MACROECONOMIC IMPACTS OF DERIVATIVE MARKETS

A Master's Thesis

by

MEHTAP BEYZA POLAT

The Department of

Economics

Bilkent University

Ankara

December 2006

To My Family

MACROECONOMIC IMPACTS OF DERIVATIVE MARKETS

The Institute of Economics and Social Sciences
of
Bilkent University

by

MEHTAP BEYZA POLAT

In Partial Fulfillment of the Requirements for the Degree of
MASTER OF ARTS

in

THE DEPARTMENT OF ECONOMICS
BİLKENT UNIVERSITY
ANKARA

December 2006

I certify that I have read this thesis and have found that it is fully adequate, in scope and in quality, as a thesis for the degree of Master of Arts in Economics.

Asst. Prof. Refet Gürkaynak
Supervisor

I certify that I have read this thesis and have found that it is fully adequate, in scope and in quality, as a thesis for the degree of Master of Arts in Economics.

Assc. Prof. Fatma Taşkın
Examining Committee Member

I certify that I have read this thesis and have found that it is fully adequate, in scope and in quality, as a thesis for the degree of Master of Arts in Economics.

Asst. Prof. Aslıhan Altay-Salih
Examining Committee Member

Approval of the Institute of Economics and Social Sciences

Prof. Erdal Erel
Director

ABSTRACT

MACROECONOMIC IMPACTS OF DERIVATIVE MARKETS

Polat, Mehtap Beyza
M.A., Department of Economics
Supervisor: Asst. Prof. Refet Gürkaynak

December 2006

There has been much debate over the effect of financial development on economic growth and well-being. A conclusion has not been reached yet; some of the works assert that the level of financial development leads to sounder macroeconomic conditions, whereas some others hold opposing views. Another line of literature concentrates on the relation between the level of existing uncertainty and the level of investment. There are again controversial conclusions reached regarding this relationship; some argue that the level of uncertainty has a negative effect on investment, whereas some argue that the correlation between these two variables is positive. In this paper, the assertions of these two different lines of the literature will be linked under a single heading, the derivative markets. This paper will analyze the effect of the existence and growth rate of the derivative market volume on the standard of living of individuals under the framework first constructed by Mankiw, Romer and Weil (1992).

Keywords: Derivative Markets, Economic Growth

ÖZET

TÜREV PİYASALARININ MAKROEKONOMİK ETKİLERİ

Polat, Mehtap Beyza
Yüksek Lisans, Ekonomi Bölümü
Tez Yöneticisi: Yard. Doç. Dr. Refet Gürkaynak

Aralık 2006

Finansal gelişmişliğin ekonomik büyüme üzerindeki etkileri literatürde sıkça tartışılmış bir konudur. Bu konuyla ilgili herhangi bir mutabakata varılamamıştır; kimi çalışmalar finansal gelişmişliğin daha sağlıklı makroekonomik sonuçlar doğurduğunu savunurken, diğer bazı çalışmalar bunun aksi görüşü benimsemektedirler. Diğer bir literatür ise var olan belirsizlik ile yapılan yatırım arasındaki ilişkiyi incelemektedir. Bu ilişki hakkında da karşıt görüşler mevcuttur; kimi çalışmalar artan belirsizliğin yatırım üzerinde olumsuz etkileri olduğunu iddia ederken, diğer bazı çalışmalar bu iki değişken arasındaki ilişkinin pozitif olduğu görüşünü savunmaktadır. Bu çalışma ile birlikte bu iki farklı literatürün bulguları tek bir başlık altında toplanabilecektir: türev piyasaları. Bu çalışma türev piyasalarının varlığı ve hacminin büyümesinin bireylerin yaşam standartları üzerindeki etkilerini, ilk kez Mankiw, Romer ve Weil (1992) tarafından oluşturulan çerçeve içerisinde inceleyecektir.

Anahtar Kelimeler: Türev Piyasaları, Ekonomik Büyüme

ACKNOWLEDGEMENTS

I would like to thank my honorable teacher Dr. Refet Gurkaynak for his guidance from the beginning to the end of this thesis. Without the invaluable comments he provided, I would not be able to complete this work.

I would also like to thank my honorable teacher Dr. Fatma Taşkın for the precious support she gave me throughout my whole graduate study.

I also want to thank my examining committee members Dr. Aslıhan Altay-Salih for her valuable comments.

I am also grateful to Banu Demir, Ozan Acar and Barış Esmerok for their sincerity and support. I would not be able to overcome the hard times of my master studies without their friendship.

I would finally like to thank to my family for giving me an invaluable support from the beginning of the primary school to the end of this thesis.

TABLE OF CONTENTS

LIST OF TABLES

CHAPTER 1

INTRODUCTION

In 1911, Schumpeter argued that the services provided by financial intermediaries are crucial for economic development and well-being. Since then there has been much debate over this issue. This ongoing debate did not reach to a single conclusion, yet. Some of the works in the literature are in favor of this view, some others hold opposing claims. A common feature of all these works is that they take the financial system as composed of banks and the stock markets, only. Another line of literature deals with the relationship between the level of existing uncertainty and the level of investment. The conclusions reached regarding this relation are again quite controversial; some argue that the level of uncertainty has a negative effect on investment, whereas some contend that these two variables have a positive correlation.

In this paper, these two different lines of the literature will be linked under a single heading, the derivative markets. Derivative markets provide the service of risk management, which is one of the most important services of financial intermediaries. In other words, derivative markets enable the economic agents to hedge themselves against the idiosyncratic risks they face. A single economic agent is not able to alter the risk existing in the market. However, by utilizing the services that derivative markets provide, s/he can reduce the unsystematic risk s/he will face and may thus reduce the uncertainty associated with the transactions s/he plans to conduct. If the correlation between uncertainty and the investment is negative, then this will end up with higher level of investment and consequently with sounder economic conditions. However, if this correlation is positive, then level of investment will be lower.

This paper will analyze the effect of the existence and growth rate of the derivative market volume on the standard of living of individuals under the framework first constructed by Mankiw, Romer and Weil (1992). The conclusions of this paper will provide some further evidence on the relation between finance and macroeconomics from a perspective different from the existing one and relate it to another important line of the literature, which is concerned with the investment-uncertainty relationship. In this paper, I do not aim to make any conclusions regarding the relation between the existence of derivative markets and the level of uncertainty. The reason why I refer to the literature on investment-uncertainty relationship is to clarify the motivation of this paper. The derivative markets enable the economic agents to reduce the unsystematic risk existent in the market and reduces the uncertainty in a way. Thus the correlation between the level of uncertainty and the level of investment, and thus the level of economic activity, makes derivative markets a relevant concept for economic growth. In other words, the investment uncertainty relation is the channel through which I make my main hypothesis that “derivative markets may have effects on economic growth”.

The organization of the paper is as follows; following section (Chapter 2) presents a very brief literature review on the finance-macroeconomics and the investment-uncertainty relations. Chapter 3 will introduce the data, methodology and the results of the empirical analysis will be presented. I will finally conclude the paper in Chapter 4.

CHAPTER 2

LITERATURE REVIEW

As stated before, this paper is associated with two distinct lines of the existing literature, the literature on the finance-macroeconomics relation and the literature on the investment-uncertainty relation. In this section of the paper, I will very briefly summarize these two lines of the literature.

Regarding the relationship between finance and macroeconomic conditions, there is a vast amount of work done. Financial development provides five major functions, which are (i) production of ex ante information about possible investments, (ii) monitoring of investments and implementation of corporate governance, (iii) trading, diversification, and management of risk, (iv) mobilization and pooling of savings, and (v) exchange of goods and services. (Levine, 2004) Derivative markets enable the economic agents to manage their risks and decrease the level of uncertainty they will face. Since this paper aims to explore the role of derivative markets, the third function provided by financial intermediaries becomes the one this paper is mainly concerned with. In Levine (2004), the risks that can be managed using the services provided by financial intermediaries are divided into three categories; cross sectional risk, intertemporal risk and liquidity risk. Several works discussed the crucial role of financial markets in terms of the cross sectional diversification of risk. Acemoglu and Zilibotti (1997) is one of those works mentioned above; they theoretically analyze the relationship between diversification and growth and conclude that "that the process of development goes hand in hand with better diversification opportunities and more productive use of funds". They argue that until an economy deepens its financial markets up to a certain level, the idiosyncratic shocks are not well diversified and this introduces an uncertainty to the growth process. The most important conclusion reached to is that variability of growth decreases and productivity endogenously increases as the diversification opportunities improve. King and Levine (1993) assert that financial systems that enable risk diversification promote innovative and thus growth-enhancing projects. The second aspect of risk diversification is the diversification of liquidity risk. In Levine (2004), it is stated that some high return projects require long periods of commitment, but savers, on the other hand, do not prefer to lose the control of their assets for such long periods. The services provided by financial intermediaries enable the savers to manage their liquidity risk and therefore foster the amount of sources devoted to high return, longer term projects. The final type of risk which is eliminated through financial intermediation is the intertemporal risk. Economic agents may try to eliminate the risks that cannot be diversified at a particular point in time. Levine (2004) states that "long run intermediaries can facilitate intergenerational risk sharing by investing with a long-run perspective and offering returns that are relatively low in boom times and high in slack times". Although derivative markets are one of the financial markets that provide the economic agents the opportunity to share intertemporal risk, the literature on finance-macro relation including Levine (2004) does not mention the possible crucial role of derivative markets.

Being analyzed the theoretical framework on which the finance-macroeconomics relation has been constructed, we can now proceed to the review of the empirical works. Several empirical works were conducted to analyze the relation between the depth of financial markets and economic growth beginning with Goldsmith (1969). Using the data of 35 countries from 1860 to 1963, Goldsmith (1969) analyzed the relation between the size of the financial system and growth. The size of the financial system is proxied by the size of the banking system in Goldsmith (1969). Although he found a significant correlation between these two variables, he did not attempt to draw any conclusion regarding the causal relation. This seminal work of Goldsmith inspired many other researchers. King and Levine (1993b) examine the relationship between level of financial development and growth and sources of growth. Using a cross section of 80 countries, they conclude that there is a long run relation between the level of financial development and economic growth. Four variables were used as a measure of financial development; the ratio of liquid liabilities to GDP, the ratio of bank credit to bank credit plus central bank's domestic assets; the ratio of credit issued to the private firms to total domestic credit and the ratio of credit issued to the private firms to GDP.

Beck, Levine and Loayza (2000) empirically assess the impact of financial intermediaries on private savings rates, capital accumulation, productivity growth and overall economic growth. They used the same four variables with King and Levine (1993b) as a measure of financial development. Using instrumental variable estimation technique and dynamic panel data techniques, Beck, Levine and Loayza

(2000) conclude that there is a large and significant relation between financial development and real per capita GDP growth and total factor productivity growth. However, the relation between financial development and physical capital growth and private savings rate is ambiguous.

Levine and Zervos (1996), on the other hand, investigate the role of stock market development on long run growth. They use an aggregate index of overall stock market development which combines information on size, liquidity and integration with world capital markets. The results suggest a strong positive relation between stock market development and long run growth.

There are also works that simultaneously investigate the role of banks and stock markets. Levine and Zervos (1998) claim that banks provide different services from those of stock markets; thus measures of stock market development and banking development should enter the growth regressions simultaneously and significantly. They find that stock market liquidity is positively and significantly correlated with current and future rates of economic growth, capital accumulation and productivity growth. Moreover, the level of banking development also enters these regressions significantly.

After briefly summarizing the literature on the finance-macro relation, I will now review some papers that aim to investigate the relationship between investment and uncertainty. Hartman(1972) is one of the first papers analyzing this relation. Hartman (1972) reaches to the conclusion that increasing output price uncertainty leads to an increasing level of investment. The output here is the physical output of the firm. Pindyck (1982), on the other hand, draws the same conclusion, but dependent on a condition. He asserts that increased price uncertainty leads to increased level of investment only if the marginal adjustment cost function is convex. If this function is concave, then increased uncertainty leads to less investment. The positive effect of uncertainty on investment is because of the fact that price uncertainty raises expected marginal profits and increase capital accumulation. These papers, however, do not take into consideration the effect shareholders' risk aversion. Risk averse shareholders demand less capital, when uncertainty increases; thus the level of investment reduces. Zeira (1990) takes into consideration both of these opposing effects. The main conclusion of this paper is that increased price uncertainty can have negative effects on investment when the shareholders are risk averse. Caballero (1991) aims to "highlight the role of the decreasing marginal return to capital assumption in determining the effects of adjustment cost asymmetries on the sign of the response of investment to changes in uncertainty". The main conclusion reached to is that the investment-uncertainty relation is not robust. The reader should note that the uncertainty referred in all these papers is the uncertainty related with the operations of the firm.

As can be seen from the very brief review of the related literature, none of the existing works stress the role of derivative markets in maintaining economic well-being. The existing works explore the finance-macroeconomics relation from a somewhat restricted point of view; they only take into consideration the banks and stock markets while trying to explain the effect of financial intermediation on economic well-being. However, derivative markets can also give clues about the financial depth of a country. On the other hand, serving as a tool of risk management, derivatives provide a medium for efficient sharing of risks and enable the economic agents to reduce the unsystematic risk and thus the level of uncertainty they will face. This reduction in uncertainty has implications on the level of investment. This paper will fill the gap in the literature by analyzing the impact of derivative markets on macroeconomic conditions with a methodology different from the existing one.

CHAPTER 3

DATA, METHODOLOGY AND RESULTS

In this chapter I will first describe the data set used in the empirical analysis. Subsection 3.2 will present the methodology of the paper in detail. In the last subsection, the results of the regression analysis will be presented.

3.1 Data Description

There are mainly three types of data sets used in this paper; the first one is the related macroeconomic variables for the period 1960-1999, the second one is the list of derivative markets operating in the year 1999 and the last one is the volume figures of derivative markets between the years 1990 and 1999. In this part of the paper, I will describe these data sets in detail.

A significant portion of the macroeconomic data was retrieved from Penn World Tables. This data set includes the real gross domestic product per capita (cgdp), investment share of the gross domestic product (ci) and the population growth rate (popgrowth). These data exist for 152 countries for the years 1960-1999, but I used different numbers of countries for different specifications. Another macroeconomic variable is the secondary school enrollment rate (hk), which was used as a proxy for the accumulation rate of the human capital. This data set is from Barro-Lee and consists of the data of 107 countries for the years 1960-1999. Table 1 presents a summary of these macroeconomic variables.

The second data set consists of the names of the countries, where a derivative market exists in 1999. These data has been retrieved from the website of The Chicago Board Options Exchange. According to this data set, in 1999 there are 33 countries in which a derivative market exists. The variable "dummy" has been assigned 1 if a derivative market exists in a country in 1999, and 0 otherwise. The distribution of the dummy variable is presented in Table 1.

The third data set used is from the Futures Industry Association[1]. This data set consists of the volume figures of the derivative markets of various countries for the years 1990-1999. In order to find the total volume of derivatives traded in a country, I summed up the volumes of all futures and options exchanges operating in that country and calculated the total derivative volume (totalvol) figures. These volume figures are not in values but are as number of commitments and therefore cannot be expressed as a share of GDP or any other macroeconomic variable. This may create some scale problems during the empirical analysis. On the other hand, since the face value of a single contract may differ across countries, these volume figures cannot be used to make cross country comparisons. In order to avoid the above mentioned problems, I calculated the annual growth rate of volume figures and

---

[1] I would like to thank Mr. Toby Taylor for providing me this valuable dataset in a very short time.

used this variable as an explanatory variable. The averaged volume figures and the averaged annual growth rates are presented in Tables 2 and 3, respectively.

Throughout the whole empirical analysis, I will use the natural logarithms of the variables, in accordance with Mankiw, Romer and Weil (1992).

3.2 Methodology

The methodology employed in this paper is mainly based on Mankiw, Romer and Weil (1992). I replicated the empirical results of Mankiw, Romer and Weil (1992) with the updated data set of Penn World Tables; the contribution of this work to the existing literature is the inclusion of derivative markets to the model as an explanatory variable. It will therefore be useful to summarize the seminal work of Mankiw, Romer and Weil (1992), in this part of the paper.

Mankiw, Romer and Weil (1992) is mainly motivated with the question "Is the classical Solow model able to explain the international variation in the standard of living?" Firstly, they reviewed the classical Solow model in order to find an answer to this question. In the classical Solow model, there is a Cobb-Douglas production function;

$$Y(t) = K(t)^{\alpha}(A(t)L(t))^{1-\alpha}$$

where Y is the output, K is the capital, L is the labor and A is the level of technology. L and A are assumed to grow exogenously at rates n and g, respectively;

$$L(t) = L(0)e^{nt}$$
$$A(t) = A(0)e^{gt}$$

It is assumed that a constant fraction of output, s, is devoted to investment. Defining k as the stock of capital per effective unit of labor *(k=K/AL)* and y as the stock of output per effective unit of labor *(y=Y/AL)*;

$$\dot{k}(t) = sy(t) - (n + g + \delta)k(t)$$
$$\dot{k}(t) = sk(t)^{\alpha} - (n + g + \delta)k(t)$$

where δ is the depreciation rate. In the steady state, *dk/dt* = 0; thus the steady state level of capital stock is described by the following equation;

$$k^{*} = [s/(n + g + \delta)]^{1/(1-\alpha)}$$

Plugging this into the production function, the authors derive the following steady state income per capita;

$$y^{*} = \left([s/(n + g + \delta)]^{1/(1-\alpha)}\right)^{\alpha}$$
$$\frac{Y}{L} = A[s/(n + g + \delta)]^{\alpha/(1-\alpha)}$$

Taking the natural logarithms and assuming the lnA(0)=a+ε, the authors derived the main empirical specification of the classical Solow model as follows;

$$\ln\left[\frac{Y(t)}{L(t)}\right] = a + \frac{\alpha}{1-\alpha}\ln(s) - \frac{\alpha}{1-\alpha}\ln(n + g + \delta) + \varepsilon$$

The authors tested the classical Solow model using this empirical specification. Recognizing that an important portion of the variation in the standard of living remains unexplained, the authors constructed a new model that incorporates the human capital accumulation rate as an explanatory variable. The only difference of this new model, namely the augmented Solow model, from the classical one is the existence of the human capital in the production function;

$$Y(t) = K(t)^{\alpha} H(t)^{\beta} (A(t)L(t))^{1-\alpha-\beta}$$

Here, H is the stock of human capital. The fraction of income invested in physical capital and the fraction of income invested in human capital are denoted as s_k and s_h, respectively. Having described the new variables, the authors describe the evolution of the economy by the following equations;

$$\dot{k}(t) = s_k y(t) - (n + g + \delta)k(t)$$
$$\dot{h}(t) = s_h y(t) - (n + g + \delta)h(t)$$

Using the same procedure, they derive the steady state level of physical capital and human capital as follows;

$$k^* = \left(\frac{s_k^{1-\beta} s_h^{\beta}}{n + g + \delta} \right)^{1/(1-\alpha-\beta)}$$
$$h^* = \left(\frac{s_k^{\alpha} s_h^{1-\alpha}}{n + g + \delta} \right)^{1/(1-\alpha-\beta)}$$

Plugging these into the production function gives the steady state level of income per effective labor;

$$y^* = \left(\frac{s_k^{1-\beta} s_h^{\beta}}{n + g + \delta} \right)^{\alpha/(1-\alpha-\beta)} \left(\frac{s_k^{\alpha} s_h^{1-\alpha}}{n + g + \delta} \right)^{\beta/(1-\alpha-\beta)}$$

Taking the natural logarithms, the authors construct the following empirical specification for the augmented Solow model;

$$\ln\left[\frac{Y(t)}{L(t)}\right] = a + \frac{\alpha}{1-\alpha-\beta}\ln(s_k) + \frac{\beta}{1-\alpha-\beta}\ln(s_h) - \frac{\alpha+\beta}{1-\alpha-\beta}\ln(n + g + \delta) + \varepsilon$$

Under this specification, log of income per capita in 1985 was regressed on the log of investment share of GDP (a proxy for the physical capital accumulation rate), log of population growth rate plus 0.05 (a proxy for the technological improvement rate plus the depreciation rate used by Mankiw, Romer and Weil (1992)) and the log of secondary school enrollment rate (a proxy for the human capital accumulation rate). The main conclusion reached to is that the Solow model is able to explain an important portion of the international variation in the income per capita figure, if the human capital accumulation enters into the model.

Regarding the magnitudes of the coefficients of the classical Solow model and the augmented Solow model, the authors made some predictions and tested them. As can be seen from the above equations, the coefficients of the savings rate and population growth rate in the classical Solow model and the coefficients of the savings rate, population growth rate and the human capital accumulation rate in the augmented Solow model should add up to 0.

Another important step taken in this paper is to test the statement "countries converge to each other in terms of income per capita as they reach to their steady states". In order to test the validity of this statement, the log difference of income per capita between the years 1960 and 1985 (the period for which the data were available) is regressed on the log of initial income per capita and the other explanatory variables averaged for the same period. The coefficient of the initial income turned out to be negative, which supports the above statement. Regarding the magnitudes of the coefficients, the authors reached the same conclusion; for the classical Solow model the coefficients of the savings rate and population growth rate and for the augmented Solow model the coefficients of the savings rate, population growth rate and the human capital accumulation rate should add up to 0.

As stated above, the main contribution of this paper to Mankiw, Romer and Weil (1992) is the inclusion of derivative markets to the model as an explanatory variable. I will use 3 different methodologies throughout the empirical analysis. Regarding the first methodology, I will estimate the three equations that are listed below;

$$\text{lncgdp}_{99} = \alpha_0 + \alpha_1 \text{lnci} + \alpha_2 \ln(\text{n} + \text{g} + \delta) + \varepsilon \quad (1)$$

$$\text{lncgdp}_{99} = \beta_0 + \beta_1 \text{lnci} + \beta_2 \ln(\text{n} + \text{g} + \delta) + \beta_3 \text{lnhk} + \varepsilon \quad (2)$$

$$\text{lncgdp}_{99} = \gamma_0 + \gamma_1 \text{lnci} + \gamma_2 \ln(\text{n} + \text{g} + \delta) + \gamma_3 \text{lnhk} + \gamma_4 \text{Dummy} + \varepsilon \quad (3)$$

The first and the second equations are to test the Solow model and the augmented Solow model with the updated data set, respectively. The third equation aims to test the effect of existence of derivative market in an economy in 1999 on the income per capita figure of the same economy in the same year. In this specification, the size of the market and the number of years the market is in operation is not taken into account. It is tested whether the countries with a derivative market established before 1999 and the ones with no derivative market in that year differ in terms of the standard of living that their citizens enjoy. Based on the existing literature summarized above, the sign of the coefficient of this dummy variable (γ_4) is expected to be positive.

Secondly, the effect of existence of derivative markets on the growth rate of income per capita between the years 1960 and 1999 is examined. Again, I replicated the results of Mankiw, Romer and Weil (1992) with the new data set and then introduced the derivative market dummy to the model. The equations estimated under this specification are as listed;

$$\text{lncgdp}_{99} - \text{lncgdp}_{60} = \alpha_0 + \alpha_1 \text{lncgdp}_{60} + \alpha_2 \text{lnci} + \alpha_3 \ln(\text{n} + \text{g} + \delta) + \varepsilon \quad (4)$$

$$\text{lncgdp}_{99} - \text{lncgdp}_{60} = \beta_0 + \beta_1 \text{lncgdp}_{60} + \beta_2 \text{lnci} + \beta_3 \ln(\text{n} + \text{g} + \delta) + \beta_4 \text{lnhk} + \varepsilon \quad (5)$$

$$\text{lncgdp}_{99} - \text{lncgdp}_{60} = \gamma_0 + \gamma_1 \text{lncgdp}_{60} + \gamma_2 \text{lnci} + \gamma_3 \ln(\text{n} + \text{g} + \delta) + \gamma_4 \text{lnhk} + \gamma_5 \text{Dummy} + \varepsilon \quad (6)$$

The main aim of Mankiw, Romer and Weil (1992) in constructing this specification was to test the hypothesis of convergence. Finding that the sign of the coefficient of the initial income is negative, Mankiw, Romer and Weil (1992) concluded that countries converge to each other as they reach to their steady states. My aim in estimating equation 6 is not to test the convergence; the existing literature does not claim any relation between the level of financial development and the convergence rate. The aim here is to test whether the growth rate of income per capita of an economy with a derivative market established before 1999 is different from that of an economy with no derivative market. If the coefficient of the derivative market dummy turns out to be statistically significant, this will be sufficient to conclude that existence of derivative markets has an effect on convergence. The sign of the coefficient of the dummy variable (γ_5) is again expected to be positive.

Up to this point, I explored whether the existence of derivative markets in an economy has an effect on the standard of living. However, it should also be explored whether the size of these markets has a differential effect or not. In order to understand whether such an effect exists or not, I adopted an approach similar to the first one. However, since the number of countries and the number of years that the derivative market volume data exist for is limited, I shortened the time periods for which the variables are averaged. Using a panel data of 23 countries and 2 time periods (1990-1994 and 1995-1999), I estimated the following equations;

$$\text{lncgdp} = \alpha_0 + \alpha_1 \text{lnci} + \alpha_2 \ln(\text{n} + \text{g} + \delta) + \varepsilon \quad (7)$$

$$\text{lncgdp} = \gamma_0 + \gamma_1 \text{lnci} + \gamma_2 \ln(\text{n} + \text{g} + \delta) + \gamma_3 \text{lnhk} + \varepsilon \quad (8)$$

$$\text{lncgdp} = \delta_0 + \delta_1 \text{lnci} + \delta_2 \ln(\text{n} + \text{g} + \delta) + \delta_3 \text{lnhk} + \delta_4 \text{lnvolgrowth} + \varepsilon \quad (9)$$

The first equation is to estimate the classical Solow model for the years 1990-1999. The second equation is the augmented Solow model of Mankiw, Romer and Weil (1992). The last equation is the one this paper is mainly concerned with. The fourth explanatory variable in equation 9 is the annual growth rate of the total derivative market volume averaged for the corresponding 5-year periods. With this equation, I aim to determine whether the annual growth rate of derivative market trading volume in a country has a significant effect on the income per capita figure besides the other important explanatory variables. The sign of the coefficient δ_4 is expected to be positive.

With the dataset described in the previous section and under the methodological framework constructed in this section, I ran a set of regressions. The next section consists of the results and the interpretations of these regressions.

3.3 Empirical Results

In this section, the results of the regression analysis will be presented and explained in detail. The first subsection will present the interpretations of the regressions including the derivative market dummy, whereas in the second subsection the volume figures will enter into the model as an explanatory variable.

3.3.1 Analyzing the Effect of Existence of Derivative Markets

As explained before, the first aim of this paper is to replicate the results of Mankiw, Romer and Weil (1992) and then analyze the effect of existence of derivative markets by introducing a dummy variable to the augmented Solow model. Under this specification, the log of income per capita in 1999 is the dependent variable, whereas the log of investment share of GDP, log of population growth rate plus the depreciation rate plus the rate of technological improvement, log of secondary school enrollment rate and the derivative market dummy are the independent variables (Equation 3). I applied the Ordinary Least Squares (OLS) method in all of these regressions, in accordance with Mankiw, Romer and Weil (1992). The p-values for the heteroskedasticity tests are reported in the regression tables; the null hypothesis in these tests is that there exists no heteroskedasticity.

The results of the regressions of equations 1, 2 and 3 are presented in Tables 4, 5, 6 and 7. The savings rate, population growth rate and human capital figures were averaged for the periods 1960-1999, 1970-1999, 1980-1999 and 1990-1999 in Tables 4, 5, 6 and 7, respectively. This is to check the robustness of the results obtained.

The first column of Table 4 is the classical Solow model. The sign of the coefficients are as expected; a 1% increase in the average savings rate leads to a 1.011% increase in the income per capita figure of 1999, whereas a 1% increase in $(n+g+\delta)$ leads to a decrease of 3.873% in the income per capita. It is also important to note that 69% of the international variation is explained by the textbook Solow model. The second column of Table 4 is the augmented Solow model. The signs of the coefficients are again as expected; the savings rate and the human capital accumulation rate affect the income per capita positively, whereas an increase in population growth rate leads to negative consequences. With the entrance of human capital figure, the explanatory power of the model increases significantly. The third column is the contribution of this work to the existing literature. With a derivative market dummy entering to the model, the explanatory power of the model increases from 78 % to 81%. The coefficients of all the explanatory variables are highly significant and the signs of the coefficients remain to be as expected. The most important conclusion is that a country with a derivative market established before 1999 has a significantly higher income per capita in 1999 compared to a country with no derivative market in the same year.

The signs of the coefficients are in accordance with Mankiw, Romer and Weil, however it is important to check whether the magnitudes of the coefficients are in line with our expectations or not. The last row of Table 4 reports the p-values of the associated restriction tests. For the first regression, the null hypothesis is that the coefficients α_1 and α_2 in Equation 1 sum up to zero. The null hypothesis is rejected with a p-value of 0. For the second regression, it is tested whether coefficients β_1, β_2 and β_3 in Equation 2 sum up to zero or not. The null hypothesis is rejected with a significance level of 5% or higher; however, if we set the significance level to 1%, we will fail to reject the null. The same null hypothesis is tested for the third regression and it is concluded that we fail to reject the null with a p-value of 13.92%. Thus the model with the derivative market dummy passes the restriction test and fits the predictions of the augmented Solow model of Mankiw, Romer and Weil (1992). This result can be interpreted as follows; with the updated dataset on hand, the classical Solow model and the augmented Solow model are no more able to accurately predict the magnitudes of the coefficients. However, if we control for the structure of the financial system with a derivative market dummy, then the predictions of the augmented Solow model regarding the magnitudes of the coefficients become compatible with the estimated ones. An important question that should be asked at this point is about the validity of the restriction tests after the entrance of the derivative market dummy. In Appendix B, the model is reconstructed so that it includes the dummy variable and it is shown that the magnitudes of the coefficients of the variables are not affected from this modification. Thus the coefficient restriction tests are still valid for the third column of the estimation table.

I averaged the investment share of GDP, population growth rate and the secondary school enrollment rate figures were averaged for the periods 1970-1999, 1980-1999 and 1990-1999 and reported the results of the associated regressions in Tables 5, 6 and 7, respectively. The signs and magnitudes of the coefficients and the explanatory power of the models are similar in all of these specifications. This shows that the results obtained are robust.

The second aim of this paper is to test the effect of existence of derivative markets on the growth rate of income per capita between the years 1960 and 1999. In order to do this, the log difference of income per capita between the years 1960 and 1999 was regressed on the log of income per capita in 1960 (initial income per capita), log of investment share of GDP, log of population growth rate plus the depreciation rate plus the rate of technological improvement, log of secondary school enrollment rate and the derivative market dummy. I again employed Ordinary Least Squares (OLS) method in all of these regressions, in accordance with Mankiw, Romer and Weil (1992). The regression table reports the p-values of the heteroskedasticity tests, in which the null hypothesis is that the error terms are homoskedastic. The results of the associated regressions are in Table 8.

The first column of Table 8 is the classical Solow model. All the coefficients are highly significant and the signs of the coefficients are as expected. The initial income and the population growth rate have negative effects on the dependent variable, whereas the investment share of GDP has a positive effect. The model is able to explain the 46% of international variation. The second column is the augmented Solow model. The human capital variable enters to the regression equation significantly with a positive sign, altering the magnitudes of the existing coefficients without changing their signs and significances. The explanatory power of the model increases with this modification. The third column of the table is again the contribution of this paper to the existing literature. The dummy variable enters into the model in a similar way the human capital variable does. It is highly significant and positive. The signs and the significance of the existing coefficients remain unchanged, however the magnitudes are affected. The explanatory power of the third model is the highest among all. The important thing that should be mentioned is the fact that the coefficient of the dummy variable is positive; thus the existence of a derivative market in 1999 positively affects the growth rate of income per capita between the years 1960 and 1999.

The signs of the coefficients are in accordance with the expectations, however it should also be checked whether the magnitudes fit the predictions of the model or not. Table 8 also reports the p-values of the associated coefficient tests. We fail to reject the null hypothesis in each case indicating that estimations fit the predictions of the models.

Another important parameter under this specification is the rate of convergence of economies, which is captured by λ. I do not intend to make any conclusions regarding the rate of convergence; in this section of the paper, I only aim to analyze the effect of existence of derivative market on the growth rate of income per capita. Thus I will report the implied value of λ at the last row of the regressions table, just for the readers' information.

3.3.2 Analyzing the Effect of Growth Rate of the Volume of Derivative Markets

In this section, the results of the regressions of the equations 7, 8 and 9 will be presented and interpreted, i.e. the growth rate of the volume figures of the derivative markets will enter into the regressions as an explanatory variable instead of the dummy variable. As I stated before, since the number of countries and the number of years that the derivative market volume data exists for is limited, I shortened the time periods for which the variables are averaged. Using a panel data of 23 countries and 2 time periods (1990-1994 and 1995-1999), four regression equations were estimated, results of which are in Tables 9 and 10. I used fixed effects panel data method in this section of the analysis.

The first column of Table 9 is the classical Solow model. The signs of the coefficients are as expected; the average savings rate in each period affects the end of period real income per capita positively, whereas the population growth rate has a negative effect on the dependent variable. The coefficients are highly significant and the magnitudes of the coefficients fit the predictions of the textbook Solow model. With a p-value of 0.199, we fail to reject the null that the absolute values of the coefficients of the savings rate and the population growth rate are equal to each other.

The second column of Table 9 is the augmented Solow model. The signs of the coefficients are as expected and all of the coefficients are statistically significant. However, with the entrance of the human capital accumulation rate as an explanatory variable, the magnitudes of the coefficients of the savings rate and the population growth rate were altered. The coefficient test yields a p-value of 0.9032, as a result of which we fail to reject the null and conclude that the magnitudes of the estimated coefficients are in accordance with the augmented Solow model.

The third column of Table 9 is the part this paper mainly deals with. The growth rate of the derivative market volume figures of the countries entered the model as an explanatory variable in this 3rd column. The signs of the coefficients are as expected. The savings rate and the human capital accumulation rate affect the real income per capita positively, whereas the population growth rate enters into the model with a negative coefficient. The coefficients of these three explanatory variables are all statistically significant. However, the coefficient of the growth rate of derivative market volume is statistically insignificant and negative. This result does not fulfill our prior expectations; we expected this coefficient to be significantly greater than zero based on the findings of the existing literature.

The results we obtained so far can be summarized as follows; the effect of the existence of a derivative market on both the steady state level of real income per capita and the growth rate of income per capita is significantly positive. However, the growth rate of the trading volume of this market has no significant effect on the steady state level of real income per capita. This result may have two reasons; either the specification I made in the second part of the empirical analysis section might be wrong or the growth rate of the derivative market volume figures may have no effect in explaining the economic well-being. In order to be able to reach safely to the second conclusion, we have to be sure that the methodology employed in this part of the paper is not problematic.

In the regressions for the classical and the augmented Solow model, the data of countries for which the derivative market volume data exist were used, in order to make the results of the first two columns and the last column of Table 9 comparable. In other words, only 44 observations of 24 countries were used for all the regressions of Table 9. However, I want to check whether the specification I constructed fits with the predictions of Mankiw, Romer and Weil (1992) and therefore proves itself as a valid methodology. In order to check this, I averaged the savings rates, population growth rates and human capital accumulation rates of all countries for the periods 1990-1994 and 1995-1999 and estimated the classical and the augmented Solow models with this extended data set. The results of these regressions are in Table 10 in Appendix A. As can be seen from Table 10, the estimation results are in line with the conclusions of Mankiw, Romer and Weil (1992).

Knowing that the methodology employed in this part of the empirical analysis is proper, I shall now interpret the results of the regression in the last column of Table 9. As stated before, the existence of derivative markets has a positive effect on the economic well-being of individuals; however the relation between the growth rate of the derivative market volume and the real income per capita is not statistically significant. This can be explained as follows; the existence of derivative markets can be seen only as a proxy for the soundness of general macroeconomic conditions. Since the amount of transaction that takes place in these markets turned out to be insignificant in explaining the cross country differences in income per capita, we can say that the derivative markets do not have a direct effect on the standard of living in a country. Existence of derivative market in a country can only be seen as a good clue of sound macroeconomic conditions in that country. From this aspect, derivative markets are different from banks and stock markets, direct effects of which were shown several times in the existing literature.

CHAPTER 4

CONCLUSION

The existing literature on finance-macro relation concentrates on banks and stock markets as a measure of financial development. However, derivative markets, which have developed much in the last two decades, can also shed some light on the depth of the financial system of a country. Serving as a tool for risk management, derivative markets enable the economic agents to hedge their risks and reduce the uncertainty they may face in the future. Depending on the correlation between uncertainty and investment, this reduction in uncertainty may have favorable or unfavorable implications on investment. Therefore, analyzing the macroeconomic impacts of derivative markets relies on two rationales; one is the impact of financial development on economic growth and the other is the effect of uncertainty on the level of investment.

This paper analyzed the effect of existence of derivative markets and growth rate of derivative market volume on the standard of living under the framework first constructed by Mankiw, Romer and Weil (1992). The results of this paper provided some new evidence on the relation between finance and macroeconomics from a perspective different from the existing one and related it to another important line of the literature, which is concerned with the investment-uncertainty relationship.

The first section of the empirical analysis part analyzed the effect of existence of derivative market. The main conclusion reached to is that the citizens of a country with a derivative market established before 1999 enjoy more favorable conditions when compared to the citizens of a country with no derivative market in the same year. On the other hand, the growth rate of real income per capita between years 1960 and 1999 is higher if a derivative market exists in a country. In the second section of the empirical analysis part, I analyzed the effect of growth rate of derivative market volume on economic well-being. The effect of growth rate of derivative market volume turned out to be insignificant, leading us to the conclusion that the effect of derivative markets is indeed an indirect one. Derivative markets are a good proxy for sound macroeconomic conditions; however they do not act as banks or stock markets in improving standard of living.

If we take the existence of derivative markets as a proxy of financial development, then this paper constitutes empirical evidence to the hypothesis that "financial development triggers economic growth" from a different perspective and using a different methodology.

It should be noted that the causal relation between standard of living and the existence and volume of derivative markets can be a two sided relation. In this paper, it is explored whether the existence and volume of derivative markets lead to better macroeconomic conditions or not. However, the causality may well be in the opposite way; better macroeconomic conditions may be the prerequisite of establishment of a derivative market. If this link is derived, then the statement that "existence of derivative markets is an indicator of a sound and stable economy" will be further supported. Future research should be directed at analyzing this other possible side of causality.

SELECTED BIBLIOGRAPHY

Acemoglu, D. and F. Zilibotti. 1997. “Was Prometheus Unbound by Chance? Risk, Diversification, and Growth” *Journal of Political Economy,* 105: 709-775.

Beck T., R. Levine and N. Loayza. 2000. "Finance and the Sources of Growth" *Journal of Financial Economics,* 58(1-2): 261-300.

Cabellero, R.J. 1991. “On the Sign of the Investment-Uncertainty Relationship” *American Economic Review*, 81(1): 279-288.

Goldsmith, R. W.1969. *Financial Structure and Development*. New Haven, CT: Yale University Press.

Hartman, R. 1972. “The Effects of Price and Cost Uncertainty on Investment” *Journal of Economic Theory,* 5: 258-266.

Heston, A. , R. Summers and B. Aten. 2002. “Penn World Table Version 6.1” *Center for International Comparisons at the University of Pennsylvania (CICUP)*

King, R. G. and R. Levine. 1993. "Finance, Entrepreneurship, and Growth: Theory and Evidence”. *Journal of Monetary Economics.* 32: 513-542.

----------------------------. 1993b."Finance and Growth: Schumpeter Might Be Right" *Quarterly Journal of Economics,* 108(3): 717-737.

Levine, R. 2004. “Finance and Growth: Theory and Evidence” *NBER Working Paper Series*. WP 10766

Levine, R. and S. Zervos. 1996. “Stock Market Development and Long Run Growth”. *Policy Research Working Paper Series 1582, The World Bank.*

------------------------------. 1998. "Stock Markets, Banks, and Economic Growth." *American Economic Review*, 88(3): 537-558.

Mankiw, N. G. , D. Romer and D. N. Weil. 1992. "A Contribution to the Empirics of Economic Growth" *Quarterly Journal of Economics*, 107(2): 407-437

Pindyck, R. S. 1982. "Adjustment Costs, Uncertainty and the Behavior of the Firm" *American Economic Review,* 72: 415-427.

Schumpeter, J. A. 1912. *Theorie der wirtshaftlichen entwicklung*. Leipzig, Germany: Dunker&Humblot.

Zeira, J. 1990. "Cost Uncertainty and the Rate of Investment" *Journal of Economic Dynamics and Control*, 14: 53-63.

APPENDICES

APPENDIX A

Table 1: A Summary of the Variables Used

Country Name	Real Income per Capita	Investment Share of GDP	Population Growth Rate	Secondary School Enrollment Rate	Derivative Market Dummy
Algeria	8.4959	2.9214	0.9751	1.6366	0
Argentina	9.3548	2.9580	0.3929	2.9049	1
Australia	10.1790	3.2827	0.4168	3.8803	1
Austria	10.0795	3.3303	-1.0559	3.9698	1
Bangladesh	7.4274	2.4038	0.8684	2.2760	0
Barbados	9.7089	2.5323	-1.0029	3.6760	0
Belgium	10.0758	3.2611	-1.2146	3.4091	1
Bolivia	7.9486	2.4070	0.8335	2.9711	0
Botswana	8.8576	2.8450	1.1368	1.8621	0
Brazil	8.8841	3.1060	0.7765	2.1691	1
Burundi	6.6061	1.6344	0.7548	—	0
Cameroon	7.5890	2.0170	0.9659	1.7470	0
Canada	10.1841	3.1689	0.3183	3.5337	1
Cape Verde	8.2521	2.8324	0.7064	—	0
Chad	6.8778	2.2984	0.8408	—	0
Chile	9.1876	2.8272	0.5650	3.3101	0
China	8.1558	2.8273	0.4862	3.3164	1
Colombia	8.6244	2.5528	0.8502	2.7465	0
Comoros	7.4975	2.0204	0.9896	—	0
Congo, Republic of	7.4375	2.9336	1.0406	2.7866	0
Costa Rica	8.7115	2.7346	1.1049	2.3088	0
Benin	7.0689	1.8970	1.0438	1.2947	0
Denmark	10.2032	3.2507	-0.9543	3.8172	1
Dominican Republic	8.5501	2.5310	0.8883	2.1804	0
Ecuador	8.1503	3.0497	0.9829	2.4204	0
El Salvador	8.4322	2.0529	0.8154	2.0166	0
Equatorial Guinea	8.6374	2.2468	0.4280	—	0
Ethiopia	6.4932	1.5314	0.9704	—	0
Fiji	8.6858	2.9119	0.6094	2.8904	0
Finland	10.0403	3.3659	-0.9299	3.3987	1
France	10.0311	3.2850	-0.4386	3.4392	1
Gabon	8.9624	2.6048	0.8543	—	0
Gambia, The	7.1188	1.6135	1.2033	1.5764	0
Ghana	7.2328	2.1151	0.9798	2.6724	0
Greece	9.5994	3.3607	-0.5022	2.8980	1
Guatemala	8.3410	2.1407	0.9834	1.6887	0
Guinea	7.9895	2.3350	0.7765	—	0
Guyana	8.2515	2.9185	-0.2836	2.8500	0
Honduras	7.6657	2.5801	1.1354	1.9040	0
Hong Kong	10.1530	3.3423	0.7149	3.4128	1
Iceland	10.1555	3.3591	0.1591	3.1971	0
India	7.8283	2.5125	0.7664	2.1804	0
Indonesia	8.2510	2.6338	0.7157	2.1875	0
Iran	8.6968	2.9983	1.0229	2.3514	0
Ireland	10.1127	2.9467	-0.3277	3.5589	0
Israel	9.8032	3.4290	1.0157	3.4591	1
Italy	10.0223	3.3075	-1.0338	3.1543	1

Note: All figures are in natural logarithm forms. The real income per capita figure is for the year 1999. Investment share of GDP, population growth rate and the secondary school enrollment rate figures have been averaged for the period 1960-1999.

Table 1: A Summary of the Variables Used (cont.d)

Country Name	Real Income per Capita	Investment Share of GDP	Population Growth Rate	Secondary School Enrollment Rate	Derivative Market Dummy
Cote d`Ivoire	7.6293	2.0590	1.3088	—	0
Jamaica	8.1356	3.1621	0.1796	2.7973	0
Japan	10.1258	3.5017	-0.2457	3.6629	1
Jordan	8.3438	2.7454	1.5120	2.6585	0
Kenya	7.1600	2.4881	1.1906	1.6887	0
Korea, Republic of	9.5839	3.3920	0.4697	—	1
Lesotho	7.2536	2.7743	0.7747	1.5476	0
Luxembourg	10.6993	3.2379	-0.1719	—	0
Madagascar	6.7596	1.0350	0.9856	—	0
Malawi	6.7152	2.5628	1.0073	0.9012	0
Malaysia	9.2530	3.0972	0.9806	2.9319	1
Mali	6.8665	2.0936	0.8358	0.1927	0
Mauritania	7.2623	1.8564	0.9085	—	0
Mauritius	9.5202	2.5879	0.3990	2.9191	0
Mexico	9.0475	2.9629	0.9661	2.5227	1
Morocco	8.3663	2.6557	0.8339	—	0
Mozambique	6.9535	0.8122	0.7800	0.1066	0
Namibia	8.4706	2.8641	0.9676	—	0
Nepal	7.2975	2.4689	0.8345	1.2844	0
Netherlands	10.1057	3.2630	-0.1934	3.6086	1
New Zealand	9.8526	3.1355	0.2037	3.8267	1
Nicaragua	7.4960	2.4071	1.1090	2.0281	0
Niger	6.7644	2.1001	1.1739	-0.3216	0
Nigeria	6.6793	2.0624	1.0605	—	0
Norway	10.2264	3.4725	-0.5708	3.7081	1
Pakistan	7.6427	2.5378	1.0310	2.1648	0
Panama	8.7541	3.0620	0.8648	3.0727	0
Papua New Guinea	8.1057	2.4744	0.9130	1.5712	0
Paraguay	8.4604	2.5328	1.0212	2.5426	0
Peru	8.4399	3.0734	0.8840	2.8550	0
Philippines	8.2233	2.7763	0.9454	2.9164	0
Portugal	9.6991	3.1442	-0.9633	2.2721	1
Guinea-Bissau	6.5582	2.7348	0.7010	—	0
Romania	8.4802	3.2961	-0.6654	3.5997	0
Rwanda	6.8510	1.3335	1.0878	0.7300	0
Senegal	7.4090	1.9959	1.0225	1.1632	0
Seychelles	9.3461	2.7572	0.5234	—	0
Singapore	10.1838	3.8228	0.8229	3.2489	1
South Africa	8.9554	2.6453	0.8298	3.3660	1
Zimbabwe	7.9268	3.1333	1.1217	2.1804	0
Spain	9.8098	3.2854	-0.3995	2.5980	1
Sweden	10.0638	3.1730	-0.8327	3.7093	1
Switzerland	10.2094	3.4421	-0.2997	3.7347	1
Syria	8.3372	2.4706	1.1744	2.1356	0
Thailand	8.7761	3.4348	0.7623	1.8718	0
Togo	6.9032	1.9465	1.0198	1.7579	0
Trinidad &Tobago	9.3230	2.3841	0.0984	3.0808	0

Note: All figures are in natural logarithm forms. The real income per capita figure is for the year 1999. Investment share of GDP, population growth rate and the secondary school enrollment rate figures have been averaged for the period 1960-1999.

Table 1: A Summary of the Variables Used (cont.d)

Country Name	Real Income per Capita	Investment Share of GDP	Population Growth Rate	Secondary School Enrollment Rate	Derivative Market Dummy
Tunisia	8.8229	2.9116	0.7470	2.0934	0
Turkey	8.8498	2.7533	0.8072	2.2014	0
Uganda	6.9242	0.7684	1.1337	1.5608	0
Egypt	8.3438	1.9358	0.8303	2.5680	0
United Kingdom	10.0487	2.9904	-1.1148	3.4731	1
Tanzania	6.1627	3.1725	1.1148	—	0
United States	10.4260	2.9943	0.0618	3.8709	1
Burkina Faso	6.9095	2.2090	0.8077	—	0
Uruguay	9.2476	2.5593	-0.3768	3.0415	0
Venezuela	8.7480	3.1754	1.0882	2.5327	0
Zambia	6.6402	2.5792	1.0928	2.2287	0

Note: All figures are in natural logarithm forms. The real income per capita figure is for the year 1999. Investment share of GDP, population growth rate and the secondary school enrollment rate figures have been averaged for the period 1960-1999.

Table 2: Volume Figures

Country Name	1990-1994 average	1995-1999 average
Australia	18,930,028	27,857,979
Austria	955,940	1,767,064
Belgium	1,028,138	3,000,471
Brazil	44,443,977	225,583,289
Canada	3,414,836	8,607,461
China	---	13,918,229
Denmark	1,129,934	722,715
Finland	---	2,099,186
France	61,263,819	81,280,769
Hong Kong	1,936,030	6,812,366
Italy	3,117,774	6,993,278
Japan	109,789,999	131,729,350
Malaysia	355,116	878,174
Netherlands	4,612,175	10,156,150
New Zealand	687,193	887,000
Norway	507,240	1,117,484
Singapore	12,751,762	24,926,947
South Africa	---	12,682,073
Spain	13,171,685	31,191,931
Sweden	13,109,268	22,248,608
Switzerland	7,425,199	56,182,732
United Kingdom	119,758,767	223,247,147
United States	461,166,635	639,290,803

Note: The reader should note that the volume figures given in this table reflect only the volume of exchange taking place in the stock markets. In some countries, the derivative exchange may be mostly over-the-counter; that type of an exchange is not recorded in this data

Table 3: Average Annual Growth Rate of Volume Figures

Country Name	1990-1994 average	1995-1999 average
Australia	29.47%	-0.60%
Austria	94.75%	-2.23%
Belgium	44.25%	3.58%
Brazil	82.24%	-42.79%
Canada	23.31%	15.76%
China	---	-49.20%
Denmark	17.98%	15.22%
Finland	---	40.41%
France	34.40%	10.88%
Hong Kong	82.09%	7.64%
Italy	-1.00%	14.77%
Japan	6.99%	-0.64%
Malaysia	25.10%	18.73%
Netherlands	14.17%	13.05%
New Zealand	6.62%	7.62%
Norway	21.40%	26.87%
Singapore	47.23%	1.82%
South Africa	---	21.48%
Spain	120.59%	-21.29%
Sweden	44.48%	6.08%
Switzerland	22.97%	22.04%
United Kingdom	39.07%	1.73%
United States	19.15%	0.23%

Table 4 : The Effect of Existence of Derivative Markets on the Steady State Income per Capita (1960-1999)

Dependent Variable: Log of Income per capita in 1999

	1	**2**	**3**
lnci	1.011	0.588	0.459
	[0.128]***	[0.142]***	[0.139]***
ln(n+g+δ)	-3.873	-2.307	-1.75
	[0.550]***	[0.517]***	[0.511]***
lnhk	---	0.505	0.453
	---	[0.099]***	[0.094]***
dummy	---	---	0.543
	---	---	[0.157]***
Observations	105	85	85
R-squared	0.69	0.78	0.81
p-values (coefficient test)	0.0000	0.0419	0.1392
p-values (heteroskedasticity test)	0.9033	0.9913	0.3984

Note: lnci, ln(n+g+δ) and lnhk denote the natural logarithms of the 1960-1999 averages of investment share of GDP, population growth rate and the human capital figures, respectively. g+δ is assumed to be 0.05. Dummy variable is equal to 1 if a derivative market exists in a country in 1999, and 0 otherwise. The reported p-values are for the corresponding restriction tests and the heteroskedasticity tests, respectively. * significant at 10%, ** significant at 5%, *** significant at 1%. Standard errors are in brackets

Table 5 : The Effect of Existence of Derivative Markets on the Steady State Income per Capita (1970-1999)

Dependent Variable: Log of Income per capita in 1999			
	1	**2**	**3**
lnavgci70	0.993	0.664	0.504
	[0.129]***	[0.144]***	[0.143]***
lnavgpopgrowth70	-4.057	-2.432	-1.861
	[0.509]***	[0.512]***	[0.508]***
lnavghk70	---	0.469	0.434
	---	[0.101]***	[0.096]***
dummy	---	---	0.542
	---	---	[0.156]***
Observations	105	85	85
R-squared	0.71	0.79	0.81

Note: The dependent variable is the real GDP per capita in the year 1999. lnavgci70, lnavgpopgrowth70 and lnavghk70 denote the natural logarithms of the 1970-1999 averages of investment share of GDP, population growth rate and the human capital figures, respectively. Dummy variable is equal to 1 if a derivative market exists in a country in 1999, and 0 otherwise. * significant at 10%, ** significant at 5%, *** significant at 1%. Standard errors are in brackets.

Table 6 : The Effect of Existence of Derivative Markets on the Steady State Income per Capita (1980-1999)

Dependent Variable: Log of Income per capita in 1999			
	1	**2**	**3**
lnavgci80	1.04	0.749	0.556
	[0.140]***	[0.152]***	[0.152]***
lnavgpopgrowth80	-3.584	-2.331	-1.815
	[0.510]***	[0.492]***	[0.482]***
lnavghk80	---	0.457	0.425
	---	[0.105]***	[0.098]***
dummy	---	---	0.56
	---	---	[0.157]***
Observations	105	85	85
R-squared	0.69	0.78	0.81

Note: The dependent variable is the real GDP per capita in the year 1999. lnavgci80, lnavgpopgrowth80 and lnavghk80 denote the natural logarithms of the 1980-1999 averages of investment share of GDP, population growth rate and the human capital figures, respectively. Dummy variable is equal to 1 if a derivative market exists in a country in 1999, and 0 otherwise. * significant at 10%, ** significant at 5%, *** significant at 1%. Standard errors are in brackets.

Table 7 : The Effect of Existence of Derivative Markets on the Steady State Income per Capita (1990-1999)

Dependent Variable: Log of Income per capita in 1999			
	1	**2**	**3**
lnavgci90	0.942	0.597	0.379
	[0.138]***	[0.147]***	[0.140]***
lnavgpopgrowth90	-3.418	-1.963	-1.5
	[0.552]***	[0.530]***	[0.486]***
lnavghk90	---	0.576	0.488
	---	[0.114]***	[0.104]***
dummy	---	---	0.747
	---	---	[0.164]***
Observations	105	85	85
R-squared	0.62	0.71	0.77

Note: The dependent variable is the real GDP per capita in the year 1999. lnavgci90, lnavgpopgrowth90 and lnavghk90 denote the natural logarithms of the 1990-1999 averages of investment share of GDP, population growth rate and the human capital figures, respectively. Dummy variable is equal to 1 if a derivative market exists in a country in 1999, and 0 otherwise. * significant at 10%, ** significant at 5%, *** significant at 1%. Standard errors are in brackets.

Table 8: The Effect of Existence of Derivative Markets on the Growth Rate of Income per Capita (1960-1999)

Dependent Variable: Log Difference of Income per capita in 1999 and 1960			
	4	**5**	**6**
lninitcgdp	-0.257	-0.447	-0.509
	[0.075]***	[0.087]***	[0.089]***
lnci	0.695	0.525	0.455
	[0.097]***	[0.118]***	[0.119]***
ln(n+g+δ)	-1.545	-1.18	-0.986
	[0.461]***	[0.460]**	[0.457]**
lnhk	---	0.289	0.286
	---	[0.089]***	[0.087]***
dummy	---	---	0.312
	---	---	[0.142]**
Observations	104	84	84
R-squared	0.46	0.53	0.56
p-values (coefficient test)	0.0879	0.467	0.619
p-values (heteroskedasticity test)	0.4532	0.3532	0.8576
Implied λ	0.007616903	0.015189674	0.018238747

Note: lninitcgdp denote the income per capita figure of 1960. lnci, ln(n+g+δ) and lnhk denote the natural logarithms of the 1960-1999 averages of investment share of GDP, population growth rate and the human capital figures, respectively. g+δ is assumed to be 0.05. Dummy variable is equal to 1 if a derivative market exists in a country in 1999, and 0 otherwise. The reported p-values are for the corresponding restriction tests. The implied λ values are calculated from the coefficient of lninitcgdp. * significant at 10%, ** significant at 5%, *** significant at 1%. Standard errors are in brackets

Table 9 : The Effect of Volume of Derivative Markets on the Growth Rate of Income per Capita (1990-1999)

Dependent Variable : Log of Income per capita in 1995 and 1999			
	7	**8**	**9**
lnci	0.76	0.73	0.628
	[0.273]***	[0.247]***	[0.147]***
ln(n+g+δ)	-1.416	-1.176	-1.233
	[0.484]***	[0.437]***	[0.323]***
lnhk	---	0.508	0.374
	---	[0.151]***	[0.105]***
lnvolgrowth	---	---	-0.055
	---	---	[0.190]
Observations	44	44	44
Number of countries	24	24	24
p-values (coefficient test)	0.199	0.9032	0.5272

Note: Except 4 countries, all the countries in the sample countries have two data points; one for the period 1990-1994 and the other for the period 1995-1999. lnci, ln(n+g+δ) and lnhk denote the natural logarithms of the averages of investment share of GDP, population growth rate and the human capital figures for these two periods, respectively. g+δ is assumed to be 0.05. lnvolgrowth is the natural logarithm of the growth rate of derivative market volume averaged for the same periods. p-values are for the coefficient tests. * significant at 10%, ** significant at 5%, *** significant at 1%. Standard errors are in brackets.

Table 10: Testing the Validity of the Classical and the Augmented Solow Models (1990-1999)

Dependent Variable : Log of Income per capita in 1995 and 1999

	7	**8**
lnci	0.715	0.21
	[0.091]***	[0.098]**
ln(n+g+δ)	-0.612	-0.14
	[0.203]***	[0.164]
lnhk	---	0.747
	---	[0.085]***
Observations	210	170
Number of countries	105	85

Note: All the countries in the sample have two data points, for the period 1990-1994 and the period 1995-1999. lnci, ln(n+g+δ) and lnhk denote the natural logarithms of the averages of investment share of GDP, population growth rate and the human capital figures for these two periods, respectively. g+δ is assumed to be 0.05. * significant at 10%, ** significant at 5%, *** significant at 1%. Standard errors are in brackets

APPENDIX B

$$Y(t) = K(t)^{\alpha} H(t)^{\beta} \left(A(t)L(t)\right)^{1-\alpha-\beta} e^{dummy}$$

Assuming that $y(t) = \frac{Y(t)}{A(t)L(t)}$, $k(t) = \frac{K(t)}{A(t)L(t)}$ and $h(t) = \frac{H(t)}{A(t)L(t)}$;

$$\dot{k}(t) = s_k y(t) - (n + g + \delta)k(t)$$
$$\dot{h}(t) = s_h y(t) - (n + g + \delta)h(t)$$

Since $y(t) = k(t)^{\alpha} h(t)^{\beta} e^{dummy}$;

$$\dot{k}(t) = s_k k(t)^{\alpha} h(t)^{\beta} e^{dummy} - (n + g + \delta)k(t)$$
$$\dot{h}(t) = s_h k(t)^{\alpha} h(t)^{\beta} e^{dummy} - (n + g + \delta)h(t)$$

$dk / dt = dh / dt = 0$ in the steady state, thus we have the steady state level of physical and human capital as follows;

$$k^* = \left(\frac{s_k^{\ 1-\beta} s_h^{\ \beta} e^{dummy}}{n + g + \delta} \right)^{1/1-\alpha-\beta}$$
$$h^* = \left(\frac{s_k^{\ \alpha} s_h^{\ 1-\alpha} e^{dummy}}{n + g + \delta} \right)^{1/1-\alpha-\beta}$$

We can derive the steady state level of income per capita;

$$y^* = k^{*\alpha} h^{*\beta} e^{dummy}$$
$$\frac{Y}{AL} = \left(\frac{s_k^{\ 1-\beta} s_h^{\ \beta} e^{dummy}}{n + g + \delta} \right)^{\alpha/1-\alpha-\beta} \left(\frac{s_k^{\ \alpha} s_h^{\ 1-\alpha} e^{dummy}}{n + g + \delta} \right)^{\beta/1-\alpha-\beta} e^{dummy}$$
$$\frac{Y}{L} = \frac{s_k^{\ \alpha/1-\alpha-\beta} s_h^{\ \beta/1-\alpha-\beta} e^{dummy/1-\alpha-\beta}}{(n + g + \delta)^{\alpha+\beta/1-\alpha-\beta}}$$

Taking the natural logarithms, we derive;

$$\ln\left(\frac{\text{Y}}{\text{L}}\right) = \ln(A) + \frac{\alpha}{1-\alpha-\beta}\ln s_k + \frac{\beta}{1-\alpha-\beta}\ln s_h + \frac{\alpha+\beta}{1-\alpha-\beta}\ln(n + g + \delta) + \frac{1}{1-\alpha-\beta} dummy$$