GLOBALIZATION AND OBESITY

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The Supervisory Committee certifies that this ***disquisition*** complies with North Dakota State University's regulations and meets the accepted standards for the degree of

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ABSTRACT

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Obesity has been growing around the world during the last few decades leading the World Health Organization to announce the global obesity epidemic. This study focuses on identifying the impacts of different economic and socio-economic variables on the growth of obesity, as well as forecasting and monitoring this growth. A static model is developed using foreign direct investments (FDI) and trade openness as proxies for economic globalization factors and globalization social index as a proxy for social globalization. Data are collected for 76 countries over the period 1986-2008. The fixed effects model and quantile regression were used to analyze the data. A dynamic model is also set up via a differential equation to monitor the spreading of obesity. The Golden Section Search is then used to find the values for the parameters representing the number of overweight people becoming obese and the time response between the increase of overweight and the increase of obesity. Results imply that social globalization and FDI adversely impact obesity in less and medium developed countries while they have no impact on obesity rates in developed countries. Trade openness generally has no impact on changes in obesity rates across quantiles. The implications of globalization are different for different countries and regions. High social cost of obesity is surely to lower the benefits of globalization, especially in less developed countries which are the most responsive to these external influences. The dynamic model developed to monitor the spreading of obesity for three different regions: the United States, the World and the European Union, showed that the United States has the biggest proportion of overweight people becoming obese while the European Union has the least. The model also indicated that this increase occurs over a much longer period

of time for the European Union than the United States experiences this increase in really short period of time after the increase in overweight.

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

Figure | Page

CHAPTER I. INTRODUCTION

Background and Problem Statement

The National Heart Lung and Blood Institute (2010) describes being overweight as: "having extra body weight from muscle, bone, fat, and/or water" and being obese as "having a high amount of extra body fat". Obesity rate continued to grow during the past couple of decades in the US and around the world.

According to the World Health Organization (WHO) (2006), approximately 1.6 billion adults were overweight and at least 400 million were obese in 2005 all around the world. More recent statistics show that, just in the US, 33.3 percent of the total population is affected by obesity and about 60 percent are overweight or obese (Wyatt, Winter, Dubbert, 2006); these numbers set the US among top three countries in the world where the obesity rate is the highest (WHO, 2009), shared with Egypt and Saudi Arabia. Due to this rapid and continuous global increase of obesity, the WHO defines obesity as an epidemic.

Obesity has not only increased in developed countries but more surprisingly in developing countries as well. According to the Food and Agriculture Organization of the United Nations study (FAO, 2008), obesity increases rapidly in developing countries, even in those where hunger still exists. For instance, in the last decade, the number of overweight people increased from less than 10 percent to 15 percent in China; in Sub-Saharan countries, where hunger rates are the highest, obesity is also increasing. Some developing countries, like Brazil and Colombia, have a 40 percent obesity or overweight rate, a number comparable to those in developed countries.

Obesity can actually be measured with the Body Mass Index (BMI). The Body Mass Index is a number calculated from a person's weight and height and can show if a person is overweight or obese. It is calculated dividing the weight in kilograms by the height squared in meters. Nevertheless, this tool has to be taken with caution when identifying overweight people. Indeed, the BMI is not an ideal tool to diagnose overweight: some people, like high-trained athletes, can have a high BMI but have more muscle than fat (Centers for Disease Control and Prevention (CDC, 2009)). Even though the BMI is not an ideal indicator for overweight, it stays accurate to detect obesity. A person in normal shape has a BMI less than 25 percent whereas, a person with BMI greater than 25 percent but lesser than 30 percent is considered overweight. If the index exceeds 30 percent, the person is diagnosed as obese. People above this line are more susceptible to complications such as type II diabetes, cardiovascular diseases (heart disease and stroke), musculoskeletal disorders such as osteoarthritis and some cancers (endometrial, breast and colon). Obesity not only affects adults but children as well, and can cause premature death and mental disability during childhood and adolescence (WHO, 2006).

Obesity has not only health consequences affecting people but also economic consequences affecting both individuals and countries. In the United States, medical costs associated with obesity and overweight are divided in two parts: direct and indirect costs. The direct part involves preventive, diagnostic and treatment services for obesity whereas indirect costs are related to morbidity and mortality costs. The CDC defines morbidity costs as the value of income lost from decreased productivity, restricted activity, absenteeism and bed days; mortality costs are defined as the value of future income lost by premature death. A study by Misra and Khurana (2008) demonstrated that an obese person experiences a 50 percent increase in lost productivity and visits a doctor 88 percent more than a healthy person. All these factors increase health care expenditure, leading to slow the economic development/growth and *de facto*, reduce GDP. A recent study by Wang et *al.* (2008) showed that, by 2030, health-care costs attributable to obesity and overweight could range from $860 to $956 billion in the United States.

In the European Union, costs were estimated by Fry and Finley (2005) to be about 32 billion Euros in 2002 with the highest expenditures for Germany, the United Kingdom and Italy.

Developing countries encountering obesity spend a considerable amount of money for health care. For instance, cost associated with obesity in India was about 1.1 percent of GDP in 1995 whereas Tonga and Fiji consumed respectively 60 and 39 percent of the health budget as obesity costs (Popkin, 2001). China, generally considered as a healthy country, spent $50 billion in 2000 for obesity related health care and the cost was forecast to rise to $112 billion by 2015 (Popkin et *al.*, 2006). Table 1 provides a comparison of economic costs of obesity for different countries.

Table 1: Economic Costs of Obesity

Country	Year of Estimate	Total Cost (percent of GDP)[a]	Percentage of Total Indirect	Reference
United States	2000	1.2	47.8	55
Canada	2001	0.7	69.8	56
Switzerland	2002	0.6	n/a	57
Germany	1998	0.2	48.2	58
India	1995	1.1	67.3	59
China	1995	2.1	23.8	59

Source: *World Development Indicators*, World Bank, Washington DC, 2005.
[a] These costs are not directly comparable across studies as a result of methodological differences. But they can be viewed as illustrative of the sizeable and robust impact of epidemic obesity on 'sickness' system

The economic aspect of obesity is a burden for countries and slows the growth and development via an increase in health care expenditure. As obesity has become a worldwide problem, researchers have tried to develop models, either static or dynamic, to explain the growth of the disease.

Justification of the Study

The world changes rapidly due to the opening of the borders, cultures and trade between countries. The question then becomes does this phenomenon affect the habits/life-style globally, and what effect has it on the spreading of obesity across the globe?

The purpose of this study is to analyze the impact of globalization and changes in life-style on the development of obesity around the world. Even though the link between income growth and life-style changes is obvious, some other factors such as Foreign Direct Investment (FDI) and trade openness are tested to see if they have a significant impact on the obesity growth.

Study Objectives and Hypotheses

The specific objectives of this paper are:

a. To develop a global socio-economic epidemiological model of the spread of obesity.
b. To determine the impact of economic (FDI and trade openness) and social variables (social globalization) on obesity growth using a static econometric model.
c. To create a dynamic model that will monitor and explain the growth of obesity in the United States, the World and the European Union.

The study proposes that impacts of globalization via an increase in trade openness, FDI and social globalization expressed as a spread of ideas, lead to changes in life-style and in turn to the growth in obesity rates around the world. More specifically, the trade-openness and FDI are the mediums leading to the surging obesity as an externality of the globalization process.

Description of the Study

In this study, three models are used to analyze and interpret the growth of obesity. Two econometric static models are developed to analyze the impacts of both economic and social variables. A one-way fixed effects model is used to quantify the effects of FDI, trade openness and social globalization whereas a quantile regression is employed to analyze the impacts of the variables on the different categories of countries distributed in the quantiles. FDI, trade-openness, globalization are considered as independent variables and obesity rate is the dependent variable. Obesity rate comes from the World Health Organization (WHO) and the Organization for Economic Co-operation and Development (OECD) for 76 countries (developed and developing countries) running from 1986 to 2008. The World Bank and IMF were the sources used for economic variables. Globalization data are provided by the ETH Zurich from 1970 to 2007 for the 76 countries.

The third model utilized is a dynamic model using a differential equation. The purpose of this model is to be able to predict the number of overweight people and the time frame for the conversion to obesity. This method is used to evaluate these rates for the World, for the European Union and the United States. Categories (World and Europe) are based on data availability for both obese and overweight values for countries. A weighted mean is employed to determine a unique value for each year for each region (World and Europe). Finally, parameters are estimated via a Golden Section

Search and compared with each other via a cost function to find the most realistic ones for the model.

Outline

Chapter II presents the different studies that have been done on the relationships between obesity and economic factors. Chapter III explains the static and dynamic theoretical framework that the empirical model is based on and a complete scheme of the concept of the study, while chapter IV develops the empirical model and data used. The results and discussion are presented in chapter V. Chapter VI concludes the study suggesting some solutions.

CHAPTER II. LITERATURE REVIEW

This section presents the work that has been done on obesity in different studies. Most of the research on obesity is focused on identifying the impacts of socio-economic factors or health factors that are responsible for its spreading. The following paragraphs describe the findings of these studies. Moreover, both static and dynamic models uses will be reviewed in this chapter.

Health Factors of Obesity

The obesity problem can be classified in two different categories: a health problem as well as a socio-economic problem. According to the WHO, overweight and obesity result from an energy imbalance between calories consumed on one hand and calories expended on the other hand. Obesity has some internal causes: some genes are being responsible for the disease, especially for severe obesity, inducing death most of the time (Bell, Walley and Froguel, 2005). Though, changes in the genetic makeup of populations occur too slowly to be responsible for the fast growth of obesity in the world (CDC, 2010).

Socio-Economic Factors of Obesity

Even though obesity can have genetic origins, the main factors are principally socio-economic factors. Many study focused on understanding the environmental factors causing obesity. Age, ethnicity, gender or geographic characteristics have been pointed out as relevant factors for over- nutrition. Wang and Beydoun (2007) showed that some ethnicities in the US are more likely to develop obesity than others. Non-Hispanic Black women and children, Mexican-American women and children, low-Social Economic Status Black men and White women and children, Native Americans and Pacific Islanders are more often affected by obesity while Asian Americans have a lower prevalence of obesity.

As seen in the previous study, children and teenagers are also affected by obesity, probably even more. According to Ogden et *al.* (2006), the prevalence of obesity among preschool children in China increased from 1.5 percent in 1989 to 12.6 percent in 1997. Based on estimates from the NHANES conducted during 2003-2004, the proportion of overweight children and adolescents in the US reached 17.1 percent and the trend shows that this amount keeps increasing through the years.

The most obvious environmental factor would probably be the geographic characteristics, *i.e.* the place of living for people. A study by Chen, Florax and Snyder (2009) focused on determining whether or not the place of living has an impact of overweight and obesity. Using a spatial lag model and calculating marginal effects, they showed that changes in access to chain grocers have different impacts depending on location. This is true especially for segregated cities where disparities among people's incomes are noticeable.

This leads us to study the economic factors of obesity. As Chen, Florax and Snyder (2009) described in their study, income is a consequent factor of obesity. Lakdawalla and Philipson (2002) suggest that weight increases as income increases. Though, this statement has to be qualified: the effect of income on calorie consumption is highly inelastic in developed countries, which means that there is a different causal relationship between income and weight at the macro (long-run) and micro (individual) levels. A positive correlation exists between bodyweight and income at the macro level, but at the micro level, this correlation is not necessarily positive (Liu, Rettenmaier and Saving, 2007). Cutler, Glaeser and Shapiro (2003) found that for women, income and obesity are negatively correlated. Nevertheless, they moderate the effect of income on obesity: in 25 years, real incomes haven't really increased much for low-income groups, though obesity kept increasing.

Increases in income modify habits of people, inducing life-style changes. As seen previously, an increase in income induces higher calorie consumption. Indeed, after staying constant from 1910 to 1985, the calorie intake in the United States increased by 12 percent (roughly 300 calories per day) after 1985 due to an increase in consumption of grain, added sugars and added fats (Putnam and Allshouse., 1999). According to the Centers for Diseases Control and Prevention (2004), the calorie consumption remained stable between 1971-1974 and 1976-1980 but increased by 7.3 percent (179 calories per day) for men and 23.3 percent (355 calories per day) for women between 1976-1980 and 1999-2000. This is confirmed by the study from Nielsen and Popkin (2003) who showed that the calorie consumption didn't change from 1977-1978 through 1989-1991 but increased by 11 percent (190 calories per day) from 1989-1991 to 1994-1996. These increases are due essentially to a change in the way of eating and an increase in carbohydrates consumption. The CDC evaluated that in 1976-1980, a man and woman aged 20-74 years consumed, respectively, 1,039 and 700 kcal daily of carbohydrates. In 1999-2000, the amount of carbohydrates consumed reached 1,283 kcal for men and 969 kcal for women. Table 2 provides data comparing the energy intake and calorie consumed of different elements through three periods.

The amount of energy intake has largely increased from 1976 to 2000 (23 percent for women and 7.3 percent for men), followed by the percentage of kilocalories from carbohydrates which increased by more than 10 percent for both genders. The percentage of kilocalories from total fats increased between 1976-1980 and 1988-1994, but regarding the overall percentage change, the amount of fats consumed has decreased by 11 percent and 8.9 percent for men and women respectively.

Table 2: Calorie and Fat Consumption for Three Periods between 1976 and 2000 in the United States

Variable	**Gender**	**1976-1980**	**1988-1994**	**1999-2000**	**Overall % Change**
Energy intake (kcals)	Women	1,522	1,798	1,877	23.3%
	Men	2,439	2,666	2,618	7.3%
% kcal from total fats	Women	36.0	33.4	32.8	-8.9%
	Men	36.8	33.9	32.8	-11.0%
% kcal from carbohydrates	Women	46.0	50.6	51.6	12.2%
	Men	42.6	48.2	49.0	15.0%

Source: Center for Diseases Control and Prevention. 2004. "Trends in Intake of Energy and Macronutrients --- United States, 1971—2000". *National Center for Health Statistics, CDC.*

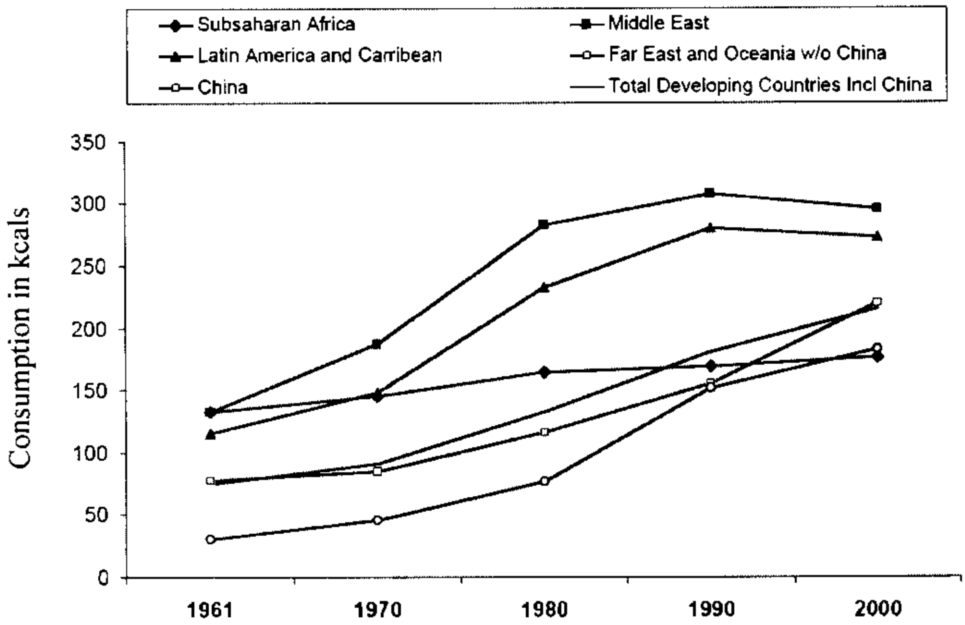
Carbohydrates or saccharides are essential components of all living organisms. The metabolic breakdown of monosaccharides (the basic units of carbohydrates) provides most of the energy used to power biological processes via sugar (Voet and Voet, 1995). According to the Dietary Reference Intakes for Energy, Carbohydrate, Fiber, Fat, Fatty Acids, Cholesterol, Protein, and Amino Acids (2002), the recommended fat per day is set between 20 and 35 percent of total energy and recommend carbohydrates intake to be between 45 and 65 percent of total energy.

The increase in carbohydrate consumption and energy intake suggest a change in food consumed, *i.e.*, the use of a different food diet. The high carbohydrate consumption implies indirectly an increase in sugar intake. For instance, Finkelstein, Ruhm and Kosa (2005) noticed that the beverage consumption among Americans was 53 gallons of soft drinks and 17 gallons of fruit juices or drinks in 1995, which represents an increase of 51 and 40 percent respectively since 1980. This increase has been noticed especially among children: during 1988-1994, 8 percent of their calories came from soft drinks. The increase in calories intake has been accompanied by changes in eating patterns: snacking has become more prevalent through years (Finkelstein, Ruhm and Kosa, 2005). Cutler, Glaeser and Shapiro (2003) found that higher snack calories are responsible for the total increase in energy intake among women between 1977-1978 and 1994-1996 and for 90 percent of men. Nielsen and Popkin (2003) incriminated the increase of snack consumption to be responsible for the growth of calories intake. Several studies showed that the prevalence of snacking has been increasing, so have the number of snacks per day and the energy density of snacks for children and adults.

Hoffman (2001) noticed that as the economies of developing countries continue to improve, the risk of becoming obese increases across all socio-economic classes as a result of improved access to food, decreased physical activity and the consumption of "western diets". Popkin (2001) in his paper states that the world moves toward the higher fat and higher refined carbohydrates Western diet. Most countries in Asia, Latin America, Northern Africa, the Middle-East and the urban areas of Sub-Saharan Africa have experienced a shift in the structure of their diet patterns, inducing an increase in calories intake. Major dietary changes include an increase of fat consumption and added sugar, as well as an increase in animal food consumed, whereas the consumption of cereals and fiber has decreased. He also noticed that, with 30 percent or more fat consumed of total energy intake, the shift in diets is directed towards a "Western diet". Figures 1 and 2 illustrate these shifts in diets in several developing countries.

The two figures show clearly an increase for every region. The highest increase for consumption of total caloric sweeteners has been encountered for Latin America and Caribbean and the Middle East.

Figure 1: Regional Trends in Availability for Consumption of Edible Oils, 1961-2000 (in kcals)

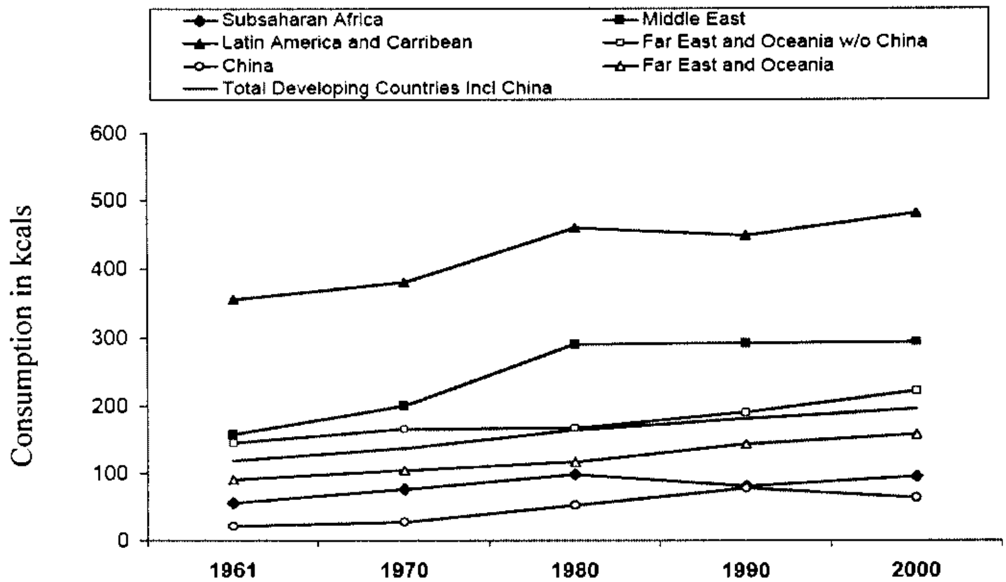


Source: Popkin, B.M. 2001. "Globalization, Urbanization and Nutritional Change in the Developing World". *Electronic Journal of Agricultural and Development Economics.* Vol. 1, No. 2, 2004, pp. 220-241

The increase in edible oils, considered as fat, is more obvious. We can see with Figure 1 that the fat consumption almost tripled for the Middle East and Latin America. The most surprising increase comes from China: the country increased her consumption from less than 50 to more than 150, an increase by at least 200 percent.

Lots of studies focus on finding the impact of socio-economic factors such as gender, age, ethnicity or income, but very few have focused on finding the impact of globalization on these lifestyle changes and on obesity. As we saw earlier, most of the studies focus on the impact of nutrition transition on the increase of energy intake or the changes in lifestyle due to changes in diet and physical activity, but not on the causes of these changes in lifestyle.

Figure 2: Regional Trends in Availability for Consumption of Total Caloric Sweeteners, 1961-2000 (in kcals)



Source: Popkin, B.M. 2001. "Globalization, Urbanization and Nutritional Change in the Developing World". *Electronic Journal of Agricultural and Development Economics.* Vol. 1, No. 2, 2004, pp. 220-241

Though, several studies have tried to explain the role and impact of Foreign Direct Investment or trade liberalization on nutrition transition and indirectly obesity. Hawkes (2004), studying the impact of FDI on the nutrition transition, found that FDI into processed food, services and retail has increased rapidly since the 1980's due mainly to transnational food companies in developed countries. The increased in FDI has been correlated to the increase of processed food sales. She also found that the amount of FDI targeted at developing countries is also increasing, associated with the largest transnational food companies present in low- and low-to-middle income countries. The effect of FDI is to make more highly processed foods available to more people. The FDI has made possible to lower prices, open up new purchasing channels, optimize the effectiveness of marketing and advertising, and increase sales. These effects lead inevitably to an increase in obesity. The goal is now to monitor these changes and to see how many people would go obese.

Dynamic Models

Dynamic models are used as predicators of a spreading of diseases in science. As we saw earlier, obesity is considered as an epidemic, spreading rapidly across the globe. Research has been done on modeling epidemics with mathematical equations. According to Hethcote (2000), mathematical models have become important tools in analyzing the spread and control of infectious diseases. According to Nokes and Anderson (1988, p 1), "a major goal of theoretical or mathematical study in epidemiology is to develop understanding of the interplay between the variables that determine the course of infection within an individual, and the variables that control the pattern of infections within communities of people".

The first epidemic model was formulated and solved by Daniel Bernoulli in 1760 to evaluate the effectiveness of variolation (vaccination with the virus itself) of healthy people with the smallpox virus. The development of dynamic models has though been more important during the 20^{th} century. In 1906, Hamer built and analyzed a discrete time model to understand the recurrence of measles epidemics. Ross was interested in the incidence and control of malaria, so he developed differential equation models for malaria as a host-vector disease in 1911. Because obesity is not a transmissible or infectious disease, it is necessary to find an analogy in order to be as accurate as possible. Diabetes could be an analog to obesity as a non-transmissible disease and highly related to obesity as it is considered as an epidemic (WHO, 2009). Boutayeb et *al.* (2004) developed a mathematical model to monitor the size of populations of diabetes with and without complications. Different scenarios are discussed according to a set of parameters and the dynamical evolution of the population from the stage of diabetes to the stage of diabetes with complications is clearly illustrated. They finally could evaluate how efficient and cost-effective strategies can be obtained by acting on diabetes incidence and/or controlling the evolution to the stage of complications.

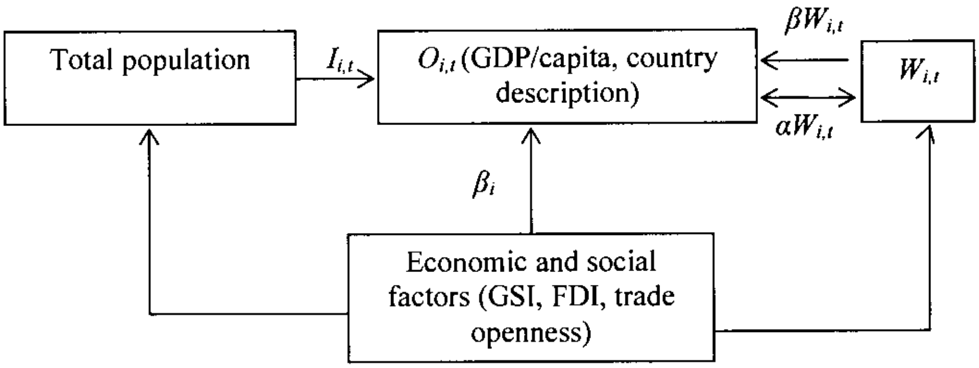
CHAPTER III. THEORETICAL FRAMEWORK

The study, as seen previously, has two major objectives: looking at the impact of economic and social variables through an econometric model and also building a socio-epidemic dynamic model in order to model the spreading of obesity.

Suppose that $O_{i,t}$ represents the obesity rate, *i.e.*, the share of obese people in total population in a country *i* at time *t*. This share depends on both indigenous factors for each country (*e.g.* level of wealth approximated by GDP per capita, dietary patterns, national food policies related to obesity, malnutrition or health) and external factors such as the impact of economic and social variables, respectively G_E and G_S, on habits and in turn on the obesity rate. Let $I_{i,t}$ be the incidence of obesity in a country *i* at time *t*. While obesity cannot be considered as an infectious disease as it is not transmittable from one person or species to another by a replicating agent, it can be considered as a global socio-economic epidemic because of the fast and continuous growth of the disease. A global socio-economic disease can be defined as a disease existing and spreading globally, and having its highest incidence in countries and among socio-economic groups predisposed to it. These predispositions are defined as a set of living and/or working conditions which are facilitated by the globalization processes. Globalization is understood here broadly, as a process by which national/regional economies, societies and cultures have become integrated through a global network of economic, technological, socio-cultural, political and biological factors (Croucher, 2004).

Let $W_{i,t}$ denote the overweight rate in a country *i* at time *t*. The percentage that an overweight person will go obese is given by β and the time correlation change between the overweight rate and the obesity rate is represented as μ. The β_i denote the impact of the external variables. A schematic representation of the model is displayed in Figure 3:

Figure 3: Model Framework



The diagram shows that $I_{i,t}$ cases are diagnosed in a country i in a time interval of length t. In that same interval, the obesity rate is a function of the indigenous factors, but is also impacted by the external globalization processes (e.g. FDI, trade openness...). The following assumptions/expectations are made:

$$\frac{\partial O}{\partial GDP} \geq 0$$

$$\frac{\partial o}{\partial Country\ C} \in \mathrm{R}$$

$$\frac{\partial O}{\partial G_E} \geq 0, \quad \frac{\partial O}{\partial G_S} \geq 0$$

Where R is the real number set and C the characteristics of the country.

Countries with higher per capita income have in general higher obesity rates which are easily explained with the higher income leading to more food consumption and larger calories intake. The impact of individual countries' characteristics on the obesity rates is uncertain given many factors combined in that variable. Finally, the larger the integration of a country into global network of economic, technological, socio-cultural, political and biological factors, the larger the obesity rate is expected to be. This is because world' s largest promoters of globalization are world' s largest exporters of goods, services, "life-style" , information or capital which also happen to be plagued with world' s highest obesity rates.

The modeling of obesity has not been used very broadly. Lakdawalla and Philipson (2002) used panel estimation procedures in order to see if the technological change had an impact on obesity growth. Finkelstein et *al.* (2008), in their study on economic costs of obesity and overweight, applied generalize linear regressions to demonstrate why private firms are likely to under invest for obesity prevention. Given that the data collected on obesity are unbalanced and have a consequent number of missing values, we chose two models appropriate for the type of data that we have:

(1) A panel model given the fact that we have both cross-sectional and time-series data. As the study focuses more on the country-wise effect, a one-way fixed effects model has been chosen.

(2) A quantile regression to explain the variation within the group of countries

Panel Data Procedure: One-Way Fixed Effects Model

Obesity factors have been studied in many papers through parametric and non-parametric models. Time-series procedures are generally used in studies on obesity as obesity varies overtime.

The time-series statistical procedure to examine the normality of obesity involves identification and accounting of systematic components by detrending. The remaining random component is the residuals used to test for normality. The time-series statistical procedure can be represented as:

(1) $y_t = \alpha + \beta x_t$

where y_t represents a $1 \times T$ matrix; x_t represents a $K \times T$ matrix of exogenous time trend variables with T representing the temporal (time series) dimension; α is the intercept, β is the associated parameters to be estimated for each country and ε represents a $1 \times T$ matrix of pure random error. The parameter coefficients in equation (1) are estimated for each country.

Extending the time-series procedure to a panel procedure involving the one-way fixed effects model, we obtain equation (2). We consider the linear model, with Y_{ij} being the dependent variable modeling obesity, given in equation (2):

(2) $Y_{ij} = \beta_0 + \beta_1 x_{ij} + \alpha_i$

where β_0 is the intercept that may be different for each point in time, the i subscript represents the different countries and j refers to the different measurements within these countries, *i.e*, the same variable measured during different years. $\beta_1 x_{ij}$ is considered as a fixed effect because the x_{ij} terms are all known values and the β are fixed parameters. The two error terms α_i and ε_{it} are different from each other. While ε_{it} varies across time and countries, the error term α_i varies only within countries. We consider α_i as representing the combined effect on Y of all unobserved variables that are constant overtime. The error term ε_{it} is a purely random parameter following a normal distribution with mean 0 and variance σ^2. The assumption that the mean is 0 is not critical as it only affects the intercept value (Allison, 2006). Variable x_{ij} is exogenous and represent the Globalization Social Index, the FDI and the trade openness in the model.

Quantile Regression Model

Quantile regression is a linear programming method that provides parameter coefficients estimation for any quantile in the range of zero and one (0,1) conditional on the exogenous variables. Where a simple Ordinary Least Squares regression is based on the mean of the distribution of the regression's variable, the quantile regression assumes that the possible difference in terms of the impact of the exogenous variables along the conditional distribution is important and must be included. Following Koenker and Hallock (2000), parameter coefficients in a single econometric model equation are generally estimated as shown in equation (3):

(3) $\hat{\beta} = \arg(\min \sum_{i=1}^{n} (y_i - \mu)^2)$

Where $\hat{\beta}$ is the estimated coefficient, μ is a parameter and y_i represents a sample of data $\{y_1, y_2, \ldots, y_n\}$.

According to Koenker and Bassett (1978), a single equation econometric model can be extended to quantile regression to examine the changes in coefficients across the distribution of an endogenous model.

The estimated parameters of the quantile regression are given by equation (4):

(4) $\hat{\beta} = \arg(\min \sum_{t=1}^{T} \tau(y_t - \mu)^2)$ for any quantile, $\tau \in (0,1)$

Given that μ is a parameter representing the one way fixed-effects model, μ can be defined as in equation (2) or as in equation (5):

(5) $\mu = f(x_{n,it}|\beta) \; or \; \mu = A \sum_{n=1}^{N} x_{n,it}^{\beta_n}$

The overall equation can therefore be written as in equation (6):

(6) $\hat{\beta}(\tau) = arg(\min_{\beta \epsilon R^p} \sum_{t=1}^{T} \tau(y_t - x_{n,t}\beta_n)^2)$ for any quantile, $\tau \in (0,1)$

The quantile regression as defined in equation (5) is used as the basis for the empirical model presented here:

(7) $Q_t[y_{it}|x_{n,it}] = \beta_{0,\tau} + \beta_{n,\tau} x_{n,it}$

where y is obesity rate, $Q_\tau\left[y \mid x_k\right]$ is the τ^{th} quantile of y conditional on covariate matrix, x_n that includes the FDI, GSI and trade openness. The coefficient $\beta_{n,\tau}$ represents the returns to covariates or inputs at the τ^{th} quantile.

These procedures are used to estimate the model that is presented in the next chapter.

Dynamic Model

The dynamic model accounts for the element of time while a static model does not; it is represented using a differential equation. Suppose that $I=I(t)$ represents the number of overweight people in year t and $y_{actual}=y_{actual}(t)$ the number of obese people in year t. The model incorporates three parameters, α, β and μ. Parameters β and α represent respectively the proportion of overweight people that will go obese and the time frame in which this transformation will happen. Parameter μ is a general parameter given by $\mu = \alpha\beta$.

This can be modeled as a differential equation given in equation (8):

(8) $y' = \alpha(I(t) - \beta y)$

Or

$y' = \beta(\mu I(t) - y)$

For more simplicity, we set $\mu I(t) = w$

The function w is a piecewise function, *i.e.* a function whose definition changes depending on the value of the independent variable. The function takes known values at time points t_j where j=1,2,..,n.

Equation (8) becomes:

(9) $y' = \beta(w - y)$

Following the general solution of differential equations, the solution of the equation is given by equation (10):

(10) $y(t_{j+1}) = e^{-\alpha(t_{j+1}-t_j)}y(t_j) + \int_{t_j}^{t_{j+1}} e^{-\alpha(t_{j+1}-s)}I(s)ds$

where t_j and t_{j+1} represent time points where the measurements w_j are available and $j = 1,\ldots, n$ is a year.

The function I(s), represented by actual data on overweight population, is given by equation (11):

(11) $I(s)_{t_j \le s \le t_{j+1}} = I(t_j) + \frac{s-t_j}{t_{j+1}-t_j}\left(I(t_{j+1}) - I(t_j)\right)$

Or

$$I(s)_{t_j \le s \le t_{j+1}} = I(t_j)\frac{t_{j+1}-s}{t_{j+1}-t_j} + I(t_{j+1})\frac{s-t_j}{t_{j+1}-t_j}$$

Knowing the function *I(s)* being on the interval $[t_j;t_{j+1}]$, an integration by parts is used to solve the integral in equation 10. The overall solution is obtained for equation (10):

$$y(t_{j+1}) = e^{-\alpha(t_{j+1}-t_j)}y(t_j) + \frac{1}{\alpha}\left[w(t_j) - e^{-\alpha(t_{j+1}-t_j)}w(t_j)\right] + \frac{w(t_j)-w(t_{j+1})}{t_{j+1}-t_j}\left(\frac{1-\alpha(t_{j+1}-t_j)-e^{-\alpha(t_{j+1}-t_j)}}{\alpha^2}\right) \quad (12)$$

$j = 1, 2, 3,\ldots, n$ where n represents the length of w and y.

Setting $t_{j+1} - t_j = dt$, which represent the time interval between years, equation (12) can be re-written as:

(13) $y(t_{j+1}) = e^{-\alpha dt}y(t_j) + \frac{w(t_j)}{\alpha}[1 - e^{-\alpha dt}] + \frac{w(t_j)-w(t_{j+1})}{dt}\left(\frac{1-\alpha dt-e^{-\alpha dt}}{\alpha^2}\right)$

A cost function is introduced in the model in order to find the best available parameters. In other words, the cost function, a quadratic function, is used to optimize results obtain for the set of parameters. The overall goal is to minimize the cost function in order to find the most suitable α, β and μ. Thus, we need to find the minimum of the function:

(14) $f(y) = min \sum_{j=1}^{n-1} \left(y(t_{j+1}) - y_{actual}(t_{j+1})\right)^2$

A Golden Section Method is used in order to find a function of several parameters. Let [a,b] be a broad interval, where a is the minimum value and b the maximum value of the interval. Let x_1 and x_2 be two values of the interval and $x_1 < x_2$

- If $f(x_1) < f(x_2)$ then the interval [a,b] is reduced to $[a,x_2]$

  where $x_2 = a + \frac{\sqrt{5}-1}{2}(d-a)$

- If $f(x_1) > f(x_2)$ then the interval [a,b] is reduced to $[x_1,b]$

  where $x_1 = a + \frac{3-\sqrt{5}}{2}(d-a)$

This method uses a loop that implements the statement above until finding a suitable interval, *i.e.* the suitable parameters.

CHAPTER IV. EMPIRICAL METHODS AND PROCEDURES

Data and Estimation Procedure

Several variables are used in the estimation: the percentage of obese adults (male and female), the Foreign Direct Investment (FDI), the Globalization Social Index (GSI), the Trade Openness and the Globalization Economic Index. The data collected are essentially secondary data, *i.e.*, data previously collected by different organizations and compiled into databases accessible by general public. Data spans from 1986 to 2008 for 76 countries, including both developing and developed countries. The data on obesity have been collected mainly from the WHO database; some missing data have been filled with data from the Organization for Economic Co-operation and Development database. It is notable that information on obesity is incomplete. All the data for economic variables, such as FDI, nominal GDP and trade data were collected from the World Bank database and also run from 1986 to 2008 for 76 countries. The mean and standard errors of the variables are presented in Table 3[1]. Table 3 also provides description for the variables.

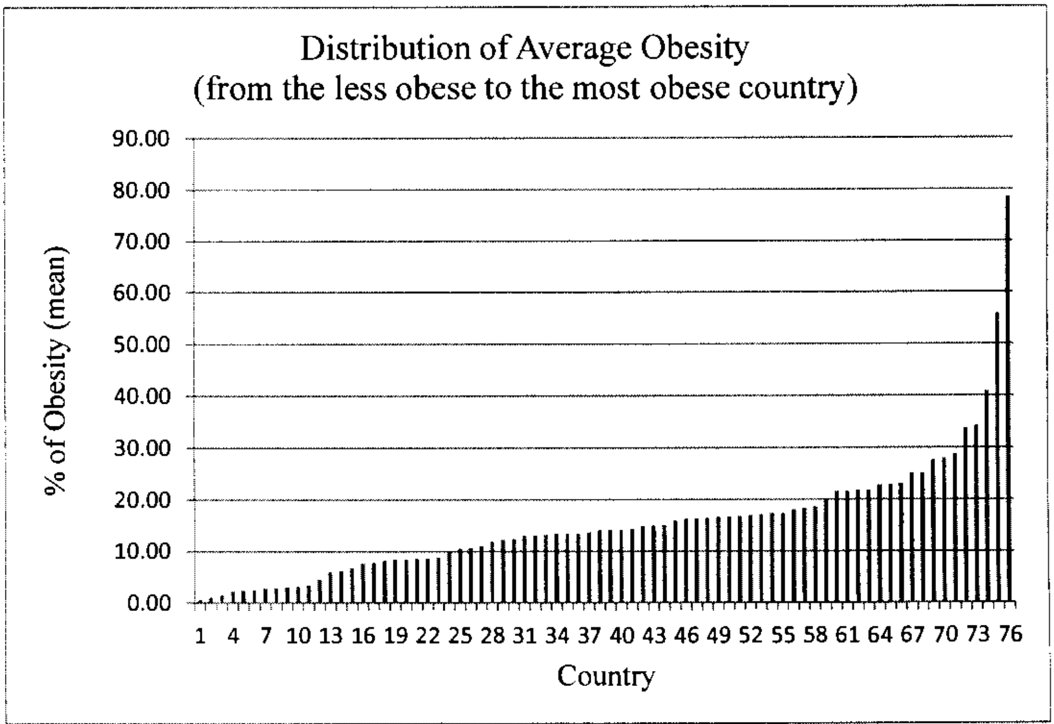
Table 3: Statistics and Description of the Variables

Variable Name	Variable Description	Mean	Standard Deviation
OBESITY	Percentage of Obese People	13.98	8.13
TRADEO	Trade Openness	0.59	0.36
SHAREA	Foreign Direct Investment Ratio	0.07	0.38
GSI	Globalization Social Index	70.23	17.81

[1] Complete data statistics for each variable are available from the author upon request.

The distribution of the obesity data is given by Figure 4, showing countries according to their degree of obesity. The description provided of the country number and the average obesity associated with the country are given in Appendix A.

Figure 4: Distribution of Average Obesity (from the less obese to the most obese country) for 22 years



Foreign Direct Investment, in the World Bank database, is defined as net inflows (new investment less disinvestment). For some countries, the disinvestment is greater than the new investment, which leads to negative values.

The Globalization Social Index was collected on the website of the Swiss Federal Institute of Technology of Zurich. The variable is part of the KOF index introduced in 2002. The overall index covers the economic, social and political dimensions of globalization.

More specifically, the three dimensions of the KOF index are defined as:

- Economic globalization, characterized as long distance flows of goods, capital and services as well as information and perceptions that accompany market exchanges
- Political globalization, characterized by a diffusion of government policies; and
- Social globalization, expressed as the spread of ideas, information, images and people.

Our study focuses on the social aspect, as data on political globalization did not provide much information for our model and the economic part represented the variables that included (FDI and trade openness). The KOF index classifies social globalization in three categories. The first covers personal contacts, the second includes data on information flows and the third measures cultural proximity.

Personal Contacts: This index is meant to capture direct interaction among people living in different countries. It includes international telecom traffic (traffic in minutes per person) and the degree of tourism (incoming and outgoing) a country's population is exposed to. Government and workers' transfers received and paid (in percent of GDP) measure whether and to what extent countries interact, while the stock of foreign population is included to capture existing interactions with people from other countries. The number of international letters sent and received also measures direct interaction among people living in different countries.

Information flows: While personal contact data are meant to capture measurable interactions among people from different countries, the sub-index on information flows is meant to measure the potential flow of ideas and images. It includes the percentage of internet users, the share of households with a television set, and international newspapers traded (in percentage of GDP). All these variables to some extent proxy people's potential for receiving news from other countries which contributes to the global spread of ideas.

Cultural Proximity: Cultural proximity is arguably the dimension of globalization most difficult to grasp. Dreher (2006) suggests the number of English songs in national hit lists or movies shown in national cinemas that originated in Hollywood. However, these data lack for the majority of countries in our sample. Instead, we thus use imported and exported books (relative to GDP). Traded books proxy the extent to which beliefs and values move across national borders.

According to Saich (2000), cultural globalization mostly refers to the domination of U.S. cultural products. Arguably, the United States is the trend-setter in much of the global socio-cultural realm. As an additional proxy for cultural proximity the number of McDonald's restaurants located in a country has been included in the index. For many people, the global spread of McDonald's became a synonym for globalization itself. In a similar vein, the number of Ikea per country is also used.

The second variable used in the model is trade openness which measures the ability for a country to trade with other countries. Trade openness is a ratio represented by equation (17):

$$(17)\quad TO = \frac{X+M}{GDP}$$

where X represents imports (million $ / current price), M represents exports (million $/ current price) and GDP is the nominal GDP of the country in current US dollars.

Model Estimation

To evaluate the factors effecting obesity using the static and dynamic framework, equation (18), equation (19) and equation (21) respectively are estimated.

Static Model Estimation

The method used to estimate the model is a one-way fixed effects model completed by a quantile regression. Using the theoretical model described in Chapter III for panel modeling, the estimated equation is given by:

Time series:

(18) $\log(\widehat{y_{it}}) = \widehat{\beta_0} + \widehat{\beta_1}\, log(tradeO_{it}) + \widehat{\beta_2}\, log(shareA_{it}) + \widehat{\beta_3}\, log(GSI_{it}) + \varepsilon_{it}$

One-way fixed effects panel model:

(19) $\log(\widehat{y_{it}}) = \widehat{\beta_0} + \widehat{\beta_1}\, log(tradeO_{it}) + \widehat{\beta_2}\, log(shareA_{it}) + \widehat{\beta_3}\, log(GSI_{it}) + \alpha_i + \varepsilon_{it}$

where the β_i are the parameter estimates of the regression and Y the dependent variable representing obesity.

The quantile regression as defined in equation (2) is used as the basis for the empirical model presented here:

(20) $Q_t[y_{it}|x_{n,it}] = \beta_{0,\tau} + \beta_{n,\tau}x_{n,it}$

(21) $Q_t[y_{it}|x_{n,it}] = \widehat{\beta_0} + \widehat{\beta_1}\, log(tradeO_{it}) + \widehat{\beta_2}\, log(shareA_{it}) + \widehat{\beta_3}\, log(GSI_{it}) + \alpha_i + \varepsilon_{it}$

The above one-way fixed effect quantile model is estimated for ten percent quantiles beginning with 10 percent.

Dynamic Model Estimation

Obesity and overweight values from the WHO database for the United States between 1976 and 2005. The model is then extended for several other regions: for the World itself and for the European Union. Countries are grouped by category, according to the criteria developed above. The countries are chosen depending on data availability for both obesity and overweight. For every year, from 1987 to 2007, a weighted average method is used in order to generate a single value for the different regions studied for each year. Equations (22) and (23) present the method used:

$$(22)\quad Obesity_{region} = \frac{\sum_{i=1}^{4} w_i y_i}{\sum_{i=1}^{4} w_i}$$

where w_i is the weight of the variable, *i.e.*, the population of the country i, and y_i is the percentage of obese people in the country *i*.

$$(23)\quad Overweight_{region} = \frac{\sum_{i=1}^{4} w_i v_i}{\sum_{i=1}^{4} w_i}$$

where w_i is the population of the country *i* and v_i is the percentage of overweight people in the country *i*.

Matlab estimates the parameters given the set of data for the United States, the World and the European Union. Results and discussion are provided in the next chapter.

CHAPTER V. EMPIRICAL RESULTS AND DISCUSSION

Empirical Results

The one-way fixed effects model includes countries as dummy variables. Nevertheless, due to a large number of countries, the coefficients of these ones won't be interpreted, but they are generally consistent with expectations. The correlation matrix given in Table 4 does not show any high correlation between the variables. The coefficients are all sufficiently low to justify the inclusion of all the variables in the model.

Table 4: Correlation Matrix

Variables	*OBESITY*	*TRADEO*	*SHAREA*	*GSI*
OBESITY	1.000	0.022	0.051	0.048
TRADEO	0.022	1.000	0.168	0.222
SHAREA	0.051	0.168	1.000	0.092
GSI	0.048	0.222	0.092	1.000

The regression results are reported in Table 5. Since the variables are estimated in logarithms, the parameter coefficients can be interpreted as elasticity. Both one-way random effects and one-way fixed effects models have been estimated. Based on its smaller Akaike criterion value, the one-way fixed effects is kept as the base model.

Table 5: Economic and Social Impact Parameter Estimates on Obesity, 1986-2008.

	Parameter Estimates	
Variable	One-Way Fixed Effects Model	One-Way Random Effects Model
Intercept	3.243*** (0.459) [5.10]	3.218*** (0.533) [6.03]
LTRADEO	0.289*** (0.101) [2.86]	0.261*** (0.088) [2.95]
LSHAREA	0.023 (0.015) [1.59]	0.025* (0.014) [1.76]
LGSI	0.775*** (0.148) [5.03]	0.720*** (0.014) [5.89]
Degrees of freedom	290	355
0.05 Critical value	1.96	1.96
R^2 / *Adjusted* R^2	0.93	
Akaike criterion (AIC)	-32.81	112.99

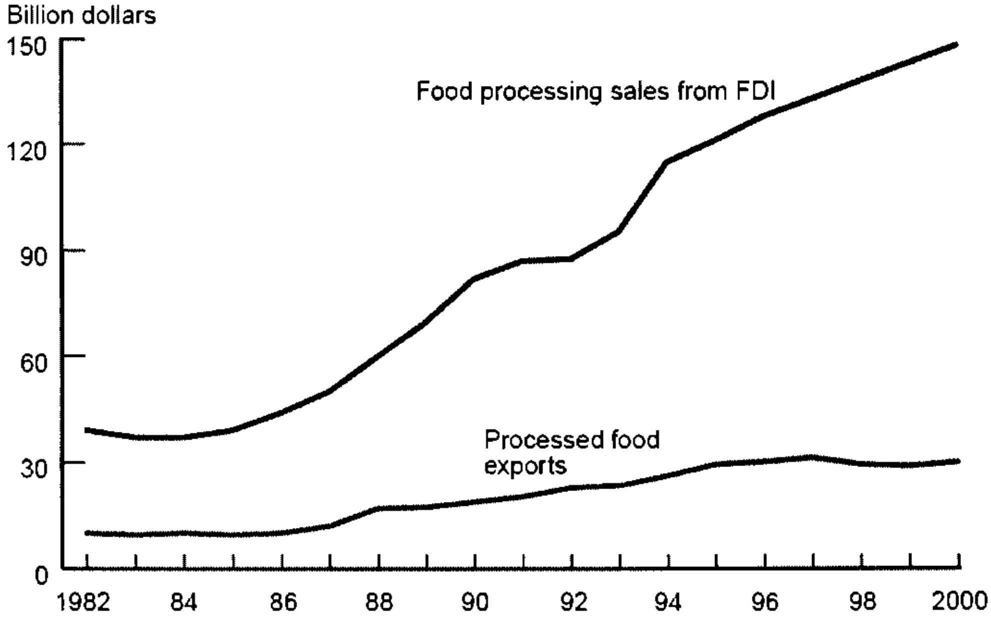
Notes: Standard errors are given in parentheses. T-stats are shown in brackets. *** indicates statistical significance at the 1 percent level. * indicates statistical significance at the 10 percent level.

The omitted (base) country is Australia and most country coefficients have negative signs and are statistically significant. Several countries such as the United States, the United Kingdom of Great Britain or Saudi Arabia have positive signs only because their obesity prevalence is higher than that in Australia. Among economic variables and social globalization factors, trade openness and the GSI are both statistically significant at 1 percent significance level. Both these variables have a positive impact on the obesity growth: a 10 percent increase on trade openness and GSI would lead to a 2.9 and 7.4 percent increase of obesity respectively. FDI's impact on obesity growth is not statistically significant.

The results on economic variables, *i.e.,* trade openness and FDI are partially unexpected. The impact of trade openness on obesity rate is positive and relatively small. The immediate availability for consumption of imported goods, including high-calorie processed food/beverage products as well as convenience and electronics goods encourage a sedentary life-style and are likely to contribute to an increase in average weight of people.

Even though the FDI impact is not statistically significant, its value is very low comparing to the trade openness. This result is contrary to our expectations: indeed, we could think that when a company invests abroad, it brings its culture in the country where it goes. McDonalds could be an example: where the firm has built its restaurants, the population has had access to fast-food. In China, the first restaurant opened in 1990 and since then, the obesity growth has not stopped increasing. The introduction of fast-food restaurants developed and spread fast and highly dense food coming originally from the US. Countries like India or China, which were not used to eat that type of food, might not have had access to it without the investment of foreign firms. Bolling and Somwaru (2001) suggest that in recent decades, foreign direct investment has been more used to penetrate foreign markets than exports. Taking the case of the US, they showed that the government, thanks to a strong dollar, gives priority to the establishment of US companies abroad. A strong dollar doesn't encourage a country to import but facilitates the setting up of foreign companies on its territory. Moreover, when a country encounters currency depreciation, the government seeks foreign capital to boost the economy, *i.e.* they look for foreign investments. Figure 5 compares the evolution of processed food sales from export with processed food coming from U.S. FDI.

Figure 5: Processed Food Sales from US FDIs Exceed US Food Exports



Source: Bolling and Sumawru (2001)

The lack of impact for the FDI could be explained by two facts. First possible explanation is that the impact of the investment made by a firm abroad cannot be accounted instantaneously; this impact is likely to occur with a lag of few years. Most investments are done gradually over time since time is needed to build facilities and make them operational. However, as data on obesity are not available for every year for most countries, it prevents the use of lagged FDIs in the model. The second explanation is that FDIs totalize all the companies in the index, not only agricultural and food companies. Therefore, it doesn't depict the only impact of settlement of agriculture and food companies abroad, but also other type of industries.

The Globalization Social Index has a large and significant impact on the obesity growth. An increase by 1% of the GSI would lead to a 74 percent increase of obesity. These results can be confirmed and illustrated by the literature. Several papers have been done, especially on the role of TV on changes in life-style affecting the growth of obesity. One of these changes is the change in diet habits. Blass et *al.* (2006), studying two populations of people eating either pizza or macaroni and cheese in front of the TV, showed that the number of calories eaten were increasing by 36% for the pizza and 71% for the macaroni and cheese. They found as well that people were taking less time between two pieces of pizza than when they don't eat in front of the television. This makes food consumption easier and leads to an important food intake. The GSI takes into account the number of TV's per home, which can indirectly capture that idea. The results obtained in the current study follow these results. TV watching is an important factor to influence obesity, especially with the consumption of high density, easy cooking and tasty food.

The R^2 of the regression (R^2=0.93) suggests a good fit of the model, while the adjusted R-squared ($R^2_{adjusted}$=0.93) confirms a good model specification.

Quantile Results

While a one-way fixed effects model can only answer the question: Do economic variables affect obesity?, a quantile regression allows us to answer the question: How these variables affect each category of countries? The quantiles represent the repartition of the number of data, *i.e.*, the highest quantile indicate the country where there was the most available data whereas the lowest quantile refers to the countries which had the least amount of data available. When looking at Table 6 it appears that the developed countries, generally referred as the most obese countries, belong to the high quantiles. For more simplicity in the interpretation, we will consider the high quantiles as most obese and low quantiles as less obese (according to Table 6).

Table 6: Distribution of the Countries in the Quantiles based on Percentage of Obesity

Country	LOBESITY	LTRADEO	LFDI2	LGSI	Quantile
Nauru	4%	0%	0%	0%	10th
Serbia and Montenegro	4%	39%	52%	96%	
Bosnia and Herzegovina	4%	65%	65%	96%	
Kyrgyzstan	4%	65%	70%	96%	
Macedonia, FYR	4%	70%	78%	96%	
Eritrea	4%	74%	57%	96%	
Slovenia	4%	74%	74%	74%	
Malta	4%	96%	96%	96%	
Romania	4%	96%	83%	96%	
Chile	4%	100%	100%	96%	
China	4%	100%	100%	96%	
Cyprus	4%	100%	100%	96%	
Dominican Republic	4%	100%	100%	96%	
Fiji	4%	100%	100%	96%	
Gambia	4%	100%	100%	96%	
India	4%	100%	100%	96%	
Indonesia	4%	100%	100%	96%	
Mauritius	4%	100%	100%	96%	
Peru	4%	100%	100%	96%	
Philippines	4%	100%	100%	96%	
Seychelles	4%	100%	100%	96%	
South Africa	4%	100%	100%	96%	
Vanuatu	4%	100%	100%	96%	
Lebanon	9%	91%	91%	96%	
Bahrain	9%	100%	100%	96%	
Brazil	9%	100%	100%	96%	
Colombia	9%	100%	100%	96%	
Greece	9%	100%	96%	96%	
Iceland	9%	100%	100%	96%	
Lao Peoples	9%	100%	91%	96%	

Table 6 (continued)

Country	LOBESITY	LTRADEO	LFDI2	LGSI	Quantile
Democratic Republic					10th
Singapore	9%	100%	100%	96%	
Tunisia	9%	100%	100%	96%	
Iran (Islamic Republic of)	13%	87%	87%	96%	20th
Ghana	13%	100%	100%	96%	
Mexico	13%	100%	100%	96%	
Morocco	13%	100%	100%	96%	
Tonga	13%	100%	100%	96%	
Turkey	13%	100%	100%	96%	
Croatia	17%	74%	70%	74%	
Poland	17%	100%	100%	96%	
Czech Republic	22%	74%	70%	65%	30th
Denmark	22%	100%	100%	96%	
Ireland	22%	100%	100%	96%	
Kuwait	22%	100%	61%	96%	
Malaysia	22%	100%	100%	96%	
Pakistan	22%	100%	100%	96%	
Latvia	26%	65%	74%	74%	
Slovakia	26%	74%	65%	65%	
Austria	26%	100%	100%	96%	
Norway	26%	100%	100%	96%	
Portugal	26%	100%	100%	96%	
New Zealand	30%	100%	100%	96%	
Switzerland	30%	100%	100%	96%	
Estonia	35%	65%	74%	74%	40th
Australia	35%	100%	100%	96%	
Luxembourg	39%	43%	30%	96%	
Lithuania	39%	65%	70%	74%	
Hungary	39%	100%	78%	96%	
Israel	48%	100%	100%	96%	50th
Spain	48%	100%	100%	96%	
Sweden	52%	100%	100%	96%	60th
Italy	57%	100%	100%	96%	
Germany	61%	100%	100%	96%	70th
Saudi Arabia	61%	100%	100%	96%	
France	65%	100%	100%	96%	
United States of America	70%	100%	100%	96%	
Canada	74%	100%	100%	96%	80th
United Kingdom of Great Britain and Northern	78%	100%	100%	96%	

Table 6 (continued)

Country	LOBESITY	LTRADEO	LFDI2	LGSI	Quantile
Ireland					
Japan	87%	100%	100%	96%	90th
Netherlands	91%	100%	100%	96%	
Finland	96%	100%	100%	96%	

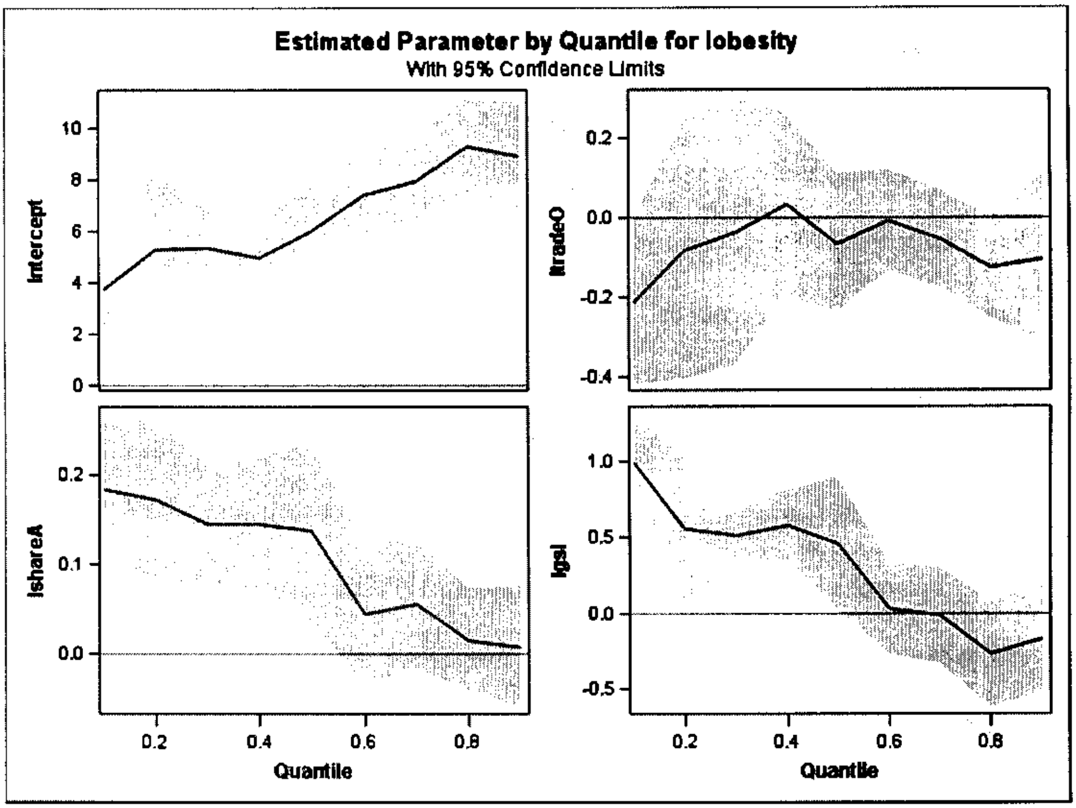
Countries with missing observations had to be deleted leaving only 71 countries to be estimated. SAS estimates the quantile regression with the Simplex method. Table 7 and Figure 6 provide the results of the quantile regression. Most of the developed countries belong to the higher quantiles whereas the developing or least developed countries belong to the lower quantiles.

Table 7: Summary of the Quantile Regression Results

Variables	Quantiles								
	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
Intercept	3.724*** (0.743)	5.267*** (1.585)	5.353*** (1.443)	4.967*** (0.871)	5.980*** (0.921)	7.410*** (0.966)	7.940*** (0.982)	9.31*** (0.935)	8.89*** (1.193)
LTRADEO	-0.212** (0.273)	-0.084 (0.171)	-0.038 (0.167)	0.031 (0.131)	-0.066 (0.082)	-0.009 (0.068)	-0.057 (0.076)	-0.126* (0.073)	-0.107 (0.111)
LSHAREA	0.184*** (0.032)	0.173*** (0.045)	0.145*** (0.030)	0.145*** (0.036)	0.140*** (0.051)	0.045 (0.046)	0.056 (0.037)	0.016 (0.035)	0.008 (0.037)
LGSI	0.986*** (0.151)	0.554*** (0.264)	0.507** (0.096)	0.573*** (0.119)	0.454** (0.202)	0.026 (0.182)	-0.020 (0.177)	-0.270 (0.171)	0.170 (0.193)

Notes: Standard errors are given in parentheses. *** indicates statistical significance at the 1 percent level. ** indicates statistical significance at the 5 percent level. * indicates statistical significance at the 10 percent level.

Figure 6: Estimated Parameters for the Quantile Regression



Quantile regression results are very informative and somewhat contradictory to the one-way fixed effects model results in the panel estimation. The GSI variable is positive and significant from the first through the fifth quantiles, while it is not positive and significant from the sixth quantile and above. This lack of GSI impact at high quantiles is fairly intuitive if we know that most countries in these above average obesity rates are developed countries. They, for the most part, share social values, life-style and high economic standards. When looking at the distribution of countries within the quantiles (Table 7), it appears obvious that results are consistent, knowing that Japan, Canada and the United Kingdom are already affected by the American culture.

Figure 6 shows that the impact of FDI's is always positive but not significant for the sixth to the ninth quantile, corresponding to the developed countries. Since most FDI's into developed countries are coming from other developed countries, their impact on way of life and in turn on obesity rate is negligible. Trade openness can be interpreted similarly as it is known that most developed countries trade primarily with other developed countries, as postulated by the Linder hypothesis (Linder, 1961). The exception in the eight quantile of a negative impact of trade openness on obesity rate might be caused by the imports of raw/unprocessed commodities and products (food and others).

Low and average quantiles tell a completely different story. Here, the impact of both GSI and FDI is positive and statistically significant. Low quantiles representing relatively lower obesity rates are for the most part typical of the less developed countries. These countries are the followers rather than the leaders in terms of global social standard setting. Hence, the impact of globalization is far more pronounced in less developed countries than in developed countries. This ultimately leads to changes in traditional life-style and in turn to an increase in obesity. The GSI has a high impact on less obese countries. Globalization, as seen earlier, mostly refers to the domination of U.S. cultural products. Products can be understood as food products (restaurants, agricultural products), media products (e.g., newspapers, TV channels), or cultural goods such as movies, songs or video games. It is understandable that a country where the obesity rate is low and which has not been yet exposed to the American culture, will be more impacted than a country where the Americanization has already taken place.

The same holds true for the impact of FDI on obesity rate. Less developed countries are large and interesting markets for companies in developed countries, *i.e.*, the capital is typically flowing from developed to less developed countries, which have a cheap and abundant labor force and other resources. In turn, many newly created companies and subsidiaries in less developed countries make products which directly (e.g., food products) or indirectly (e.g., products inducing sedentary life-style) lead to an increase in obesity. Moreover, an increase in income induced by the FDI's is likely to lead to an increase in obesity as a secondary and unwanted effect. Trade openness, on the other hand, has no impact in the low and average quantile range with the exception of the lowest quantile. Low purchasing power of the general population in less developed countries makes them unattractive for exporters of relatively high-cost value-added goods. The lowest quantile countries, *i.e.*, the countries with lowest obesity rates, are also the least developed countries. They typically export single or few raw commodities, and increasing trade openness often reflects the increase in relative exports rather than imports of these commodities. The prices of most of these commodities are often low and their export does not contribute to increasing the standard of living and in turn the obesity level.

Dynamic Model Results

Since we determined the different impacts of both economic and social variables, we are now interested in finding the proportion of people that will possibly become obese and how fast this will happen. A differential equation and a minimization process are employed to answer these questions.

Given the set of parameters, we compare between categories the different proportion of overweight people that will go obese and how fast that will happen. The comparison is made in Table 8. Parameter μ, provided in Table 8, is only a parameter that is used to calculate parameter α.

Table 8: Results of the Mathematical Model

	Parameter Estimates		
Parameter	United States	World	European Union
α	2.473	Infinity	Infinity
β	0.344	0.344	0.274
μ	0.851	Infinity	Infinity

Parameters α and β represent respectively the time frame of the transition from overweight to obesity and the proportion of overweight people who become obese. It is important to notice the difference between the United States and the European Union for the parameter β: where 34.4 percent of overweight Americans become obese, only 27.4 percent of overweight Europeans take this path. A possible explanation for these results would be different diet patterns, different life-style habits or a different perception of obesity. Overweight people in the European Union might be more aware and more concerned of the consequences of obesity on their body image. A study by McElhone et *al.* (1999) showed that European females are highly concerned with their body image; most women are unhappy with their weight and suffer from the societal pressure to be thin. People, concerned about their image, will be more willing to improve their body shape with a weight-loss diet, more physical activity or healthier eating habits in order to return to a normal BMI and avoid obesity. On the contrary, a study by Rucker III and Cash (1992) suggested that Black-American women were less concerned about their weight. The authors showed that Black-Americans judge fatness in accordance with how they perceived their own body size. Moreover, as seen in the literature review, black people are more subject to be overweight or obese. Thus, less effort will be made to change appearance and being obese will not necessarily be considered as being unconventional.

The second point to notice is the values of the parameter α for the United States, the World and the European Union. Parameter α tends to infinity for the World and the European Union. This results means that, if there is an increase in the percentage of overweight people, the response for obesity will be infinitely deferred, *i.e.*, an increase of obese people will occur a long time later. On the contrary, the value for the United States indicates that the response will happen in a shorter period of time (2.47 years). This result means that overweight people in the United States are more likely to become obese much faster than Europeans or the overall population of the world. This emphasizes the idea of "obesity consciousness" having less of an effect for people in the United States, leading to a non-surveillance of weight and a weight transition from overweight to obese. Diet habits and lifestyle are as well two potential explanations of these value differences.

CHAPTER VI. CONCLUSIONS AND IMPLICATIONS

Obesity has been growing around the world during the last few decades leading the WHO to announce the global obesity epidemic. While obesity in the past has been mostly recorded in developed countries, it has more recently become, a commonplace in less developed countries thus creating a peculiar situation of the simultaneous existence of poverty and malnutrition on one hand, and obesity on the other hand. An epidemic, in medical terms, implies that the disease is infectious and that there are agents such as viruses or bacteria which are facilitating the transmission of the disease. Obesity, however, is defined in this research as a global socio-economic disease. A global economic disease exists and spreads globally, and has its highest incidence in countries and among socio-economic groups predisposed to it by a given set of living and/or working conditions which are facilitated by the globalization processes. Therefore, the agents which facilitate spreading of obesity are the factors of the social and economic globalization.

A model is developed in which both indigenous and external (globalization) factors contribute to obesity growth. Trade openness and foreign direct investments (FDI) are used as proxies for economic globalization factors, while the globalization social index (GSI) serves as a measure of social globalization. The unbalanced panel data set contains information for 76 countries (both developed and less developed) over the period 1986-2008. Fixed-effects panel data estimation and quantile regression analysis were used to analyze the data. The fixed-effects panel model results indicate that the impact of trade openness and the GSI on global obesity rates is positive and significant, which is consistent with prior expectations, while surprisingly the FDI has no impact on global obesity. While these results are interesting, they are hiding the effect of the globalization processes across the conditional distribution of the obesity variable. This shortcoming is overcome by the use of quantile regression which uncovered that the impact of the FDI and the GSI on low and average quantiles (low and average obesity rates in our sample) is positive and significant, while high quantiles are not affected. Since low and average quantiles (low and average obesity rates) are representative of the less and medium developed countries, this result implies that social globalization and FDI adversely impact obesity in less to medium developed countries while they have no impact on obesity rates in developed countries. Trade openness generally has no impact on changes in obesity rates across quantiles.

The second model developed in the study consisted of monitoring overweight and obesity via a measurement of the proportion of overweight people becoming obese and the timeframe in which this will happen. As expected, the United States has the biggest increase proportion over the shortest period of time, whereas the World and the European Union have a tendency to experience this increase on a long-term period. Diet patterns, lifestyle habits and culture are three factors that might explain these differences among the three different regions.

Globalization is a process by which national/regional economies, societies, and cultures have become integrated through a global network of economic, technological, socio-cultural, political, and biological factors. The implications of globalization are different for different countries and regions. Rich, more developed countries are leading the charge and promote the idea of globalization which enables them to enlarge the markets for their products and increase socio-political influence on the rest of the world. Many positive aspects of globalization are likely to lead an increase in standard of living in most countries of the world. Yet, there are some unwanted side-effects of globalization such as an increase in obesity which is now considered a global epidemic.

High social cost of obesity is surely to lower the benefits of globalization, especially in less developed countries which are most responsive to these external influences.

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APPENDIX A. SUPPLEMENT STATISTICS

Table 9: Summary Statistics for Obesity for 76 Countries from 1986 to 2008

Country	Number	Number of observations	Mean	Standard Deviation	Min	Max
India	1	1	0.70	.	0.70	0.70
Lao Peop.Dem.Rep.	2	2	1.13	0.01	1,06	1,20
South Korea	3	2	1.60	1,13	0.80	2.40
Gambia	4	1	2.30	.	2.30	2.30
Indonesia	5	1	2.40	.	2.40	2.40
Japan	6	20	2.62	0.58	1.80	3.90
China	7	1	2.90	.	2.90	2.90
Korea (North)	8	3	2.97	0.68	2.20	3.50
Ghana	9	3	3.14	0	3.14	3.14
Eritrea	10	1	3.30	.	3.30	3.30
Pakistan	11	5	3.42	0	3.42	3.42
Philippines	12	1	4.60	.	4.60	4.60
Singapore	13	2	6.00	1.27	5.10	6.90
Switzerland	14	7	6.25	1.31	4.95	8.20
Norway	15	6	6.85	1.48	5.10	9.00
Netherlands	16	21	7.79	2.24	4.80	11.30
Mongolia	17	2	7.85	2.75	5.90	9.80
Italy	18	13	8.30	1.33	6.40	10.20
Denmark	19	5	8.38	2.19	5.50	11.40
Sweden	20	12	8.39	1.75	5.40	10.70
Romania	21	1	8.60	.	8.60	8.60
Kyrgyzstan	22	1	8.71	.	8.71	8.71
France	23	15	8.83	2.93	5.70	16.90
Iceland	24	2	9.95	3.46	7.50	12.40
Finland	25	22	10.65	2.37	7.50	15.70
Austria	26	6	10.73	1.63	8.50	12.40
Brazil	27	2	11.10	0	11.10	11.10
Ireland	28	5	11.90	3.75	8.00	17.80
Cyprus	29	1	12.30	.	12.30	12.30
Estonia	30	8	12.48	2.27	7.77	15.20
Portugal	31	6	13.02	2.29	9.00	14.70
Spain	32	11	13.20	4.22	8.20	23.70
Czech Republic	33	5	13.22	2.65	11.30	17.00
Malaysia	34	5	13.43	4.37	5.80	16.30
Morocco	35	3	13.47	2.19	12.20	16.00
Lebanon	36	2	13.50	0	13.50	13.50
Colombia	37	2	13.70	0	13.70	13.70
Fiji	38	1	14.10	.	14.10	14.10
Iran (Islamic Republic of)	39	3	14.21	3.88	10.34	18.10

Table 9 (continued)

Country	Number	Number of observations	Mean	Standard Deviation	Min	Max
Latvia	40	6	14.24	1.59	11.90	16.30
Mauritius	41	1	14.39	.	14.39	14.39
Poland	42	4	14.95	3.55	11.40	18.00
Slovenia	43	1	15.00	.	15.00	15.00
Canada	44	17	15.16	2.38	12.10	23.10
Vanuatu	45	1	15.90	.	15.90	15.90
Peru	46	1	16.30	.	16.30	16.30
Dominican Republic	47	1	16.40	.	16.40	16.40
Slovakia	48	6	16.48	1.62	14.30	18.90
Lithuania	49	9	16.70	2.35	14.80	20.40
Greece	50	2	16.75	8.13	11.00	22.50
Turkey	51	3	16.80	5.19	12.00	22.30
Luxembourg	52	9	16.94	1.45	14.90	18.60
Tunisia	53	2	17.21	0	17.21	17.21
Australia	54	8	17.37	3.41	10.80	20.82
Serbia and Montenegro	55	1	17.38	.	17.38	17.38
Germany	56	14	18.07	3.19	11.00	22.00
Hungary	57	9	18.37	2.33	15.76	21.11
United Kingdom of Great Britain and Northern Ireland	58	18	18.58	4.48	10.00	24.20
United States of America	59	16	20.16	7.17	11.60	34.30
South Africa	60	1	21.56	.	21.56	21.56
Bosnia and Herzegovina	61	1	21.70	.	21.70	21.70
New Zealand	62	7	21.71	4.79	12.70	26.50
Chile	63	1	21.90	.	21.90	21.90
Israel	64	11	22.82	0.14	22.60	22.90
Croatia	65	4	22.89	0.39	22.30	23.08
Malta	66	1	23.10	.	23.10	23.10
Macedonia, FYR	67	1	25.10	.	25.10	25.10
Seychelles	68	1	25.10	.	25.10	25.10
Saudi Arabia	69	14	27.59	7.20	20.93	26.50
Mexico	70	3	27.93	3.75	23.60	30.20
Bahrain	71	2	28.86	0	28.86	28.86
United Arab Emirates	72	2	33.74	0	33.74	33.74
Kuwait	73	5	34.25	7.53	28.75	42.50
French Polynesia	74	1	40.90	.	40.90	40.90
Tonga	75	3	56.00	0	56.00	56.00
Nauru	76	1	78.53	.	78.53	78.53