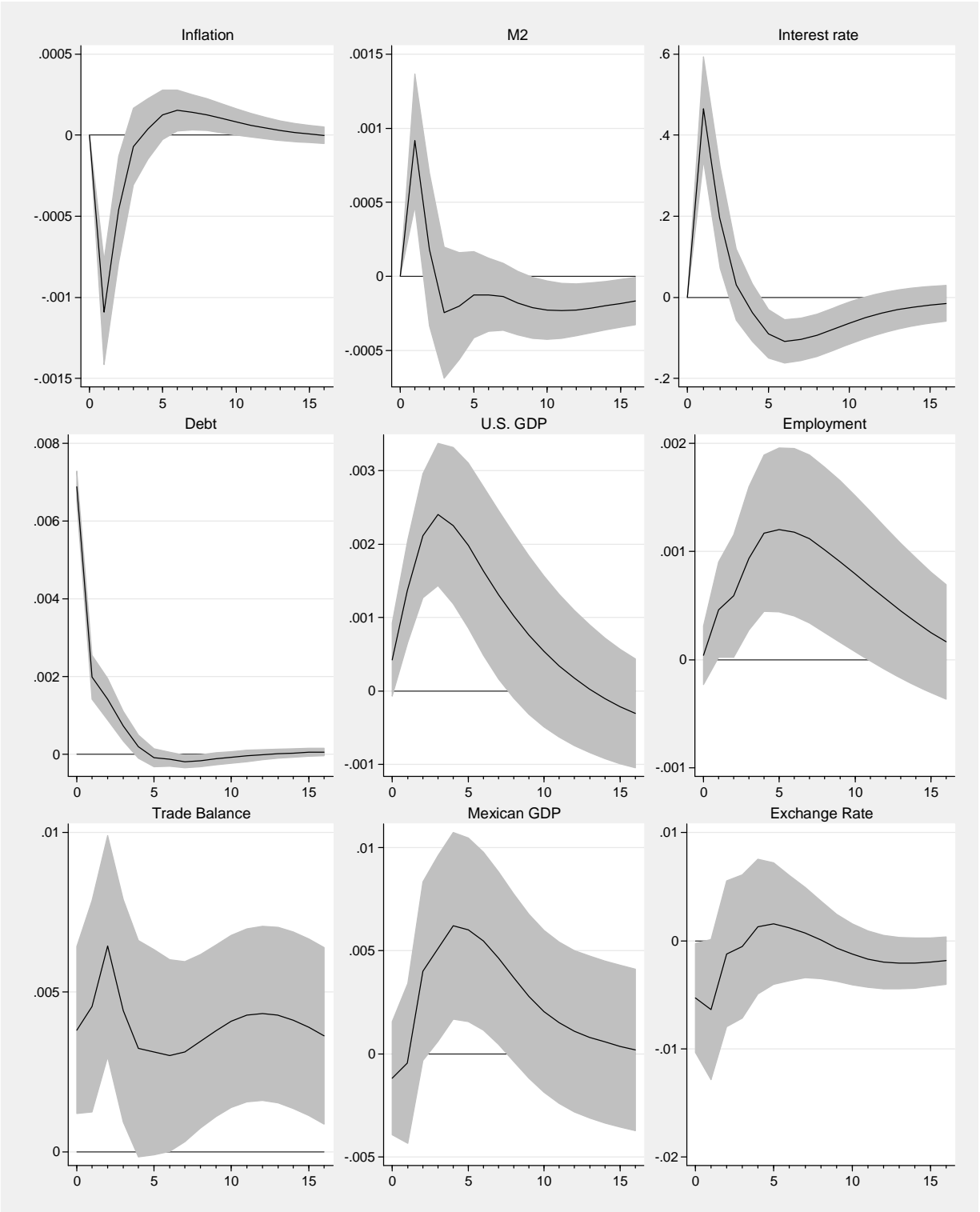
Figure 4.3 Orthogonalized impulse responses to government debt shocks.
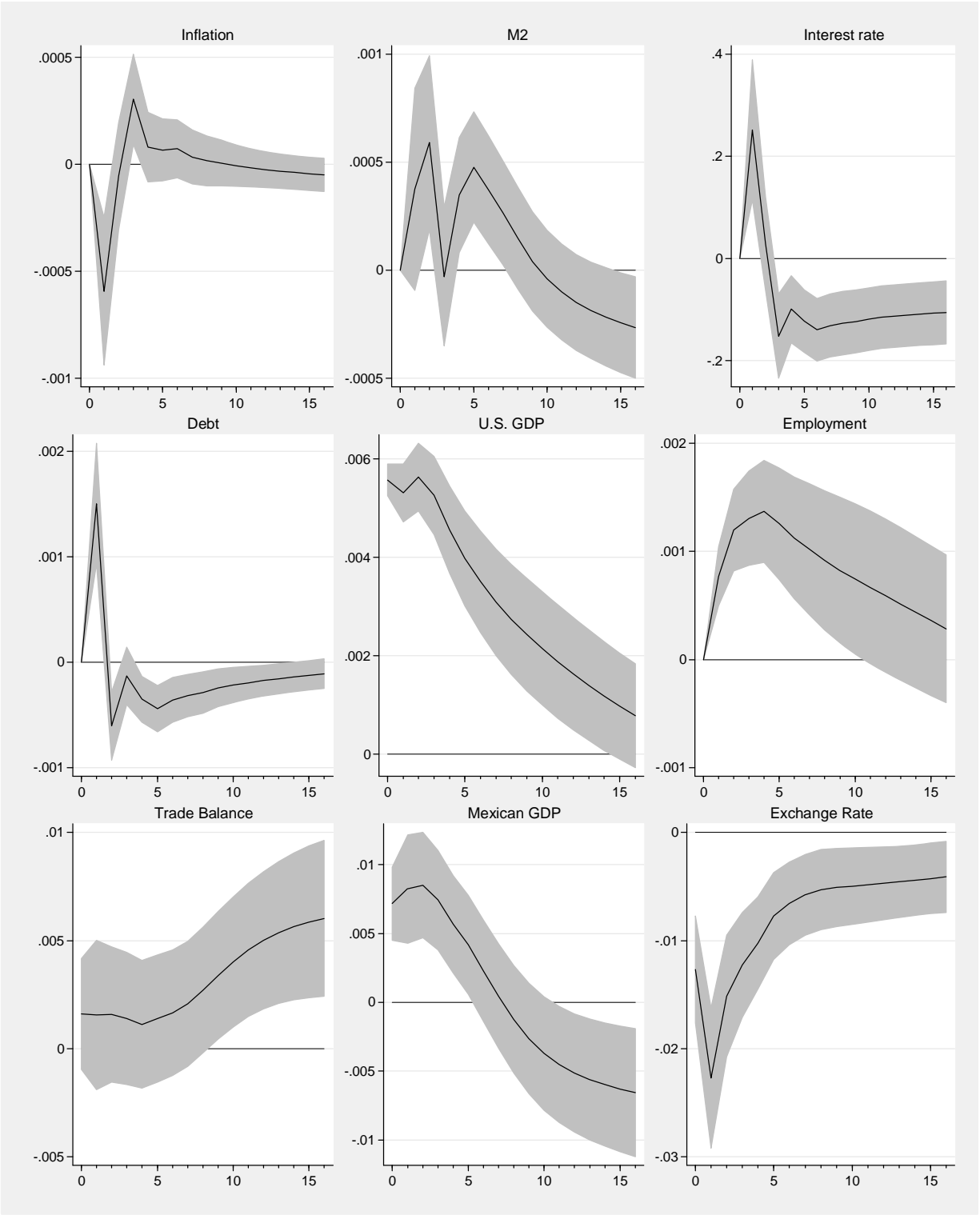
Figure 4.4 Orthogonalized impulse responses to U.S. GDP shocks.
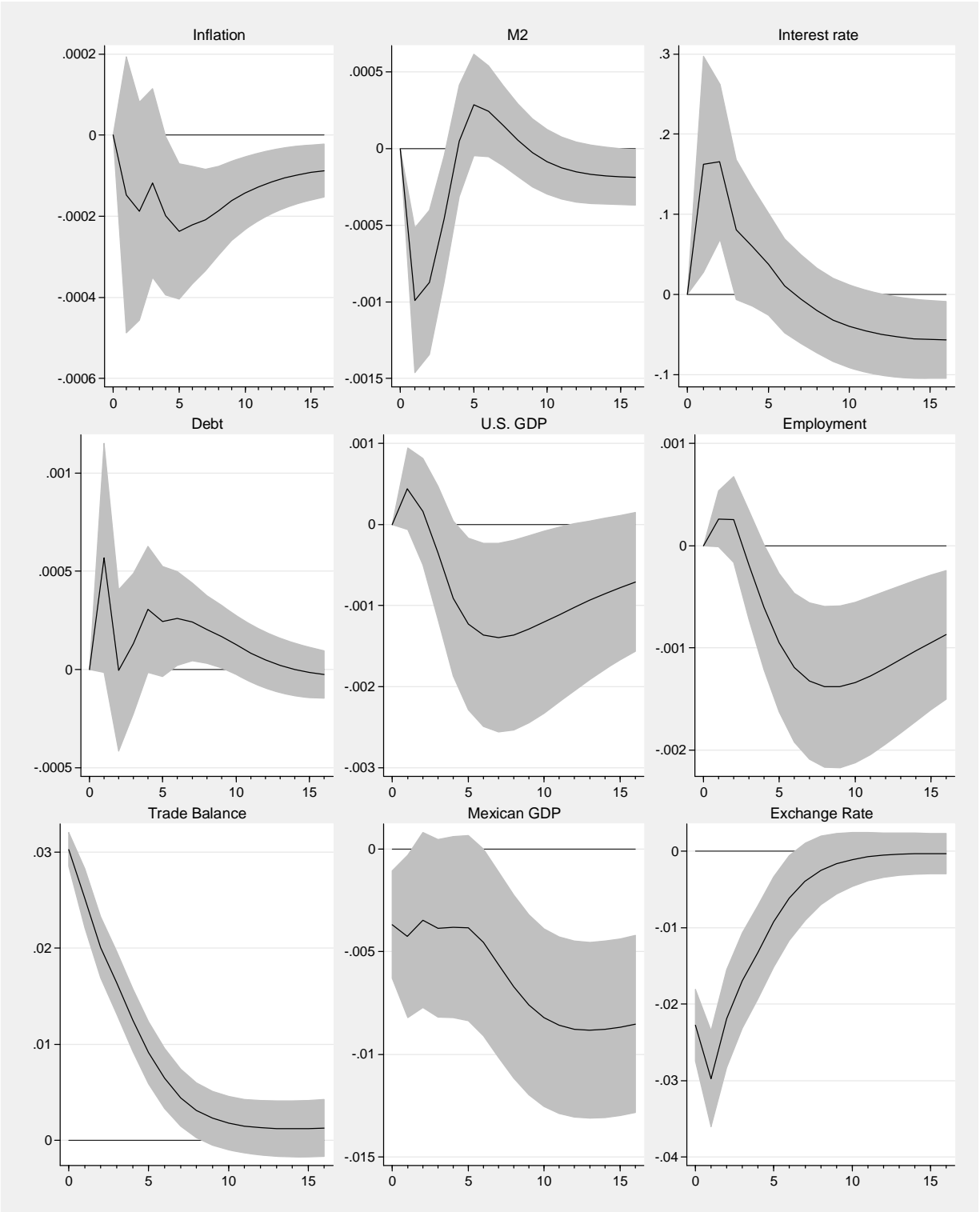
Figure 4.5 Orthogonalized impulse responses to trade balance shocks.
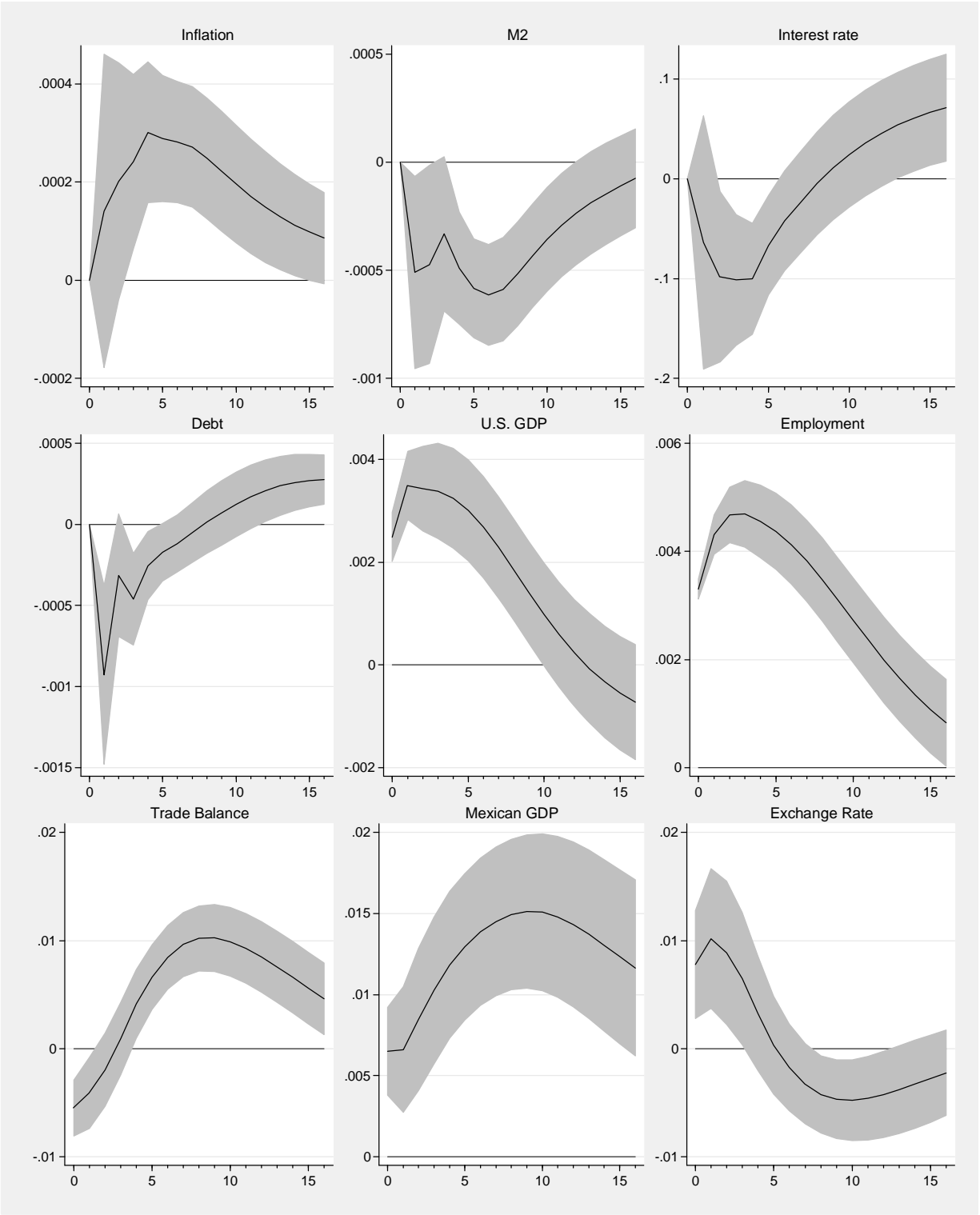
Figure 4.6 Orthogonalized impulse responses to employment shocks.
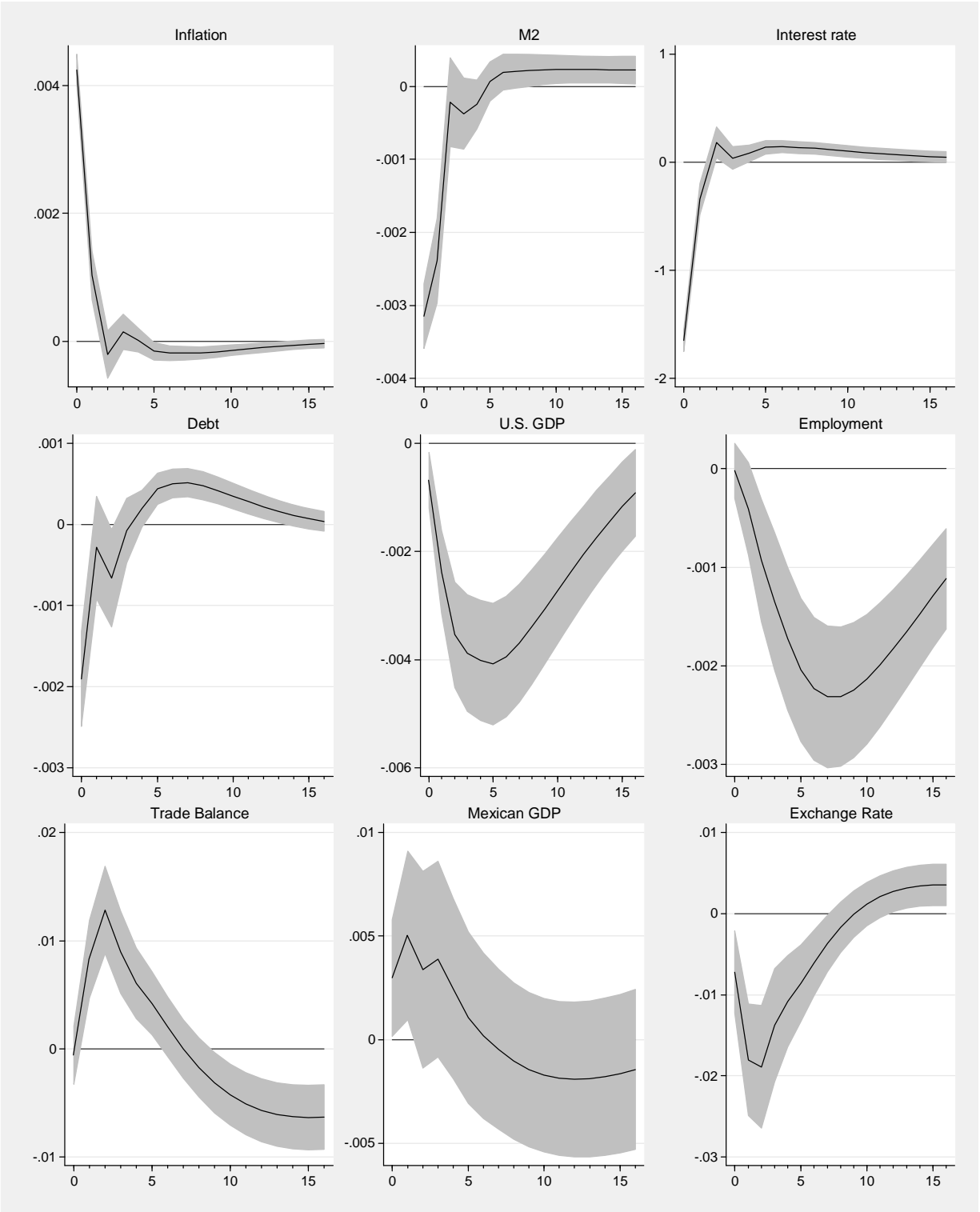
Figure 4.7 Orthogonalized impulse responses to inflation shocks.
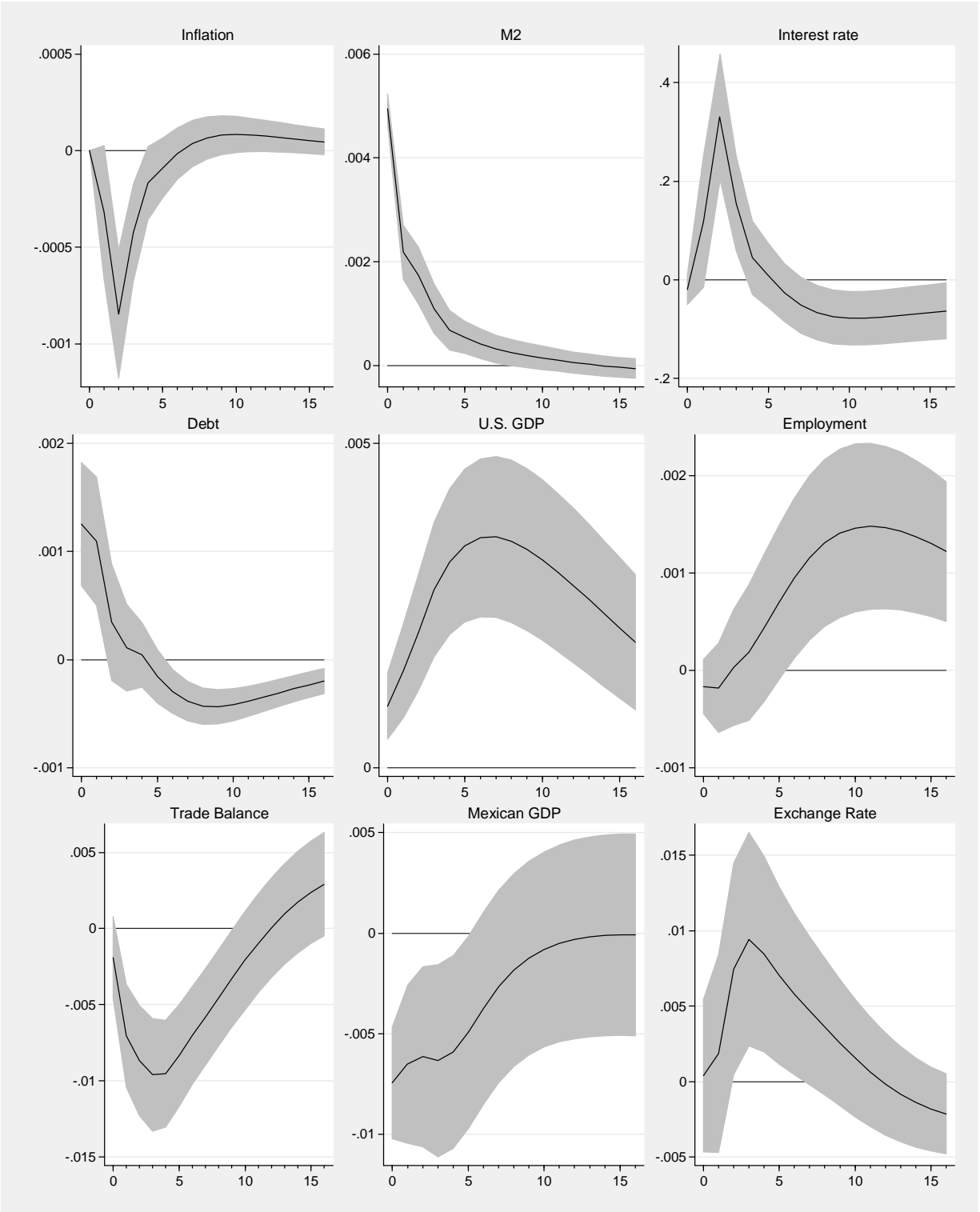
Figure 4.8 Orthogonalized impulse responses to M2 shocks.
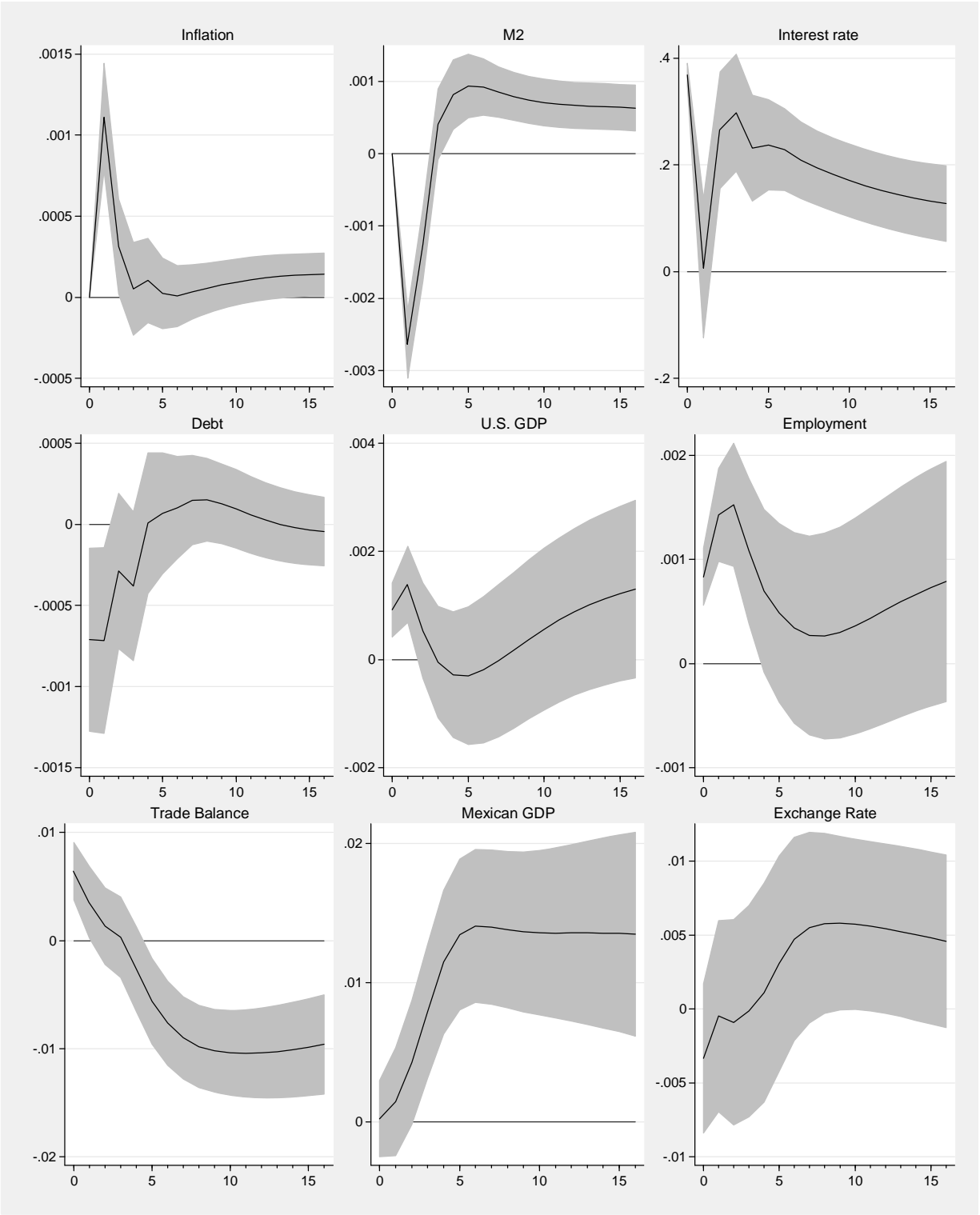
Figure 4.9 Orthogonalized impulse responses to interest rate shocks.
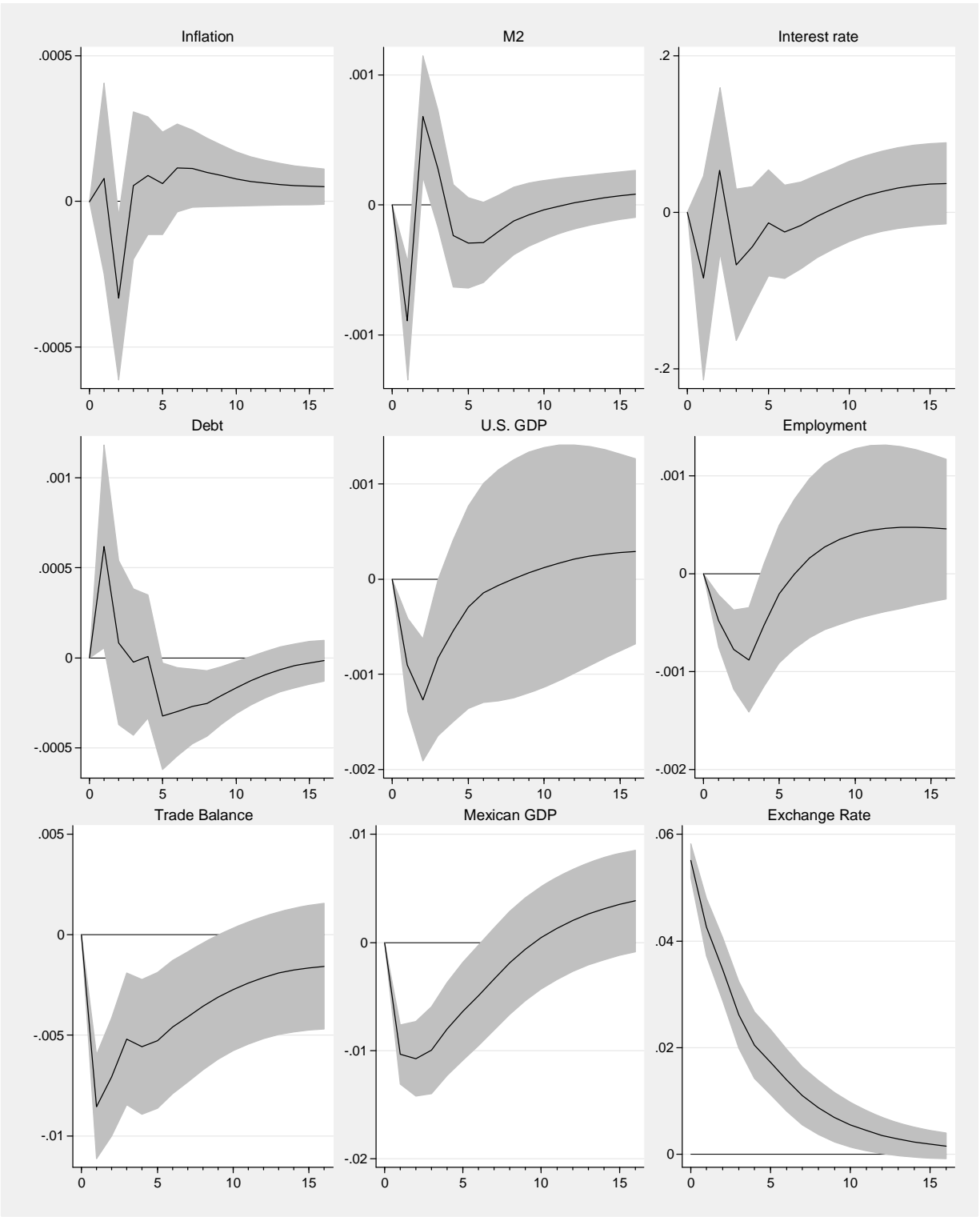
Figure 4.10 Orthogonalized impulse responses to bilateral real exchange rate shocks.
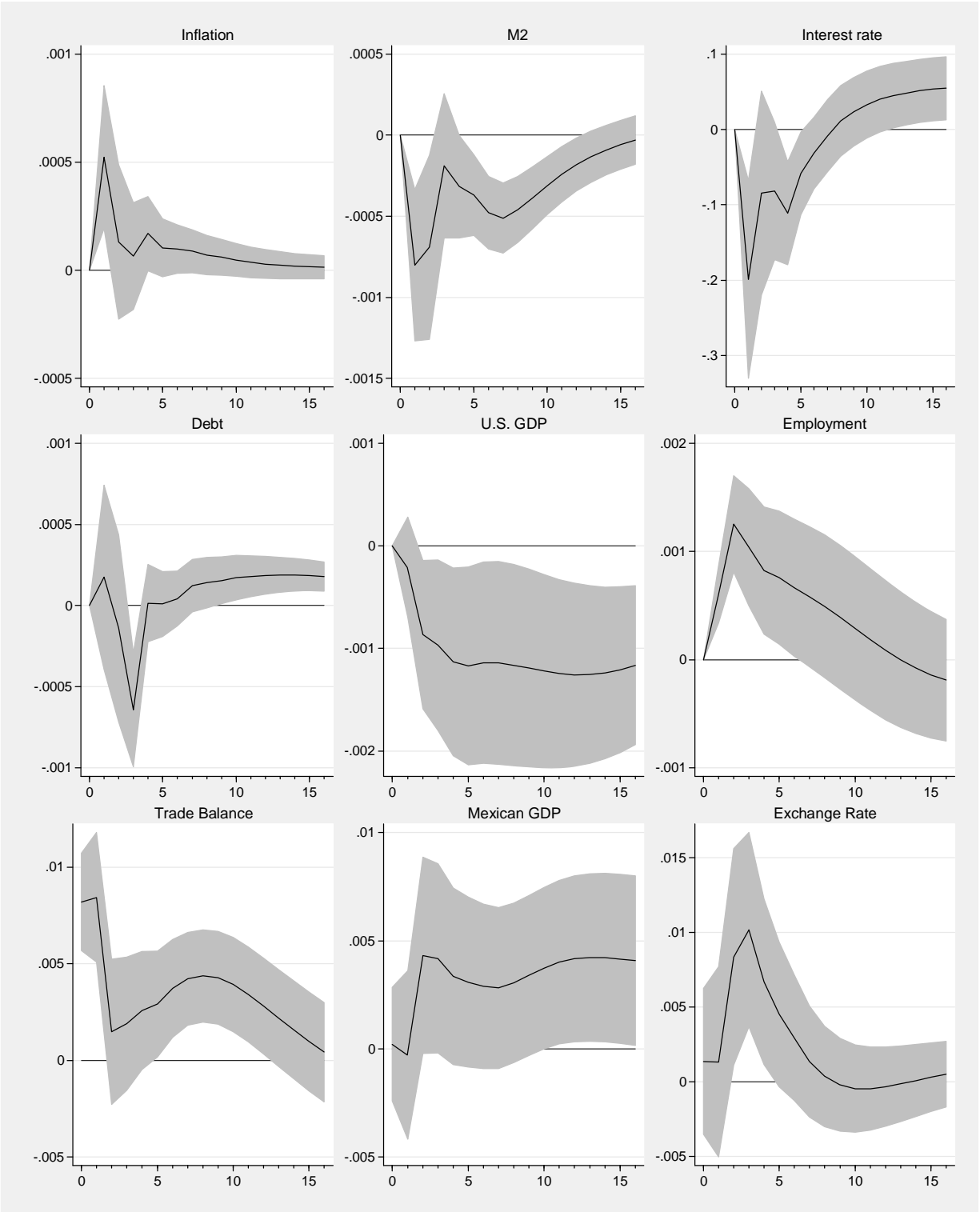
Figure 4.11 Orthogonalized impulse responses to adjusted U.S. exports shocks.
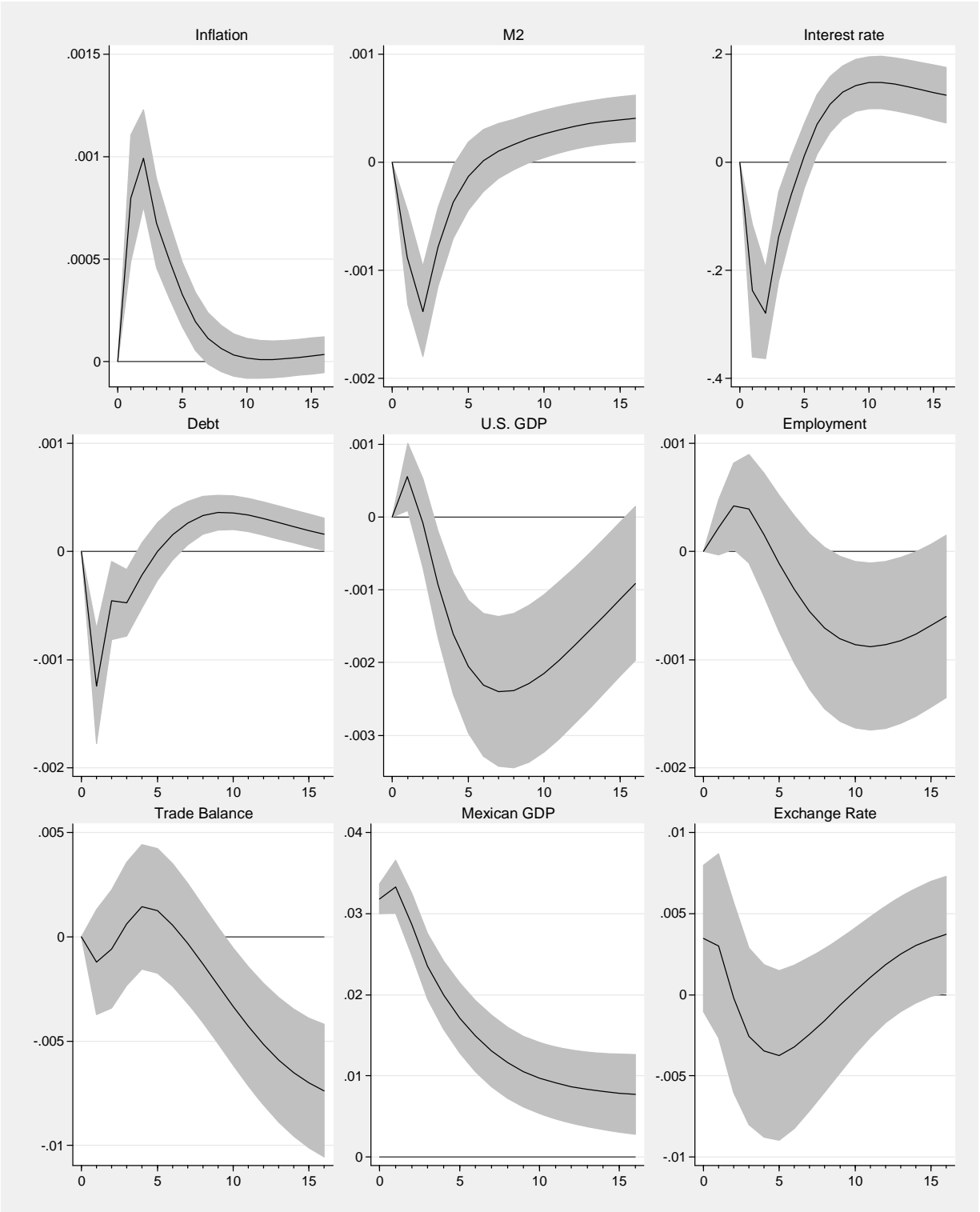
Figure 4.12 Orthogonalized impulse responses to Mexican GDP shocks.

Trade Weighted Exchange Rate Index of Major Currencies

In substitution for the bilateral real exchange rate, an additional VAR model was estimated to evaluate the effects of the trade weighted exchange rate index of major currencies. Such index, measures the relative value of the U.S. dollar against the currencies of the Euro Area, Canada, Japan, United Kingdom, Switzerland, Australia, and Sweden. The index uses 1973 prices as the benchmark for comparisons across years, the data was obtained from the Federal Reserve Bank of St. Louis; an appreciation (depreciation) of the U.S. dollar is denoted by an increase (decline) of the index. Additional results are included in appendix V.

The orthogonalized impulse responses to trade weighted exchange rate index of major currencies shocks show that employment, the U.S. trade balance with Mexico, and Mexican GDP responded similarly to bilateral real exchange rate shocks (Figure 4.13). However, the decline in employment lasted for eight periods from the initial shock. In contrast, Mexican GDP declined from the third period onwards. In contrast, the trade balance responded negatively and significantly only from the sixth to the eleventh period, whereas the response lasted for nine consecutive periods when currency shocks were represented by the bilateral real exchange rate.

The trade weighted exchange rate index of major currencies responded negatively to U.S. government shocks whereas the bilateral real exchange rate was unaffected (Figure 4.14); the effect was distinguishable from zero from the second period. An interest rate shock permanently affected the values of the trade weighted exchange rate index. Moreover, an inflation shock depreciated the currency for about four periods whereas an M2 money stock shock appreciated the currency consistently after the second period. Furthermore, the currency tended to appreciate after a shock on employment and the trade balance. However, a shock to exports to the rest of the world had an immediate depreciating effect, thereafter the currency tended to appreciate.

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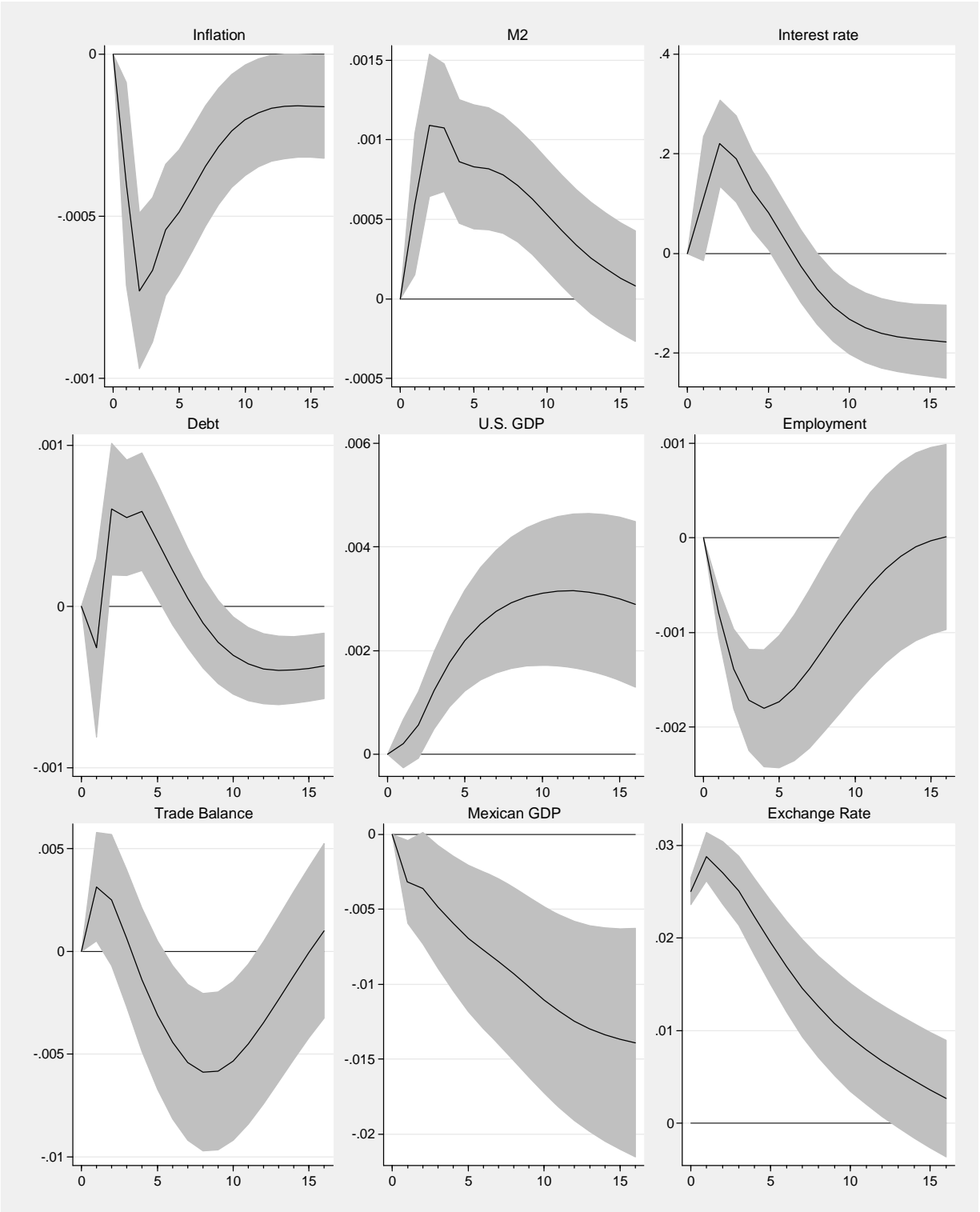
Figure 4.13 Orthogonalized impulse responses to exchange rate index shocks.
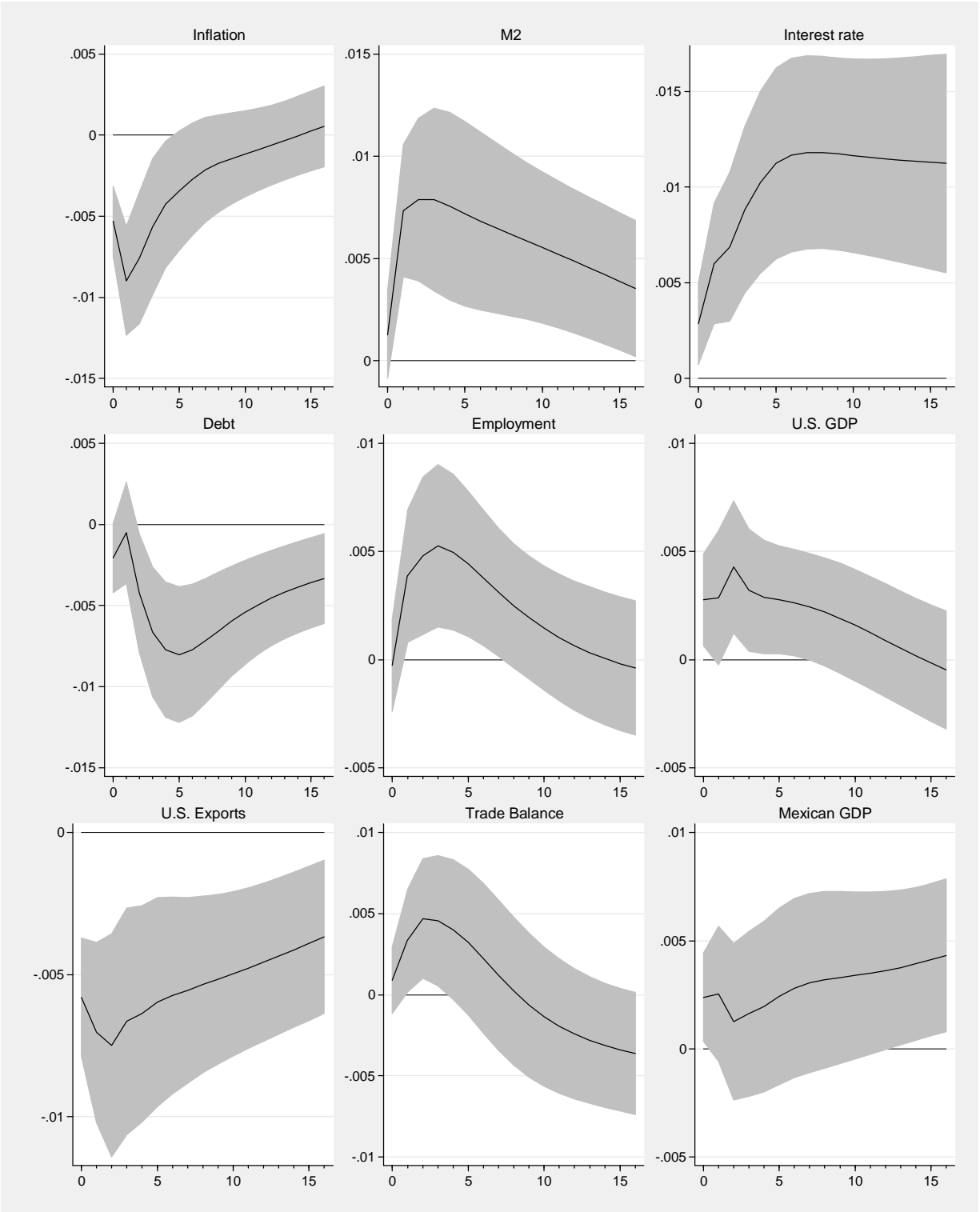
Figure 4.14 Orthogonalized impulse responses of the exchange rate.

Discussion and Concluding Remarks

The United States and Mexico have a long tradition of economic cooperation; especially, in the trading sectors as more exports and imports are exchanged after the signing of the North American Free Trade Agreement. Thus, the economic conditions of the U.S. are likely to be transmitted to Mexico not only through trade but also through financial conditions. As pointed out by Dooley and Hutchison (2009), the Mexican financial markets are strongly integrated with those of the U.S. as suggested by the reaction of Mexican equity prices to U.S. equity prices.

This dissertation research article evaluated the effects of U.S. government debt accumulation in the Mexican economy, mainly the trade balance between these countries and GDP, controlling for financial conditions such as U.S. M2 money stock, yields in U.S. treasuries and the bilateral real exchange rate as well as U.S. GDP, employment, and the trade weighted exchange rate index of major currencies.. VAR models were estimated following the modeling approach of Arin and Koray (2009), then, orthogonalized impulse responses were estimated for analysis.

After a shock in U.S. government debt, the GDP of Mexico tended to increase but such responses were distinguishable from zero from the third to the seventh period from the initial shock. Consequently, U.S. accumulation of government debt tends to stimulate the Mexican economy as well; however, such effects are not only delayed but it lasts for only a few periods. This empirical evidence provides strong support to the previously formulated hypothesis that *U.S. government debt influences the Mexican economy through trade; if there is an increase in the stock of debt—as GDP and employment increase, and the Peso depreciates—then, Mexican GDP will grow since U.S. imports from Mexico will increase*. The results in this dissertation contrast those of Arin and Koray (2009) who found that increasing U.S. government expenditures had negative effects on real GDP of Canada.

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Although Arin and Koray (2009) evaluated the effects of shocks to U.S. government expenditures and U.S. tax revenues in Canadian GDP, it is noteworthy to point out that expenditures had a persistent negative effect on Canadian GDP whereas U.S. tax shocks did not produce a significant effect. Hence, the effects of U.S. fiscal policy to neighboring countries are essentially different. Nevertheless, we need to keep in mind that the specification of the VAR models are different; for instance, Arin and Koray (2009) did not control for either U.S. M2 money stock, employment and the U.S. trade balance with Canada.

The Mexican economy responded positively to increasing U.S. GDP and employment, and U.S. trade deficits with Mexico. For instance, a shock to U.S. GDP produced an increase in the GDP of Mexico, and the cumulative effect was distinguishable from zero until the tenth period from the initial shock; this result is in accordance with the findings of Blecker (2009).

The effects of U.S. government debt accumulation on the bilateral real exchange rate was basically null, while Arin and Koray (2009) found that the bilateral real exchange rate between the U.S. and Canada declined significantly only after the ninth period from the initial shock to U.S. government expenditures. Furthermore, the trade weighted exchange rate index of major currencies declined after a shock in U.S. government debt; the effect was distinguishable from zero after the second period and remained negative until the sixteenth period.

Therefore, government debt shocks produced divergent responses of the bilateral real exchange rate and the trade weighted exchange rate index of major currencies, the difference may be due to the measurements themselves, since the former rate only takes into consideration the inflation from the United States and Mexico whereas the later rate indexes the value of the U.S. dollar to a basket of currencies from six trading partners and the Euro area.

As the United States and Mexico look forward for stronger integration of their economies, it is of paramount importance to recognize how the effects of U.S. fiscal policies are transmitted into Mexico. Based on data in the 1973-2010 period, it is found that debt accumulation by the U.S. government have positive effects on U.S. GDP, the U.S. trade balance with Mexico and U.S. employment. In turn, they have stronger and positive effects on Mexican GDP.

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CHAPTER 5.   SUMMARY AND CONCLUSIONS

The United States of America is an indebted nation in the early years of the new millennium; after the last recession in 2008, the growth rate of GDP is at lower levels even after banks were bailout and new spending bills were enacted such as the Emergency Economic Stabilization Act of 2008, the Economic Stimulus Package in 2008, and the American Recovery and Reinvestment Act of 2009. Tax cuts and new spending are justified on helping to save the economy, to create new jobs, or to increase benefits to society through mandatory and discretionary spending without specifying sustainable sources of revenue simultaneously.

Inevitably, in the last four decades, high accumulation of federal U.S. government debt has occurred during fiscal expansions that have originated from either military buildups or recessionary periods; changing from $469 billion in 1973 to $14 trillion in 2010. Despite the benefits of debt, high accumulation affects liquidity in the financial system, and nations may collapse in the worst case-scenarios. Then, troubled economies are left with higher inflation and unemployment rate, lower investment rate and underlying value of their currencies, and most appallingly—higher interest rate in new debt issues. These economic conditions make the recovery more costly; and politically, austerity measures may generate social upheavals.

Therefore, the economic effects of national debt accumulation by the U.S. government are studied in three empirical research articles developed in this dissertation. The first article, corresponding to the second chapter, deals with the effects of debt in the labor market; in particular, the responses of employment and the unemployment rate are studied. The second article, equivalent to the third chapter, focuses on understanding the effects of debt on exports growth and economic growth; moreover, Granger causality tests were conducted to validate the exports lead growth hypothesis. Finally, the third article corresponding to the fourth chapter, the

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analysis concentrates on the international transmission of U.S. government debt shocks into the Mexican economy; but, emphasis was given to the trade channel.

Due to high openness and integration of the U.S. economy in terms of trade and international financial markets, the analysis included the exchange rate. The measure of the underlying value of the currency was the trade weighted exchange rate index of major currencies; moreover, the third article also analyzed the bilateral exchange rate between U.S. and Mexico. The sample period of the study corresponded to the post Bretton Woods System of monetary management among industrialized nations (1973:1-2010:3), far beyond the initial shock in 1971 for eliminating noise that appeared from newly adopted policies for currency exchange, financial liberalization and policies that have promoted freer trade and more economic cooperation.

In the first article, second chapter, a VEC model was estimated to study the effects of government debt on employed labor. A long-run-stable relation was found between employment, GDP, interest rate, exchange rate and government debt. The long run effects of government debt in the level of employment were positive and smaller in comparison with the effects of interest rate, exchange rate and GDP; the estimated long-run debt elasticity of labor demand was 0.03 whereas the long-run GDP elasticity of labor demand was 0.88.

The second analysis in this chapter studied the effects of government debt in the unemployment rate by estimating a VAR model. From the impulse response analysis, it is found that the unemployment rate decreased until the fourth period after a government debt shock, and the effect remained negative until the tenth period from the initial shock. However, an unemployment rate shock produced a hump shaped impulse response of government debt; the immediate expansion lasted for about nine periods. Furthermore, the two-stage response of the

exchange rate to a debt shock started with a short-lived appreciation period followed by a more lasting period of currency depreciation. All in all, this empirical evidence supported the hypothesis that *U.S. government debt changes the foreign exchange value of the dollar, which leads to price fluctuations of output and labor; if there is an increase in the stock of debt, then, as the currency depreciates—more labor is likely to be employed.*

The second article, third chapter, aimed to unfold the effects of U.S. government debt accumulation on exports growth and GDP growth by estimating a VAR model that helped to perform Granger-causality tests as well as the evaluation of orthogonalized impulse responses. The findings indicate that exports Granger-caused the growth of GDP but the reverse relationship was not statistically significant. Moreover, based on Granger-causality tests, government debt accumulation and exports growth seemingly appeared as if they were not related.

However, after a government debt shock, exports tended to decrease; from the third period, exports increased until the ninth period, thereafter the effect was not distinguishable. Moreover, the hump-shaped response of exports may be attributed to the initial appreciation and lasting depreciation of the exchange rate after the initial shock, *ceteris paribus*. This empirical evidence supported the hypothesis that *U.S. government debt changes the foreign exchange value of the dollar; if there is an increase in the stock of debt—as the currency depreciates, and GDP and employment increase—then, the exports component of GDP is likely to increase.*

Finally, the third article—corresponding to the fourth chapter, assessed the economic effects of U.S. government debt accumulation in the Mexican economy, mainly through the trade balance between these countries. Two measures for the foreign exchange value of the U.S. dollar were

analyzed in VAR models, the bilateral real exchange rate and the trade weighted exchange rate index of major currencies. A U.S. government debt shock resulted in stimulating the Mexican economy as well; GDP tended to increase, but such short-lived responses were distinguishable from zero from the third to the seventh period from the original shock.

The growth of the Mexican economy was favored by rising U.S. trade deficits with that nation. Similarly, Mexican GDP responded positively to increasing U.S. GDP and U.S. employment; the cumulative effects were distinguishable from zero until the tenth and sixteenth period, respectively. Unlike a U.S. GDP shock, U.S. employment produced a hump-shaped response on Mexican GDP that peaked in the ninth period. As such, based on this emprirical evidence, I found support for the hypothesis that *U.S. government debt influences the Mexican economy through trade; if there is an increase in the stock of debt—as GDP and employment increase, and the Peso depreciates—then, Mexican GDP will grow since U.S. imports from Mexico will increase.* Moreover, as for the response of the foreign exchange value of the dollar, accumulation of U.S. government debt had a null effect on the U.S./Mexican bilateral real exchange rate. In contrast, the trade weighted exchange rate index of major currencies declined persistently after a shock in U.S. government debt.

In conclusion, debt accumulation by the United States government has helped to either decrease or retain the unemployment rate from rising by expanding the gross domestic product and employing more labor in the economy. Moreover, government debt has supported the financing of economic growth; also, it has fostered a thriving exports sector while facilitating the formation of capital. These benefits have also being transmitted to Mexico through trade. Furthermore, expansionary fiscal policy that utilizes debt to finance spending, has a depreciating effect on the underlying value of the currency which in turn affects the prices of output and the inputs of

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production such as capital; but, if the prospects for GDP growth and employment are advantageous relative to other nations—then, the economy may experience declining interest rates that help finance the U.S. government at more favorable terms.

Given the conditions and expectations about the economy, this dissertation research project may help guide the economic rational choices carried out by economic agents such as taxpayers, businesses, policy-makers and regulators, economic and financial institutions, as well as domestic and international providers of capital. Future research endeavors in the economics of government debt accumulation may contemplate the study of the political institutions and political environment that determine its effective use; research efforts may focus not only on the underlying conditions for the creation of these institutions but also on the resulting economic policies that determine their performance as well as their cooperative interdependence.

APPENDIX I: ADDITIONAL DESCRIPTIVE STATISTICS FOR DEBT

This appendix presents additional descriptive statistics for nominal U.S. federal government debt; the variable is used throughout the dissertation. The graphs for the data correspond to the period 1973:1-2010:3—U.S. recession bars are depicted—dates came from the National Bureau of Economic Research (http://www.nber.org/cycles/cyclesmain.html).

Statistic	U.S. Federal Government Debt (1973:1-2010:3)		
	Total*	Change**	Percent Change***
Mean	4168.600	87.353	2.2579
Median	3801.700	57.674	2.2632
Minimum	457.320	-87.454	-1.5264
Maximum	13562.000	675.080	6.5206
Std. Dev.	3237.600	110.550	1.4238
C.V.	0.777	1.266	0.6306
Skewness	0.803	2.590	0.2839
Kurtosis	0.013	8.026	0.5057

*Billions **Quarter to quarter change in billions. *** Continuously compounded rate of change.

U.S. Federal Government Debt
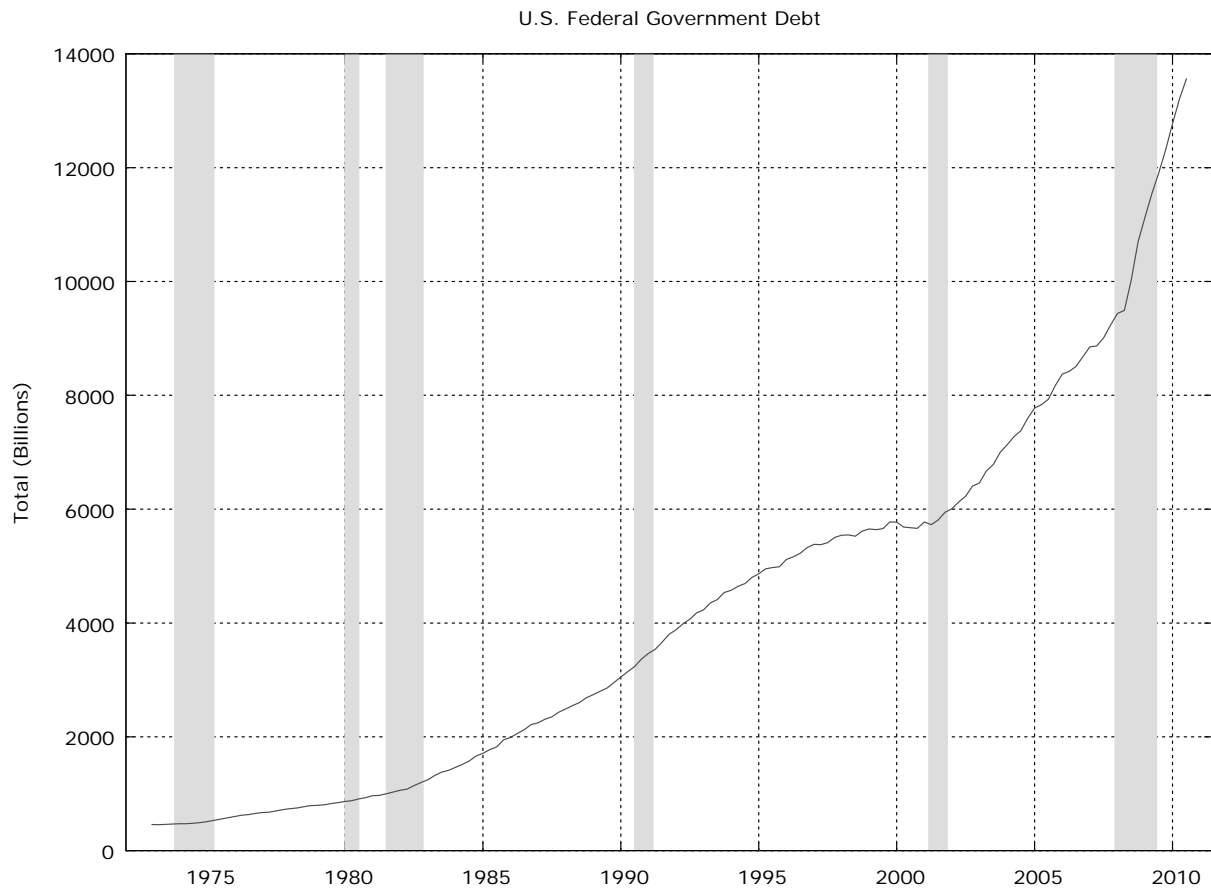
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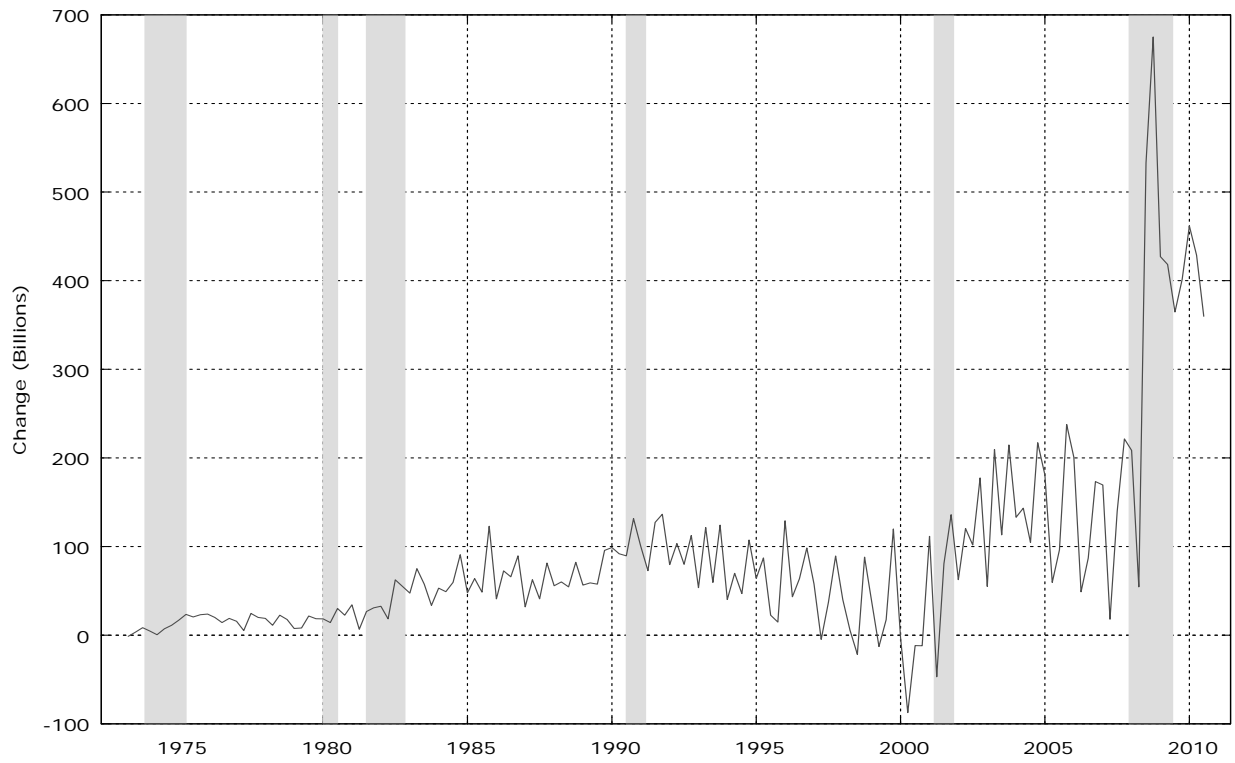
U.S. Federal Government Debt
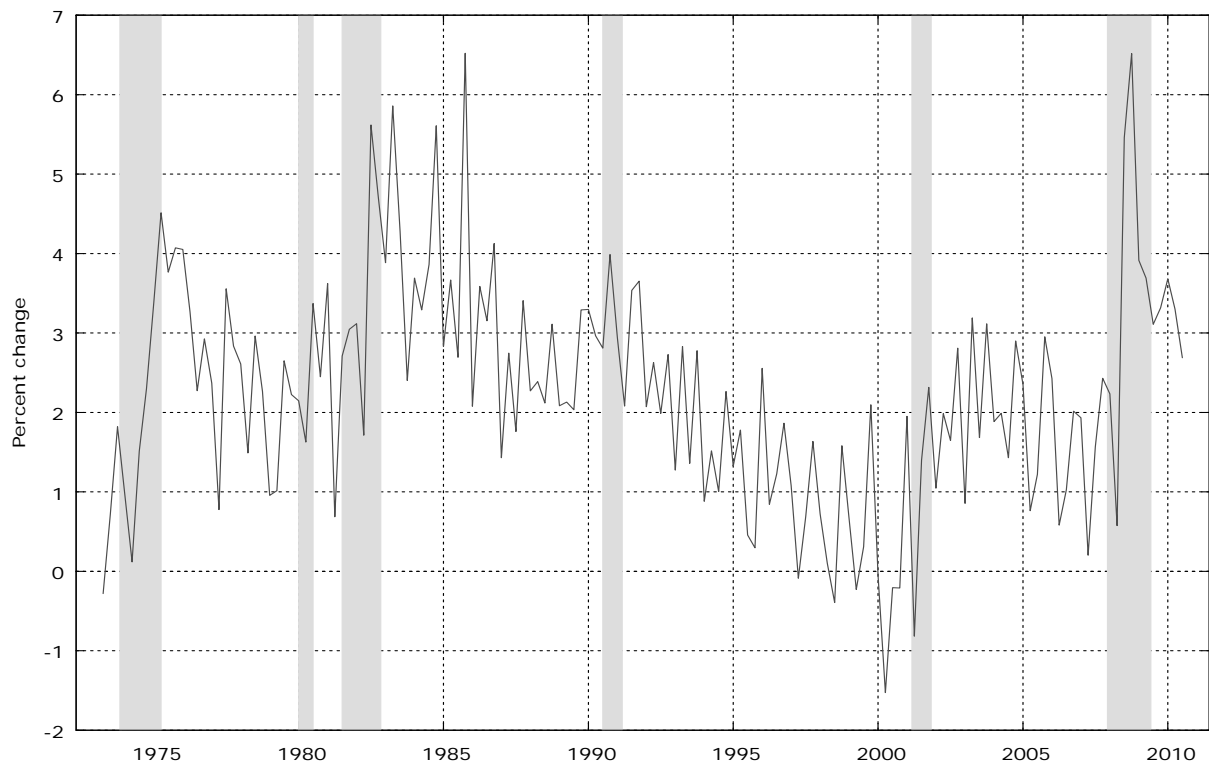
Scaled U.S. Federal Government Debt

Debt to GDP Ratio

180
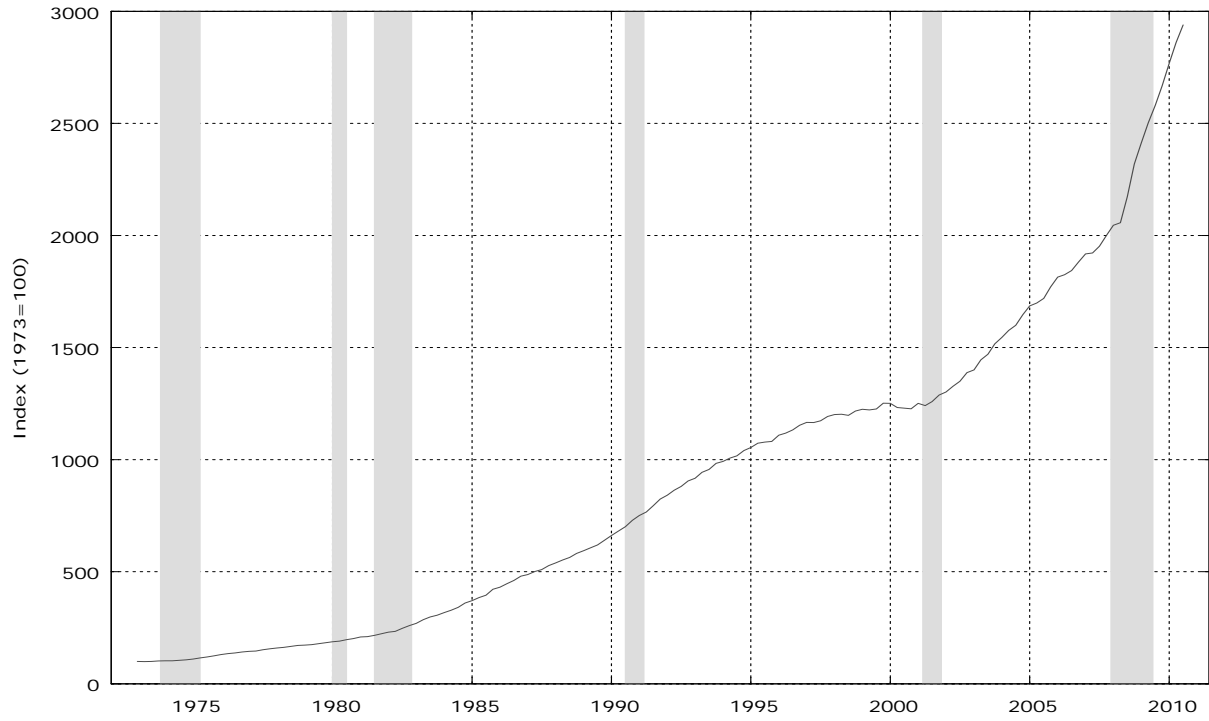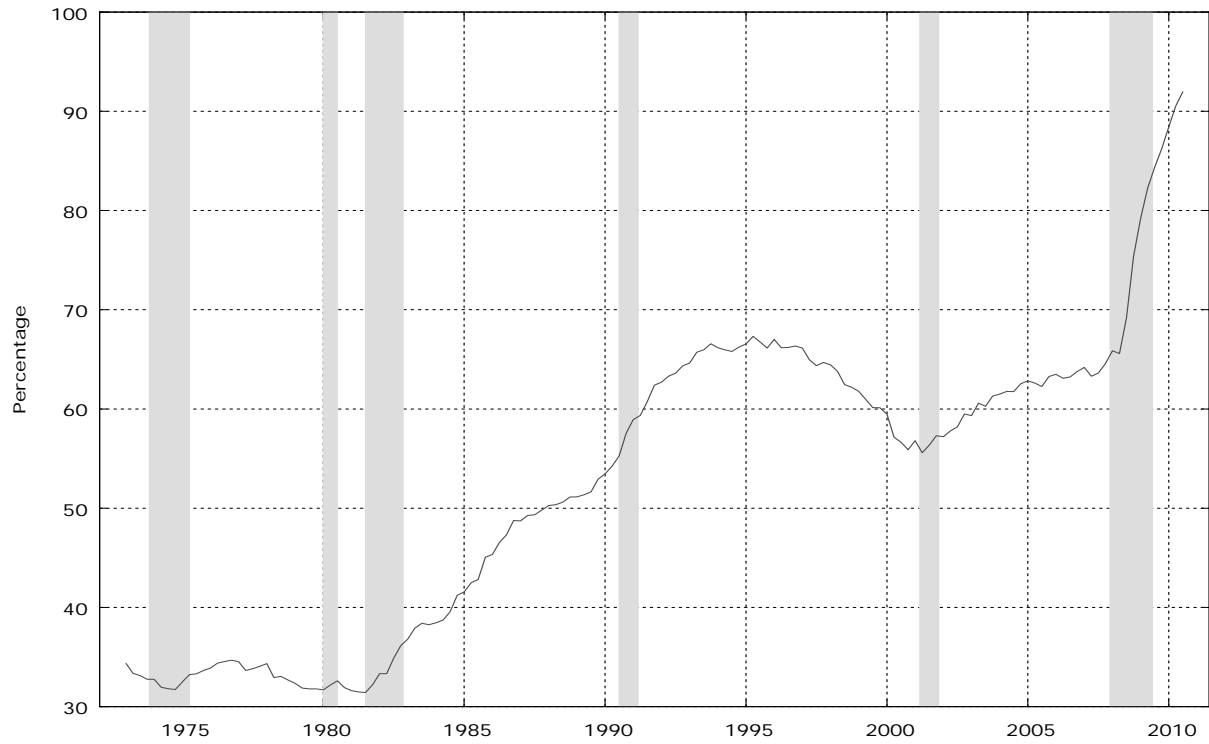
Change in the Debt/GDP Ratio
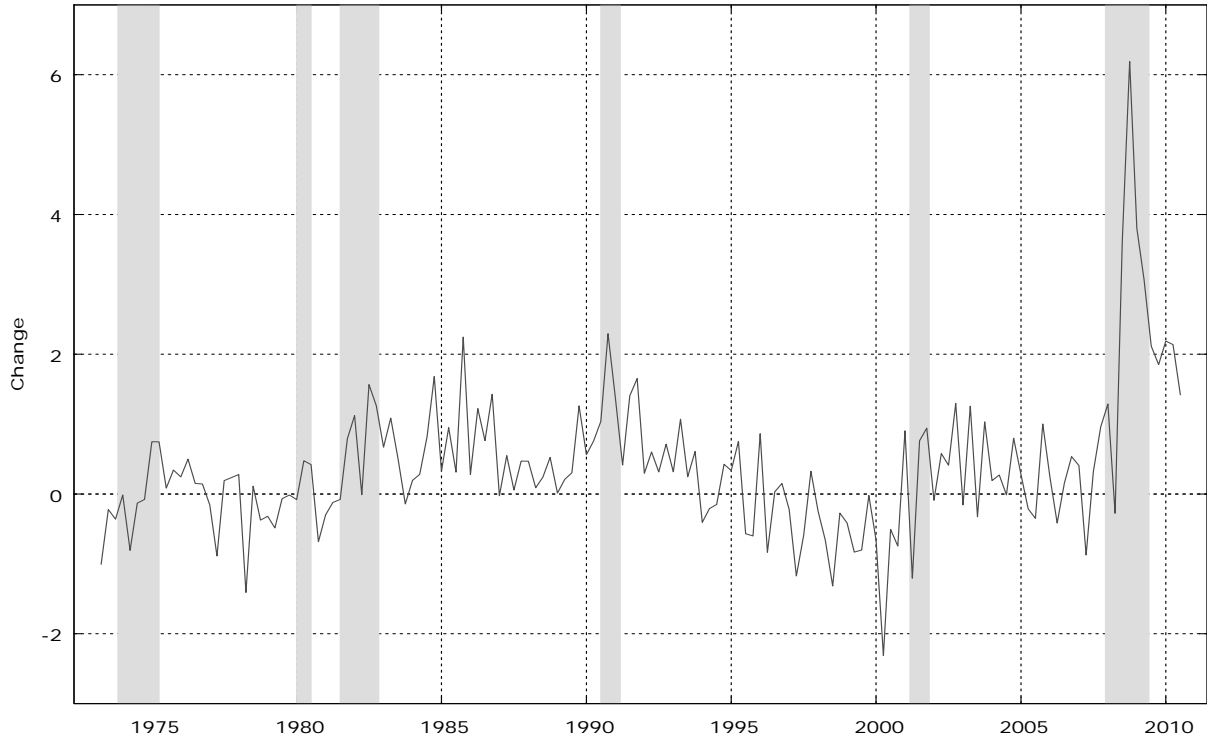
Scaled Debt/GDP Ratio

181
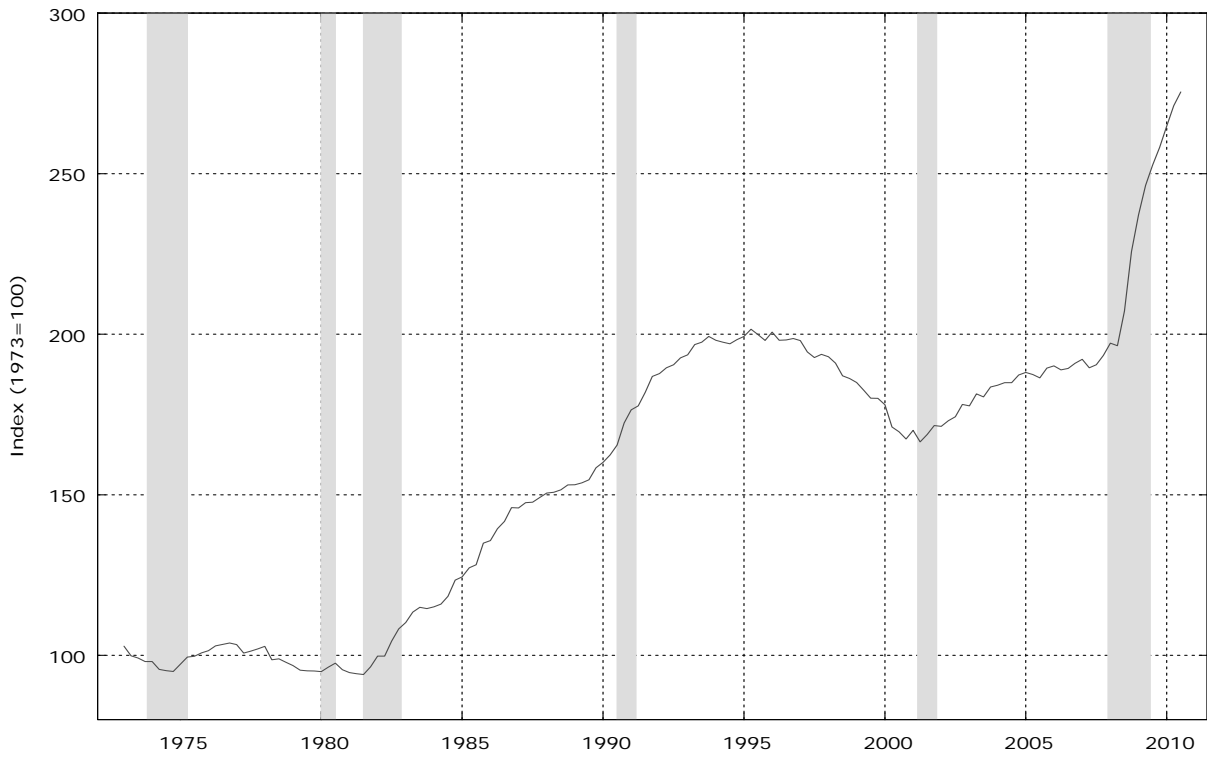
U.S. Exports to Government Debt Ratio
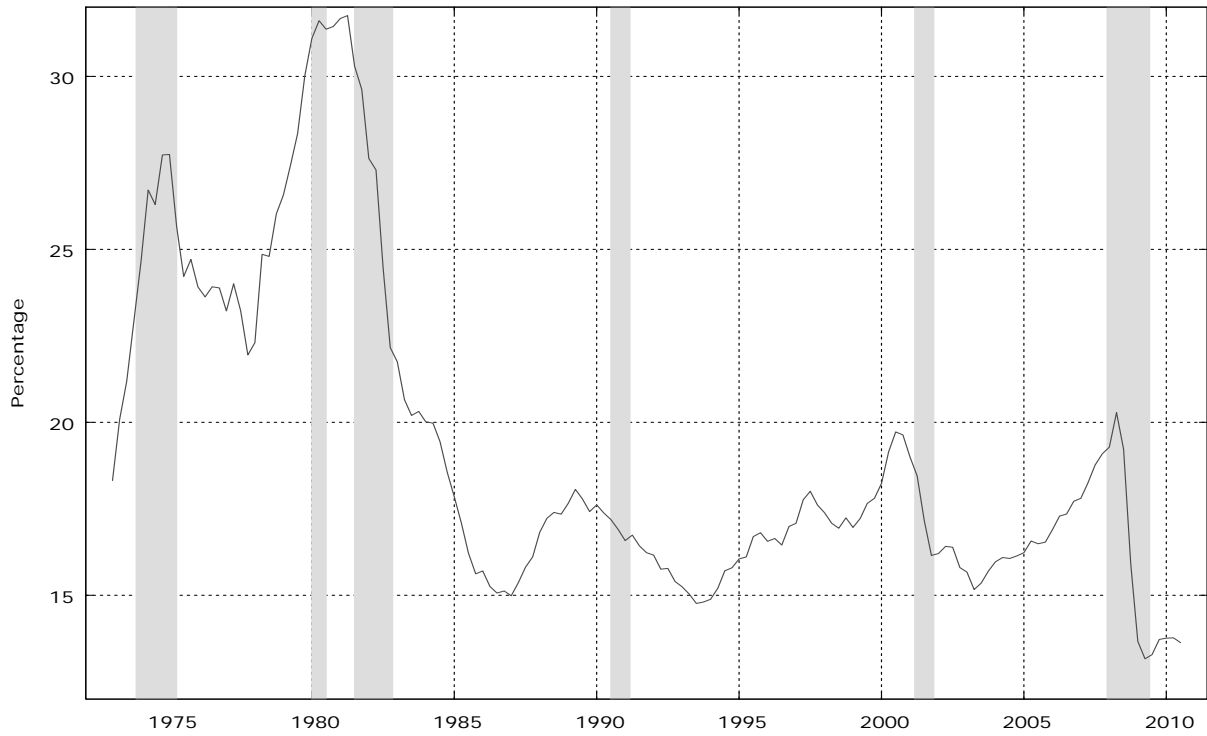
Debt and Exports in the United States

182
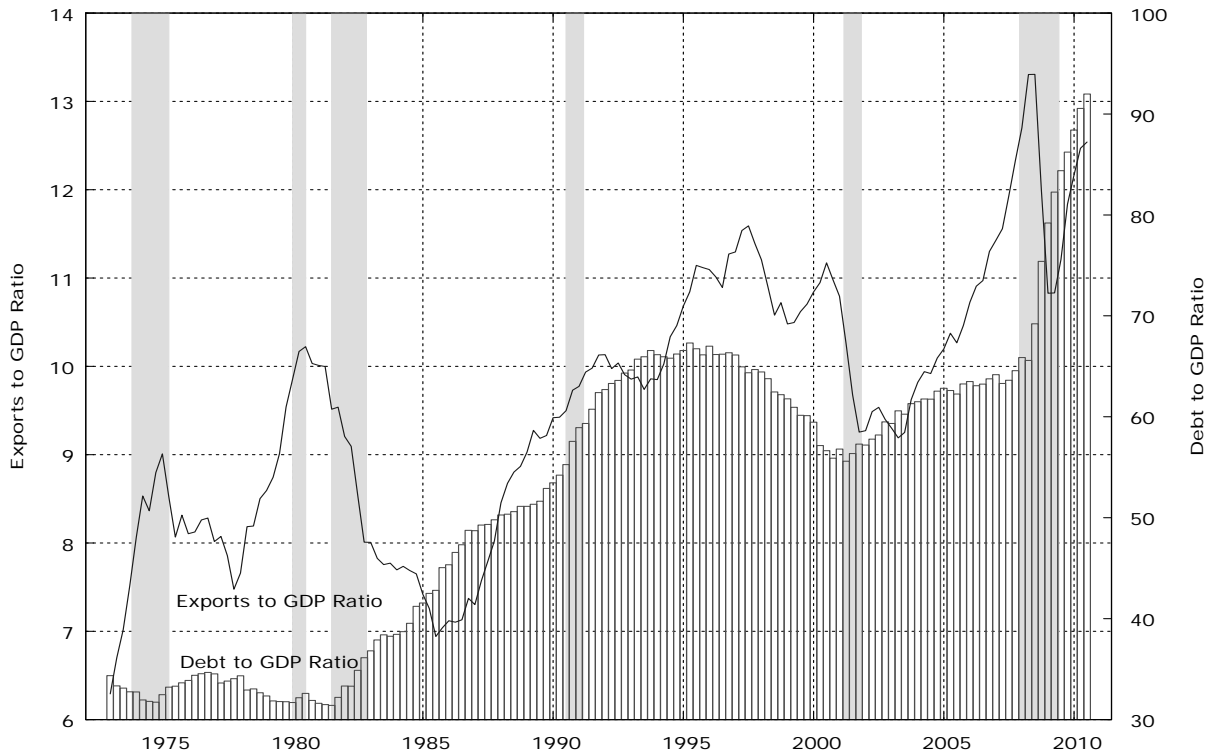
APPENDIX II: OUTPUT AND EMPLOYMENT RELATIONSHIP

Logarithmic transformation is applied to $Q = A^\gamma \left[\dfrac{w\alpha N}{c\beta} \right]^\alpha N^\beta$ and solve for N, results in:

$$\ln Q = \gamma \ln A + \alpha \ln \left[\frac{Nw\alpha}{c\beta} \right] + \beta \ln N$$

Then, $\gamma \ln A$ is brought to the left side, so that

$$\ln Q - \gamma \ln A = +\alpha[\ln w\alpha N - \ln c\beta] + \beta \ln N$$

and then, $\ln N$ terms are extracted from those in brackets as follows:

$$\ln Q - \gamma \ln A = +\alpha \ln w\alpha N - \alpha \ln c\beta + \beta \ln N$$

$$\ln Q - \gamma \ln A = +\alpha \ln N + \alpha \ln w\alpha - \alpha \ln c\beta + \beta \ln N$$

$$\ln Q - \gamma \ln A = +\alpha \ln N + \alpha[\ln w\alpha - \ln c\beta] + \beta \ln N$$

$$\ln Q - \gamma \ln A = +\alpha \ln N + \beta \ln N + \alpha[\ln w\alpha - \ln c\beta]$$

Now, $\ln N$ terms are summed in the right side of previous equation to obtain

$$\ln Q - \gamma \ln A = +(\alpha + \beta)\ln N + \alpha[\ln w\alpha - \ln c\beta]$$

And $\alpha[\ln w\alpha - \ln c\beta]$ is switched to the left side,

$$\ln Q - \gamma \ln A - \alpha[\ln w\alpha - \ln c\beta] = +(\alpha + \beta)\ln N$$

Now, the solution for $\ln N$ is searched, as such:

$$(\alpha + \beta)\ln N = \ln Q - \gamma \ln A - \{\alpha[\ln w\alpha - \ln c\beta]\}$$

$$(\alpha + \beta)\ln N = \ln Q - \gamma \ln A - \alpha \ln w\alpha + \alpha \ln c\beta$$

$$(\alpha + \beta)\ln N = \ln Q - \gamma \ln A + \alpha[\ln c\beta - \ln w\alpha]$$

$$(\alpha + \beta)\ln N = \ln Q - \gamma \ln A + \alpha \ln \frac{c\beta}{w\alpha}$$

Finally,

$$\ln N = \frac{1}{(\alpha + \beta)}\ln Q - \frac{1}{(\alpha + \beta)}\gamma \ln A + \frac{1}{(\alpha + \beta)}\alpha \ln \frac{c\beta}{w\alpha}$$

$$\ln N = \frac{1}{(\alpha + \beta)}\ln Q - \frac{1}{(\alpha + \beta)}\gamma \ln A + \frac{\alpha[\ln \beta - \ln \alpha]}{(\alpha + \beta)}\ln \frac{c}{w}$$

Simplifying the previous equation, the following is obtained:

$$\ln N = \phi_0 + \phi_1 \ln Q + \phi_2 \ln(\frac{c}{w})$$

where $\phi_0 = \dfrac{-\gamma \ln A}{\alpha + \beta}$, $\phi_1 = \dfrac{1}{\alpha + \beta}$, and $\phi_2 = \dfrac{\alpha[\ln b - \ln \alpha]}{\alpha + \beta}$.

APPENDIX III: REPARAMETERIZATION OF TFP

Re-parameterize total factor productivity $A = e^{\phi_3 T} Debt^{\phi_4} ER^{\phi_5}$, where T corresponds to a deterministic trend, Debt is government debt, and ER corresponds to the exchange rate; so,

$$\phi_0 = \frac{-\gamma \ln A}{\alpha + \beta} = \frac{-\gamma \ln[e^{\phi_3 T} Debt^{\phi_4} ER^{\phi_5}]}{\alpha + \beta}$$

After applying logarithms to terms in A, ϕ_0 becomes

$$\phi_0 = \frac{-\gamma \ln A}{\alpha + \beta} = \frac{-\gamma[\phi_3 T + \phi_4 \ln Debt + \phi_5 \ln ER]}{\alpha + \beta} = \frac{-\gamma}{\alpha + \beta} * [\phi_3 T + \phi_4 \ln Debt + \phi_5 \ln ER]$$

Now, ϕ_0 is substituted in $\ln N = \phi_0 + \phi_1 \ln Q + \phi_2 \ln(\frac{c}{w})$ for obtaining:

$$\ln N = \phi_1 \ln Q + \phi_2 \ln(\frac{c}{w}) + \frac{-\gamma}{\alpha + \beta} * [\phi_3 T + \phi_4 \ln Debt + \phi_5 \ln ER]$$

After simplifying,

$$\ln N = \phi_1 \ln Q + \phi_2 \ln(\frac{c}{w}) + \phi_3 T * \frac{-\gamma}{\alpha + \beta} + \phi_4 \ln Debt * \frac{-\gamma}{\alpha + \beta} + \phi_5 \ln ER * \frac{-\gamma}{\alpha + \beta}$$

Now the parameters ϕ_3, ϕ_4 and ϕ_5 are weighted by $\frac{-\gamma}{\alpha + \beta}$ to obtain:

$$\ln N = \phi_1 \ln Q + \phi_2 \ln(\frac{c}{w}) + \phi_3 T + \phi_4 \ln Debt + \phi_5 \ln ER$$

where new $\phi_i = \phi_i * \frac{-\gamma}{\alpha + \beta}$, for i=3,4, and 5.

APPENDIX IV: RESULTS OF MODEL WITH UNADJUSTED GDP

Orthogonalized impulse responses to government debt shocks.
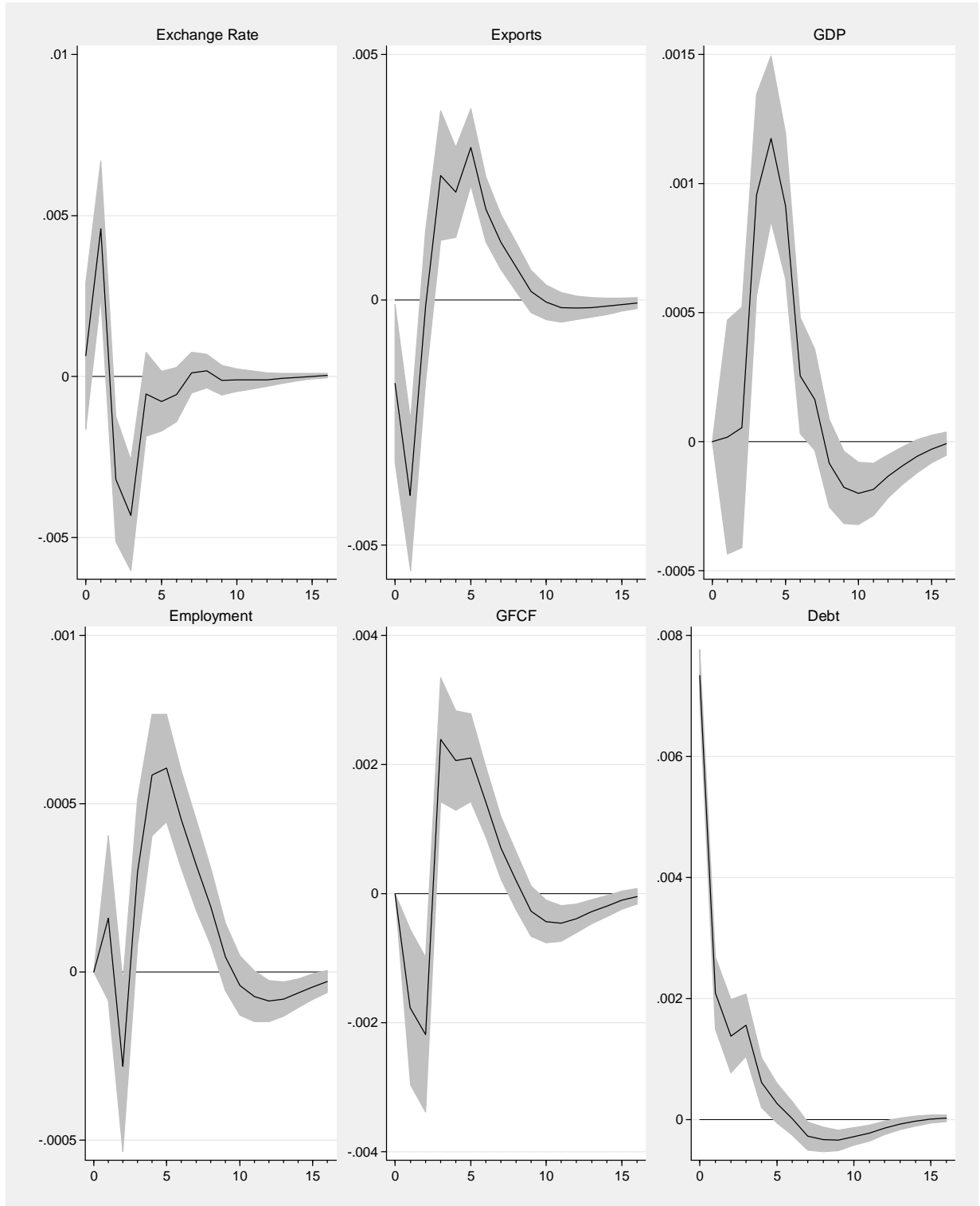
Orthogonalized impulse responses to GDP shocks.
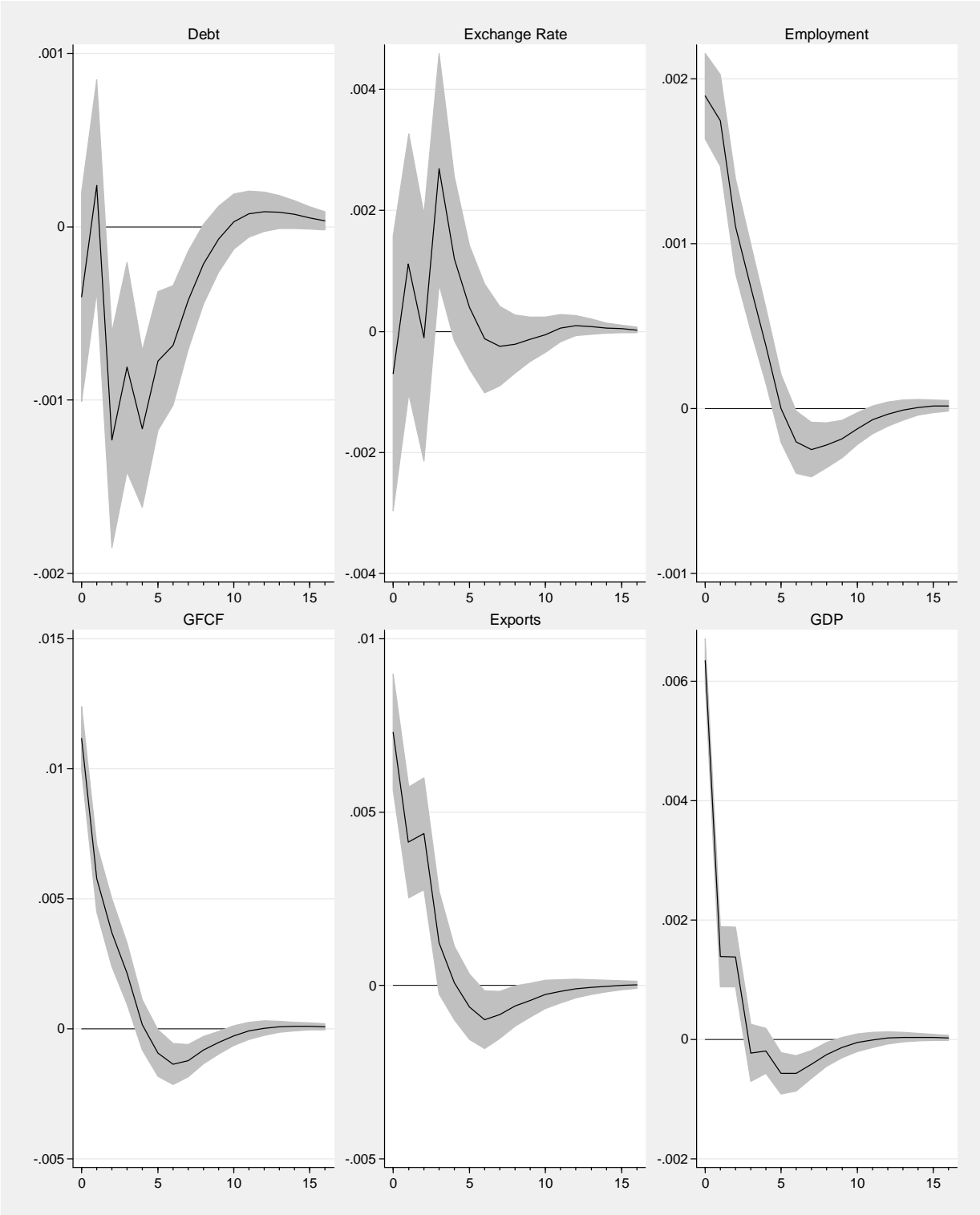
Orthogonalized impulse responses to GFCF shocks.
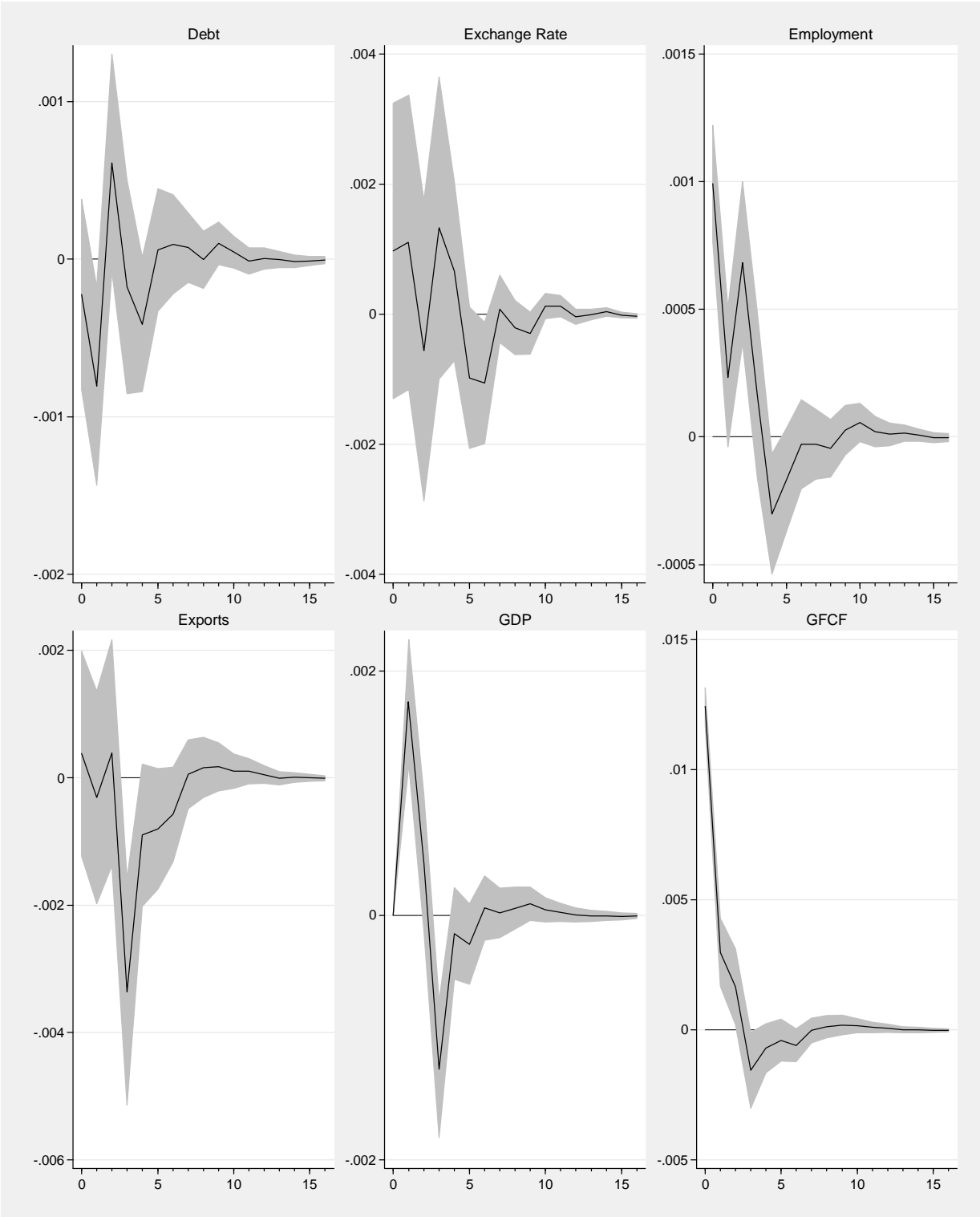
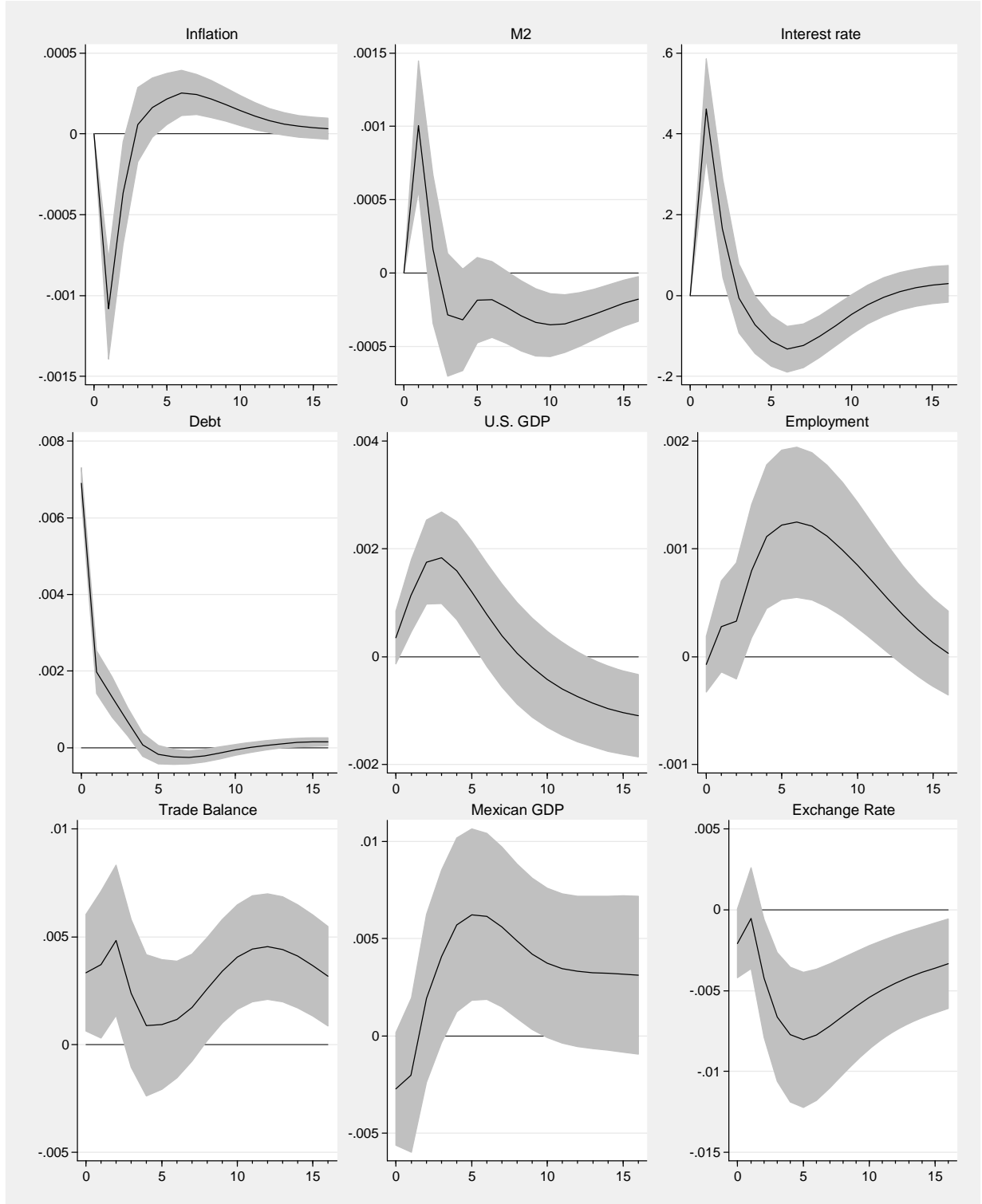Orthogonalized impulse responses to exchange rate shocks.
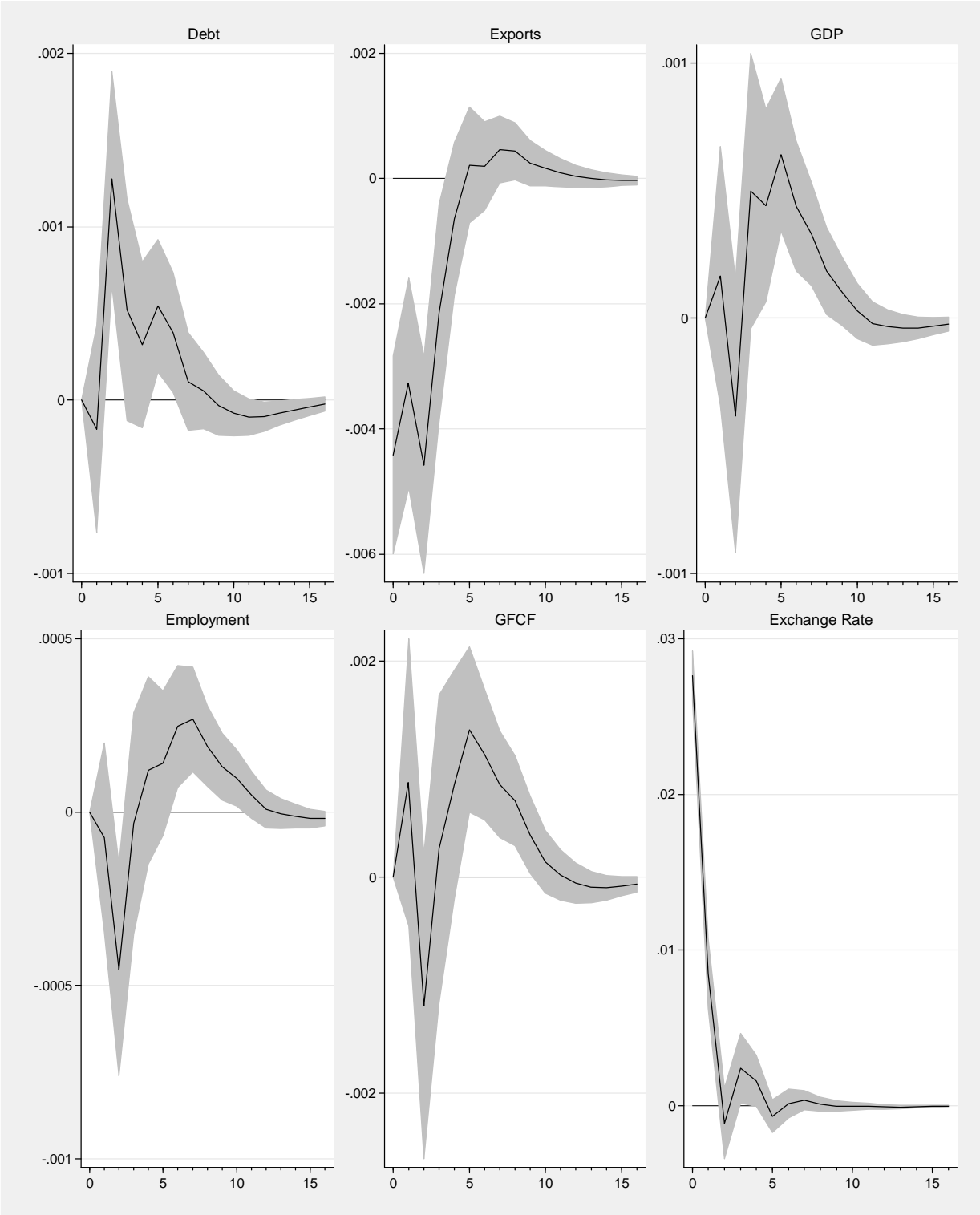
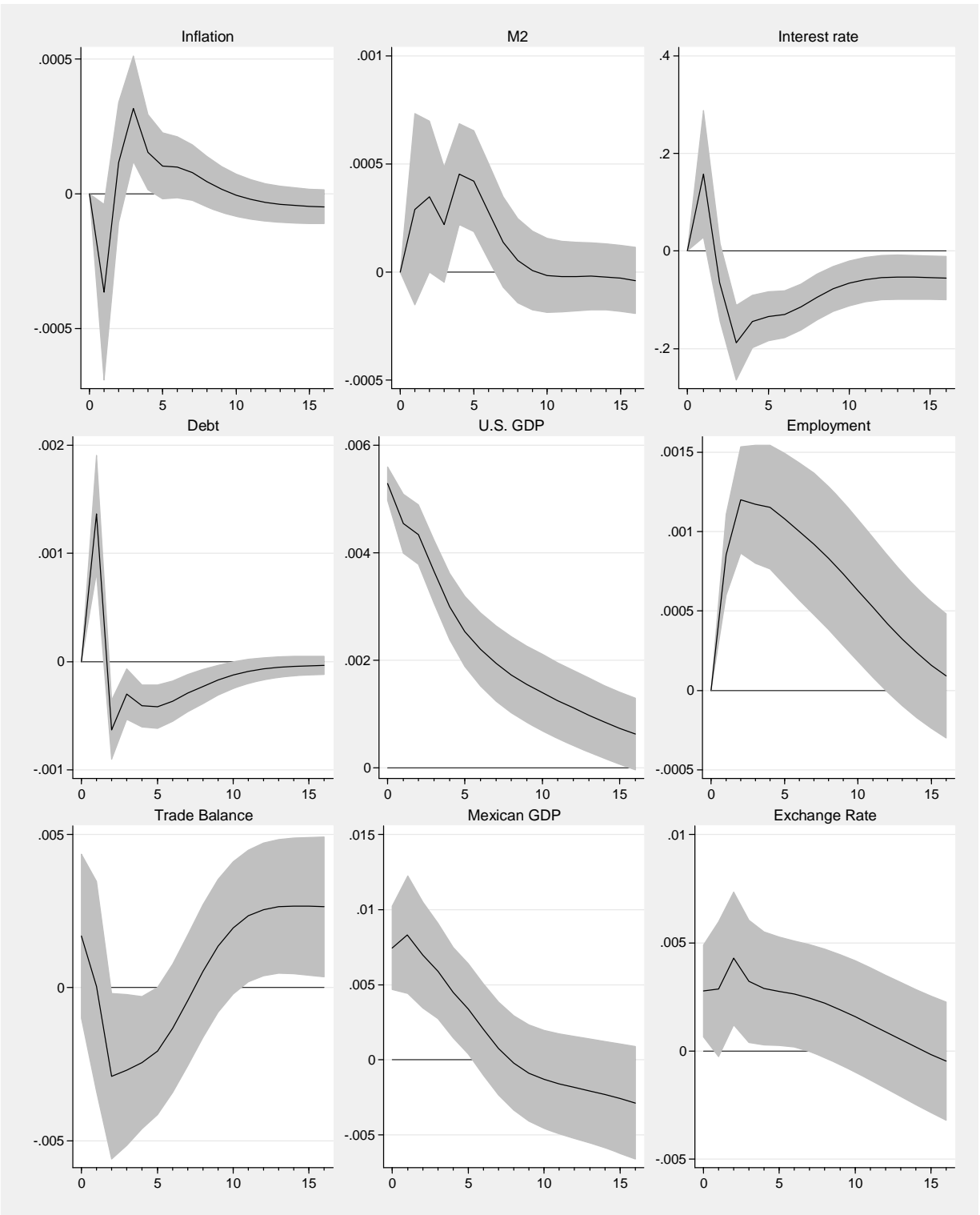Orthogonalized impulse responses to employment shocks.
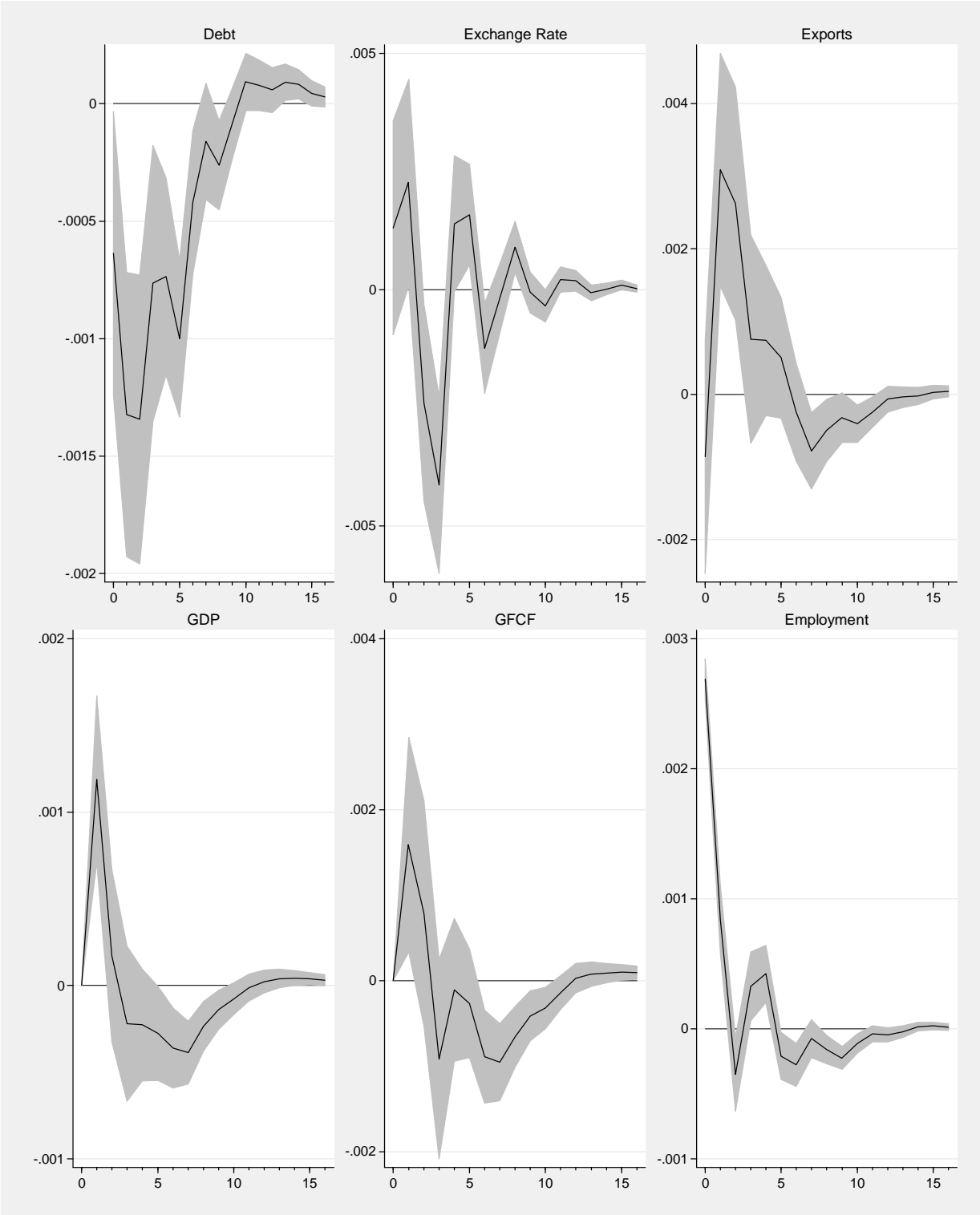
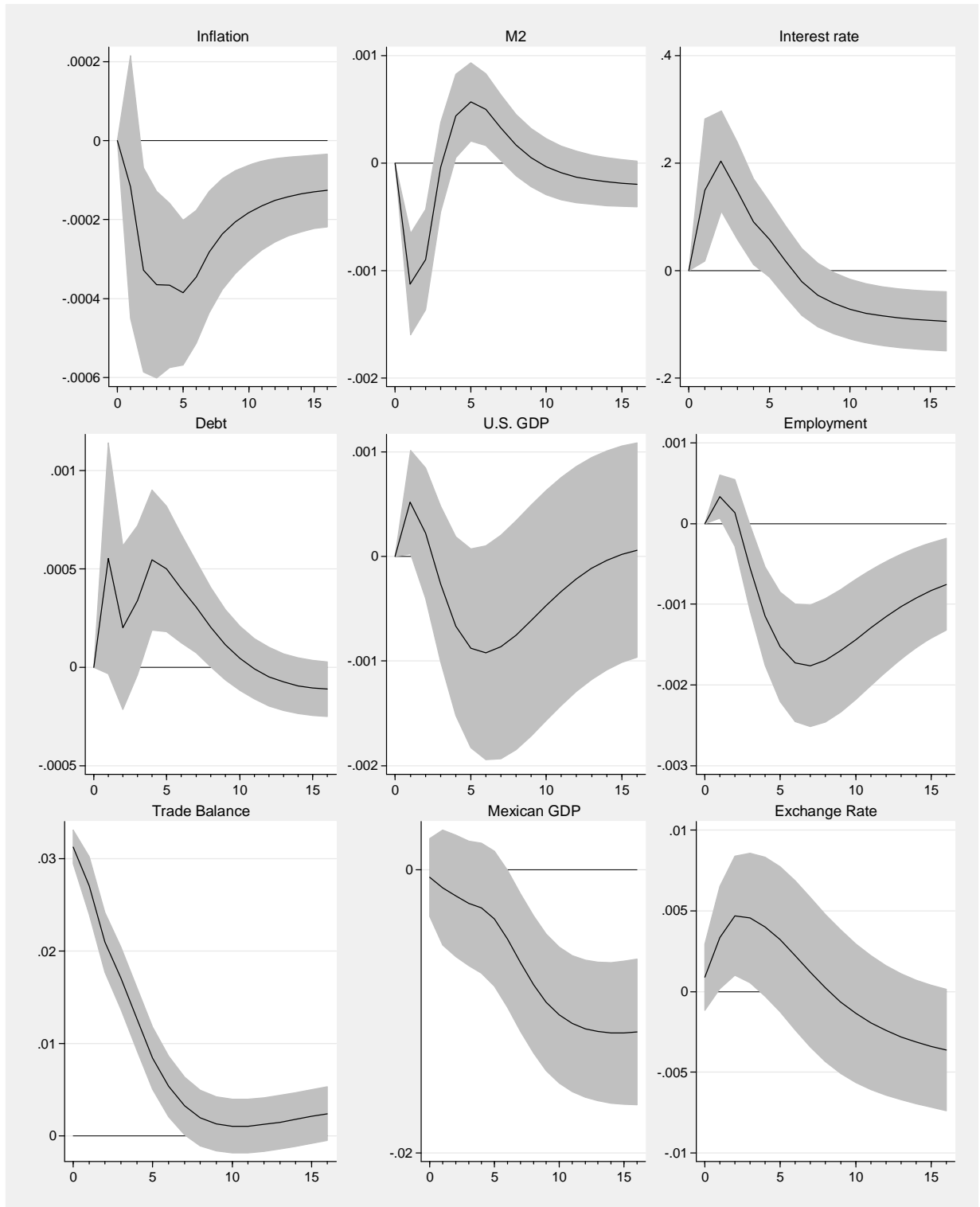# APPENDIX V: RESULTS OF MODEL WITH EXCHANGE RATE INDEX
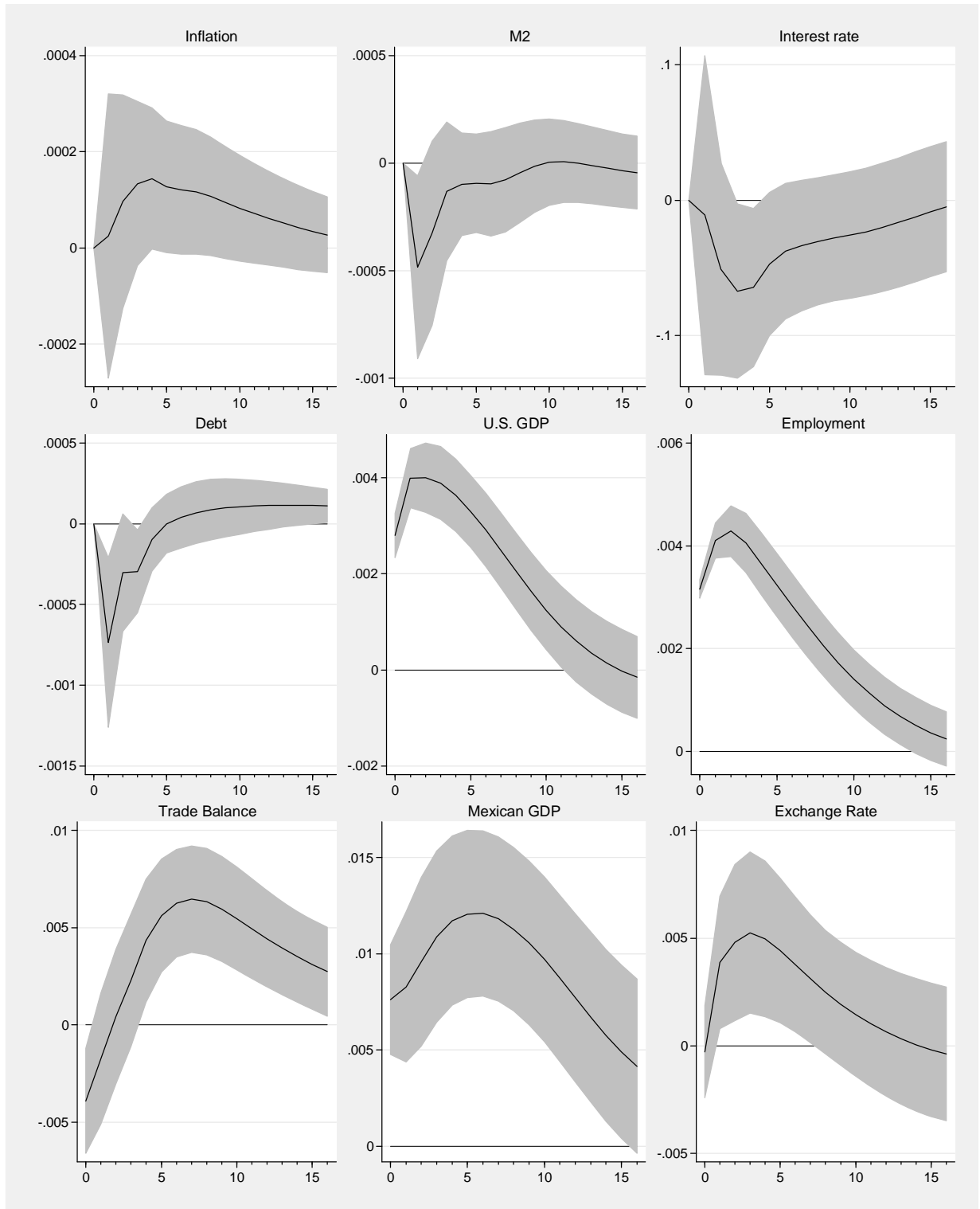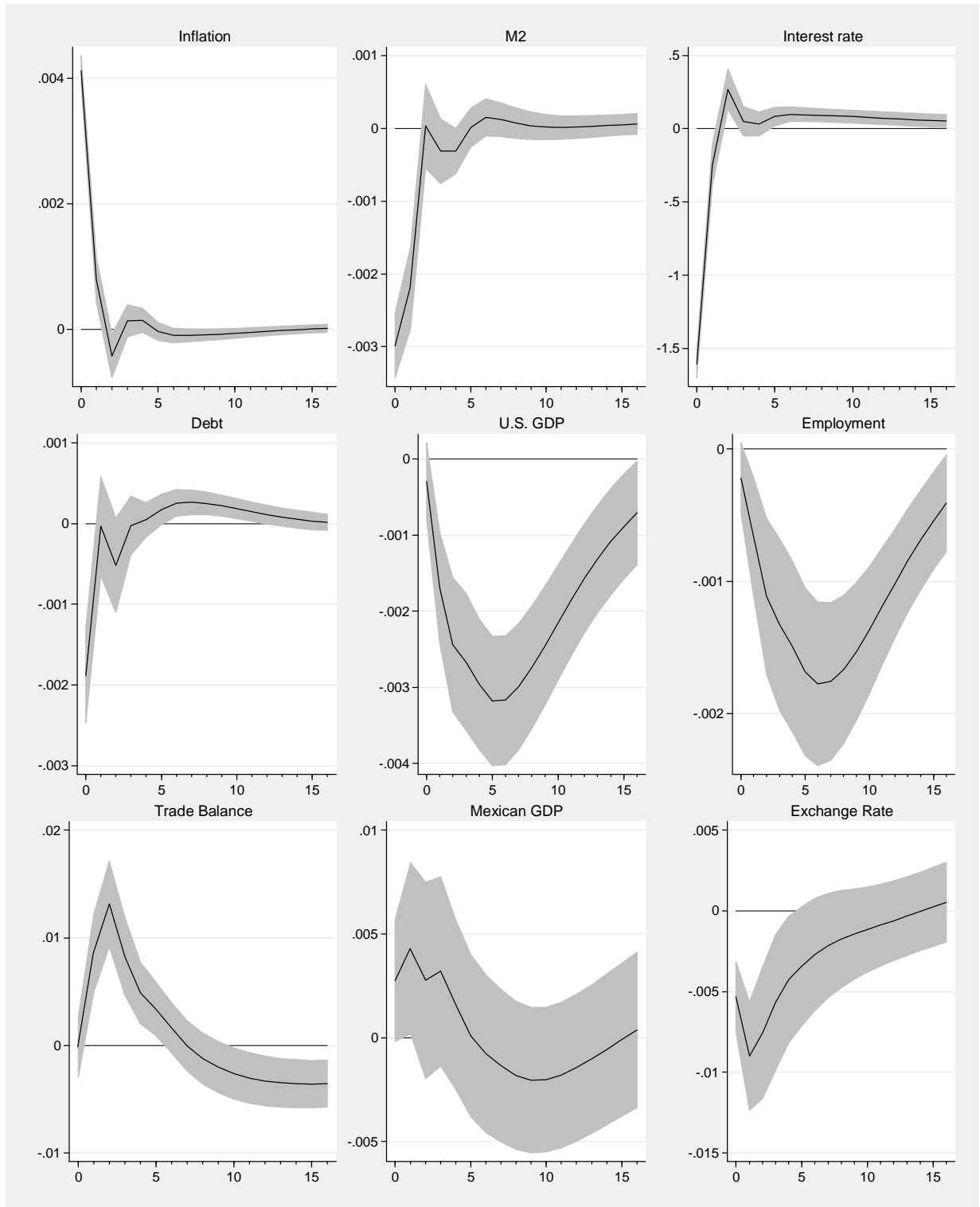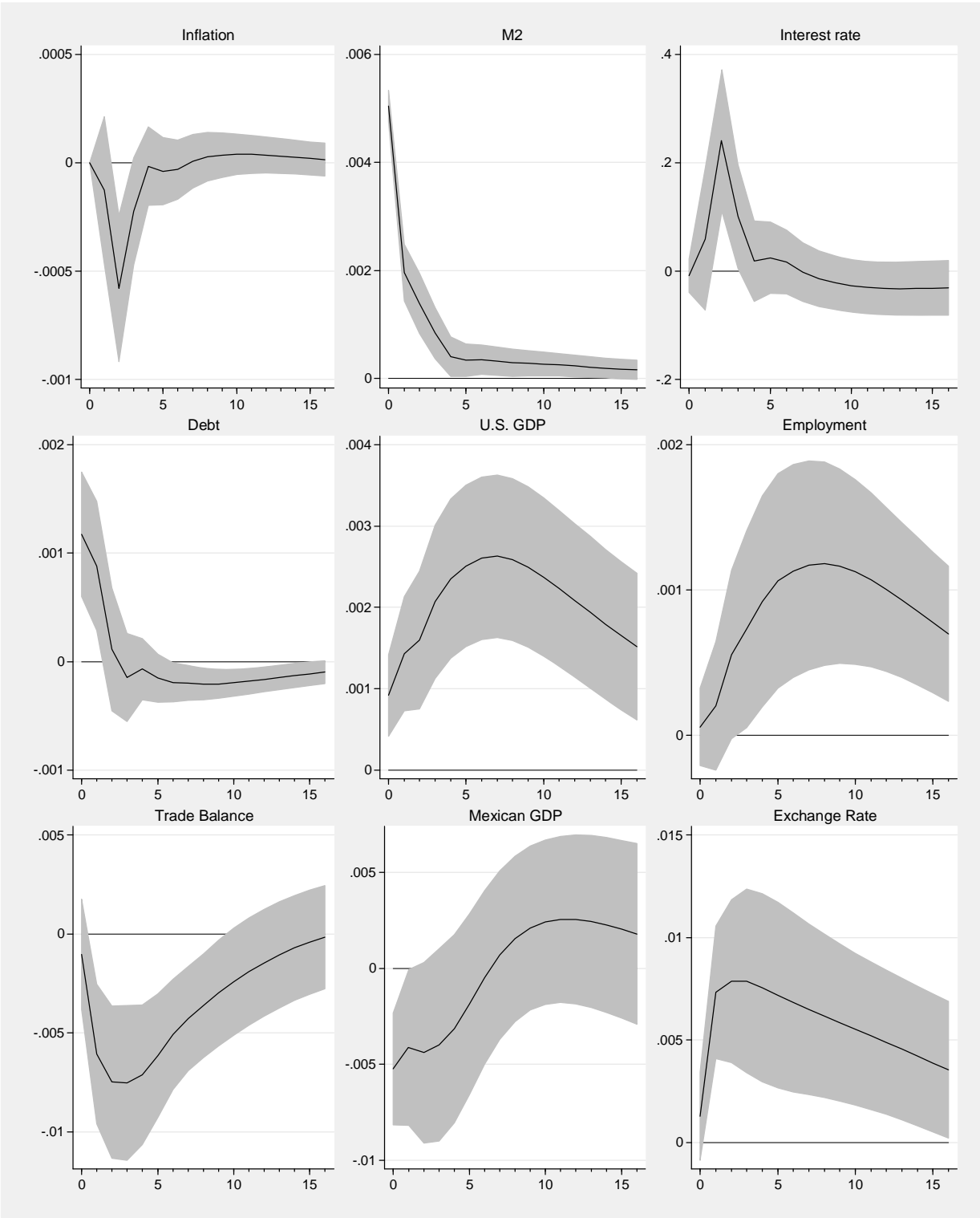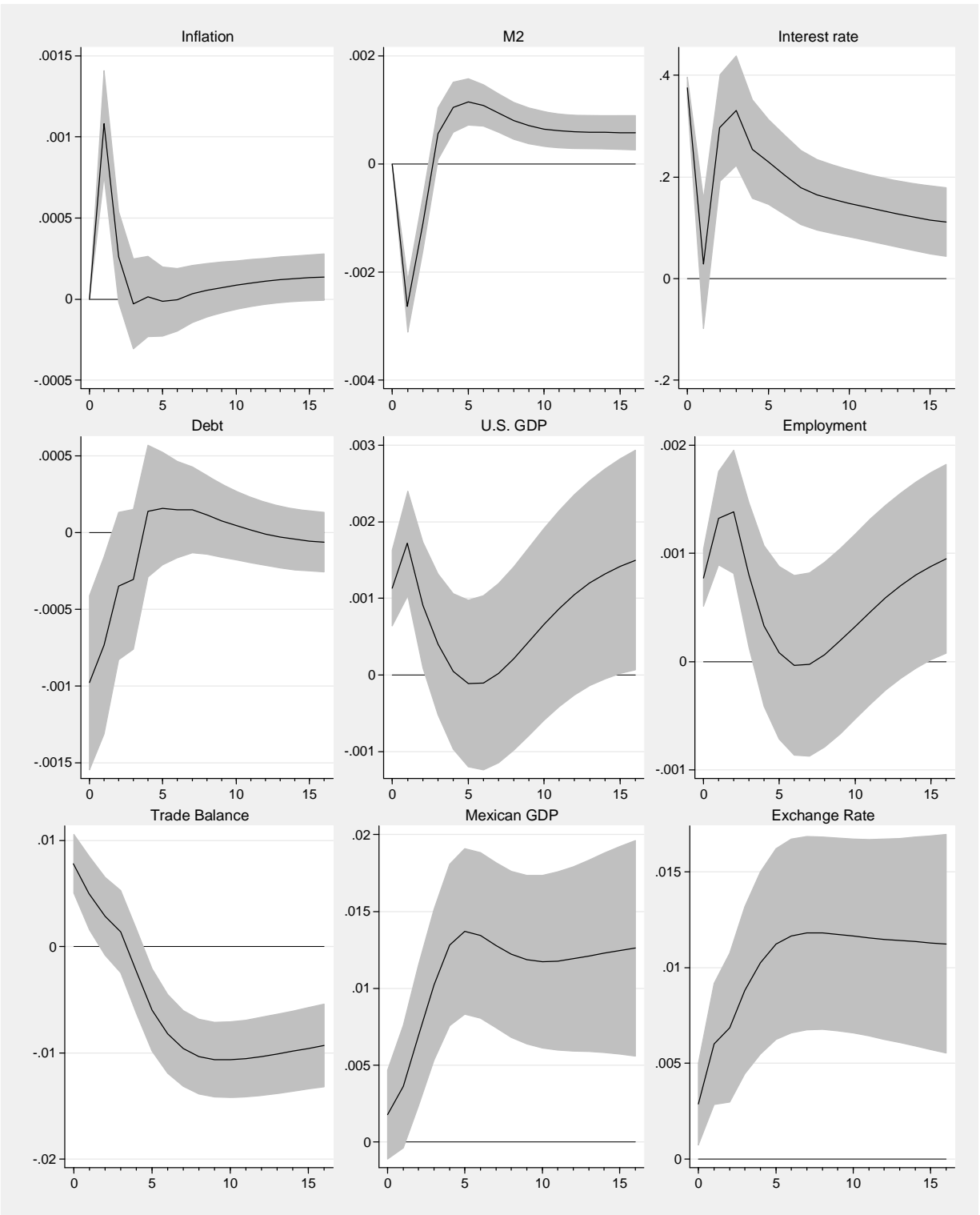
Orthogonalized impulse responses to government debt shocks.

Orthogonalized impulse responses to U.S. GDP shocks.

Orthogonalized impulse responses to trade balance shocks.

Orthogonalized impulse responses to employment shocks.
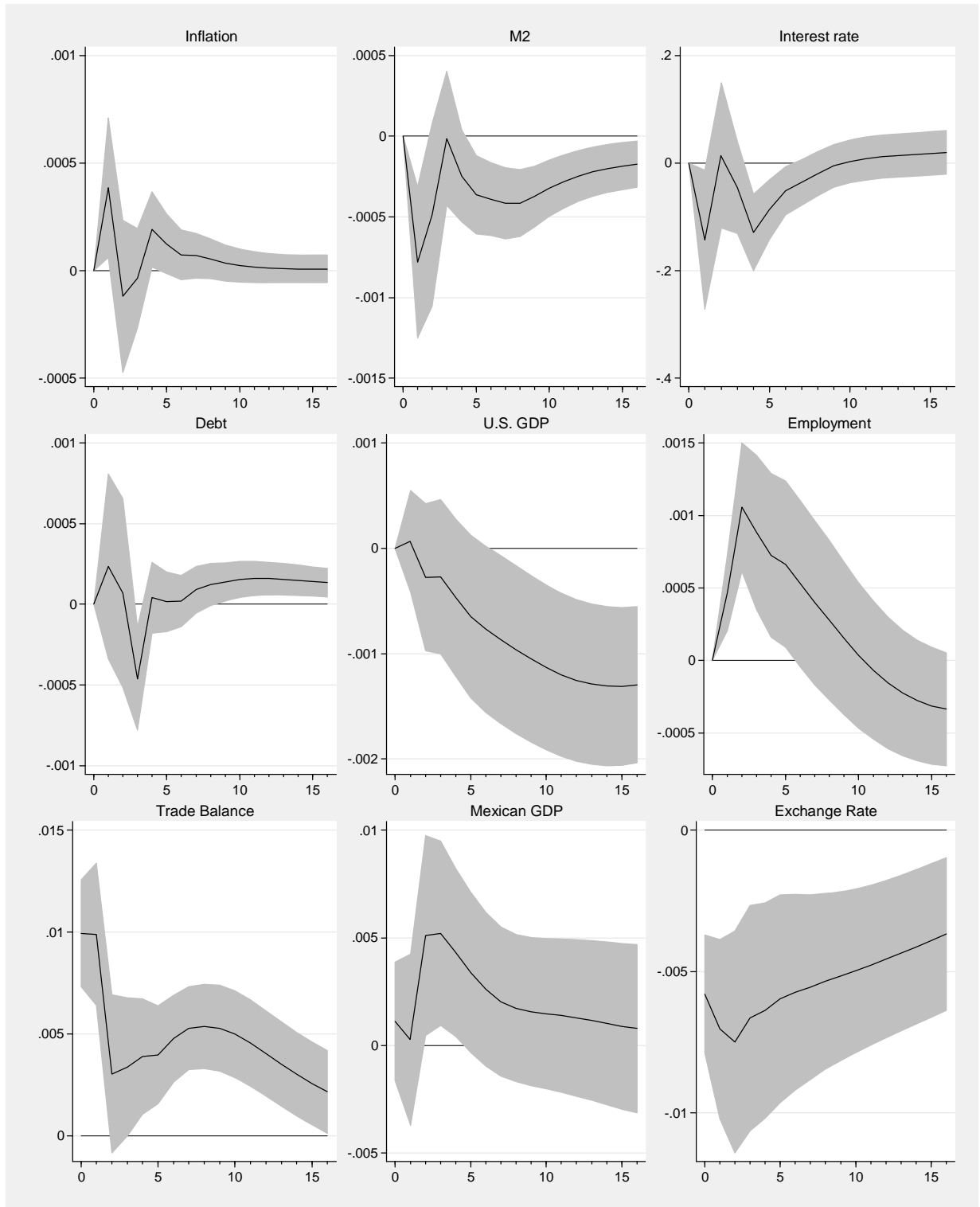
Orthogonalized impulse responses to inflation shocks.

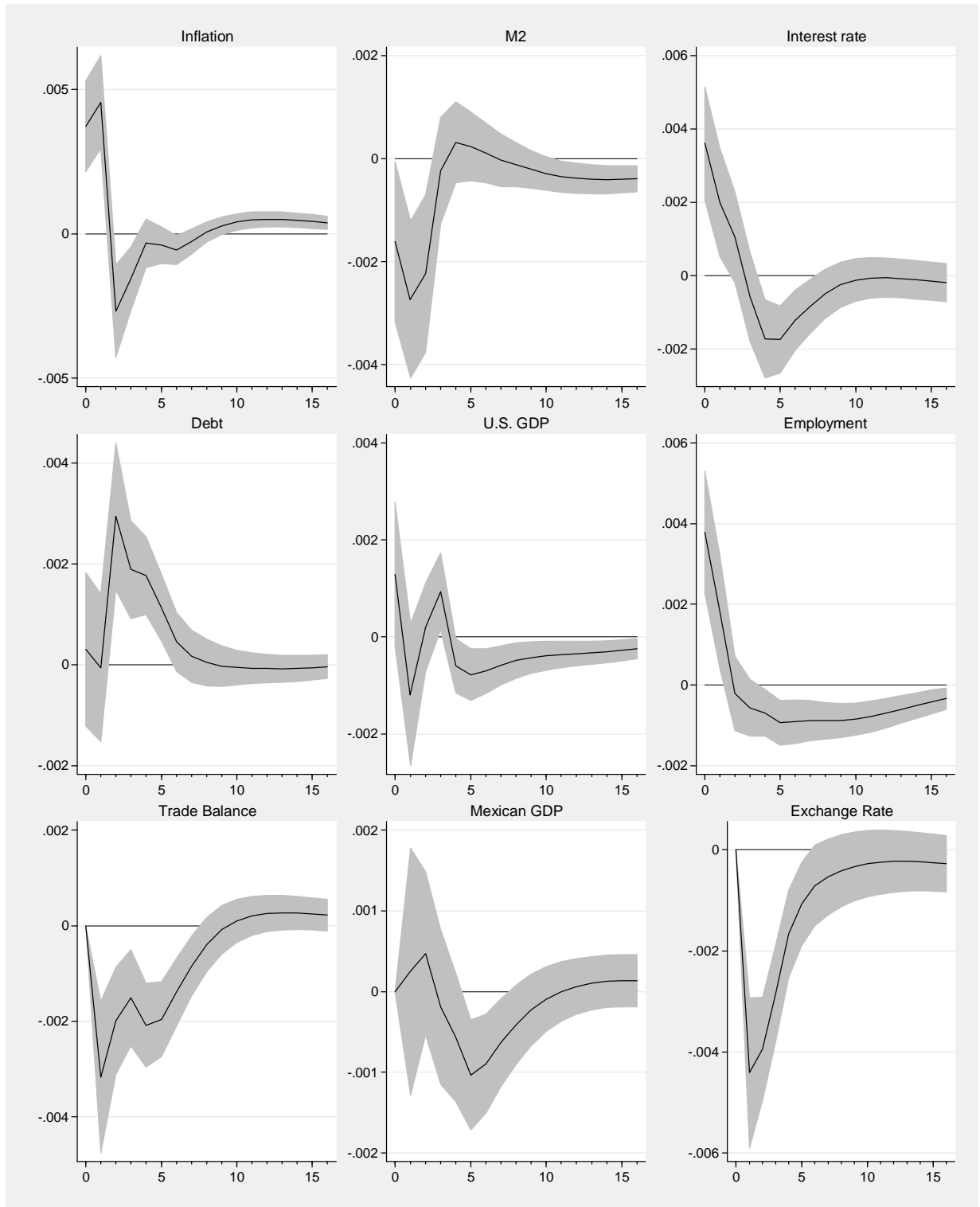Orthogonalized impulse responses to M2 shocks.

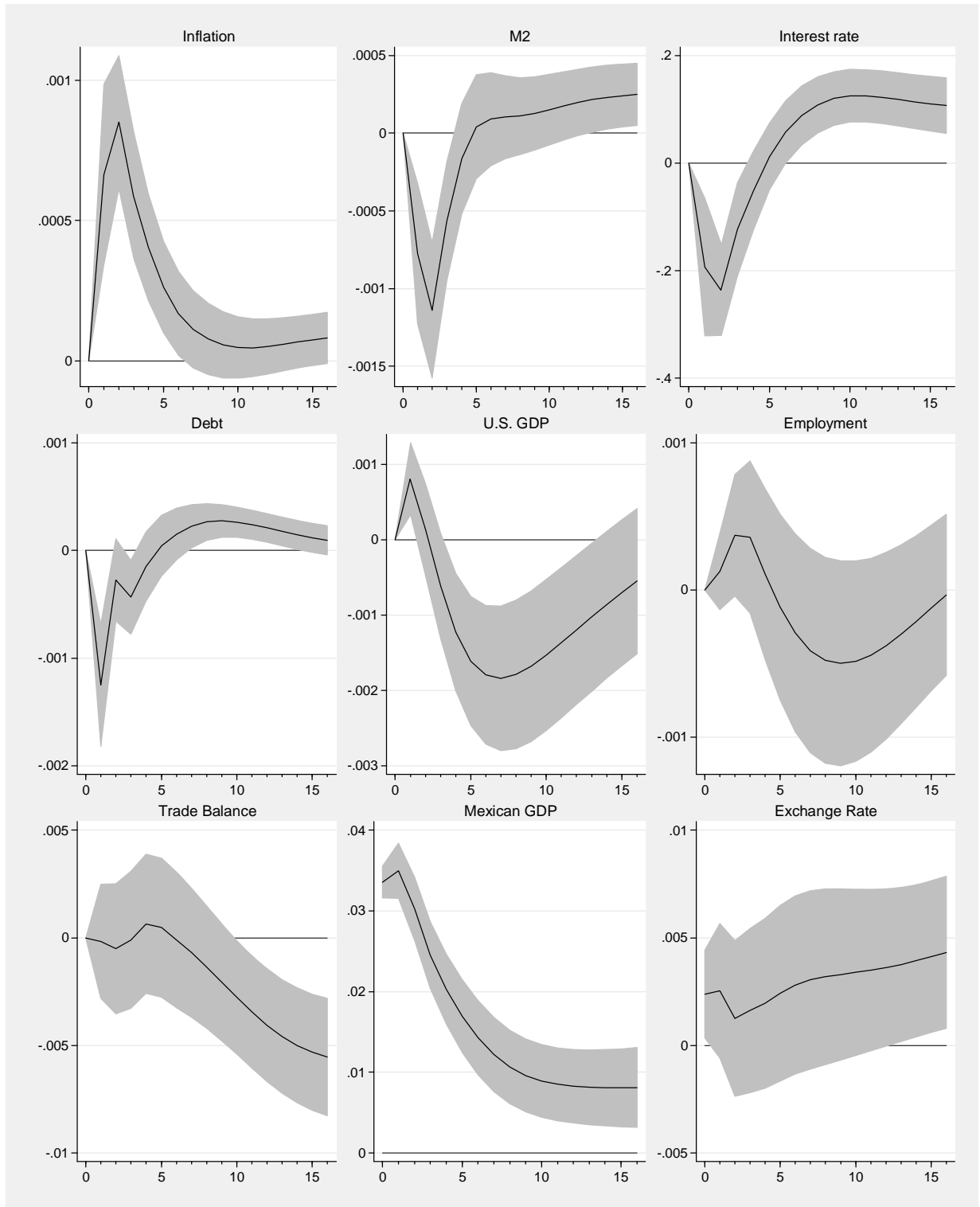Orthogonalized impulse responses to interest rate shocks.

Orthogonalized impulse responses to adjusted U.S. exports shocks.

Orthogonalized impulse responses of Adj. U.S. Exports to different shocks.

Orthogonalized impulse responses to Mexican GDP shocks.

VITA

Carlos Ignacio García Jiménez was born in Guatemala. After receiving the bachelor of sciences degree in Honduras, he came to the United States and obtained the master of sciences degree. During graduate school, Carlos Ignacio also self-studied history—and enjoyed talking to people from around the world. He also interacted with faculty from different academic departments which allowed him to obtain a better understanding of the functioning of institutions of higher education. Carlos Ignacio will receive the Doctor of Philosophy degree in the fall 2011 commencement.