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Does Human Capital Cause Economic Growth? A Case Study of India

Sushil Kumar Haldar[1] and Girijasankar Mallik[2]

Abstract

This study examines the time series behavior of investment in physical capital, human capital (comprising education and health) and output in a co-integration framework, taking growth of primary gross enrolment rate and a dummy for structural adjustment programme (openness which has been initiated in 1991) as exogenous variables in India from 1960 to 2006. The results suggest that physical capital investment has no long-run nor short-run effect but the human capital investment has significant long-run effect on per capita GNP; the stock of human capital measured by primary gross enrolment rate (lagged by three years) and openness is found to have a significant effect on growth of per capita GNP. The Generalized Impulse Response Function confirms that the innovation in per capita GNP growth can only explain the movements of the growth of per capita GNP (itself) and investment in education human capital positively and significantly only for a short period of time but does not explain the movements of the investment in physical capital and health human capital. Moreover, the innovation in change in education human capital investment significantly and positively explains the movement of the changes in education human capital investment (itself), health human capital investment and growth of GNP per capita; the innovation in health human capital investment significantly explains the changes of education and health human capital investment only. This study may help towards policy modeling of economic growth in India, taking into account the relevance of endogenous growth.

Keywords: Human Capital Investment, Cointegration, Economic Growth

JEL classification: C22, O47, F43

1. Introduction

Traditionally, economic theory has given emphasis on physical capital accumulation as the most robust source of economic growth, at least in the short-run, with exogenous technical progress being the long-run determinant of growth. The exogeneity of technological progress in the neoclassical growth model and the difficulty of explaining long-term economic growth (because of diminishing returns to physical capital) have restricted the analytical capacity of the neoclassical model and its empirical verification. This problem is solved by endogenous growth models developed by Romer (1986) and

1. Jadavpur University, Jadavpur, Kolkata-700032, India - email: sushil.haldar@gmail.com.
2. School of Economics and Finance, University of Western Sydney, Locked Bag 1797, Penrith South DC, NSW 1797 - email: g.mallik@uws.edu.au

Lucas (1988) giving emphasis on human capital accumulation. Human capital theory suggests that individuals and society derive economic benefits from investments in people (Sweetland, 1996). Education has consistently been emerged as the prime human capital but Becker (1993) and Schultz (1997) have argued that health and nutritional expenditure is also a part of human capital investment. This is because education is perceived to contribute to health and nutritional improvements. Education, health, nutrition, water and sanitation complement each other, with investments in any one contributing to better outcomes in the others (World Bank, 2001b). In models of economic growth, human capital in the form of schooling or enrollment has been given a central place while the role of health has remained peripheral. Health may have been left in the periphery because neither health related data covering a long horizon nor the historical framework to study them is within the purview of mainstream macro-growth economics (Arora, 2005). The concept of human capital refers to the abilities and skills of human resources of a country, while human capital formation refers to the process of acquiring and increasing the number of people who have the skills, good health, education and experience that are critical for economic growth. Thus, investment in education and health are considered as human capital development. This paper examines the interplay between human capital and economic growth whereby human capital is understood as the sum of the investments in education and health. Although it is obvious that there are correlations between human capital and income (GNP), the interconnections between the specific parts of human capital (education and health) and GNP are of diversified nature. Education - especially in its qualitative fashion, like the number of various types of degrees or employed academic staff in the industry and less in its quantitative fashion, like schooling or enrollment numbers - is said to be an explanative variable for GNP, while health behaves in a different mode.

Investments which meet existential healthcare needs do not grasp as GNP driver in the same way as healthcare investments above this existential or 'surviving' minimum. The first ones are said to be 'strategic' long-run investments, while the second ones perform as true short-run GNP drivers. The first are growth enablers, the second growth drivers, especially in developing economies.

Given the fiscal constraints of developing countries like India, investments in social sector development mainly in health and education may be contemporaneous substitutes or complements.

Our objective is to explore the effect of both education and health human capital investment and their stocks on economic growth besides other growth influencing factors in a multivariate cointegration framework. Before formulating the theoretical model, let us first consider the important findings relating to the effects of education and health on economic growth across the countries in the world. Section 2 and section 3 outline the important review of literature on the effects of education and health on economic growth respectively. The progress of human capital investment and human capital stock is illustrated in section 4. Section 5 deals with the theoretical framework, data and estimation technique. The results of the model are given in section 6. Section 7 reports the concluding observations.

2. Education Human Capital and Economic Growth

From the early 1990s, various studies have attempted to identify the determinants of economic growth; long-run growth is endogenous rather than exogenous (Romer, 1986; Lucas, 1988; Mankiw et al. 1992). Lucas's (1988) interpretation of human capital seems closer to population wide education - a social activity not directly related to the knowledge on the frontier of science and technology as argued by Romer (1986). The contribution of education to economic development has mainly relied on cross-country estimates of gross enrolment rates or average years of schooling, which may be grossly inadequate if rates of return to investment in education or quality of education differ substantially across the countries. The weak correlation between growth and increases in educational attainment across the countries is observed by Benhabib and Spiegel (1994) and Pritchett (1997). Using panel data, Caselli et al. (1996) find a negative and significant correlation between output growth and secondary enrolment ratio. Knowles and Owen (1995) find education is not statistically significant in a range of models that include life expectancy and base period output per capita. In contrast to these findings, Barro and Sala-i-Martin (1995), Sala-i-Martin (1997), McMahon (1998), Temple (1999), Bils and Klenow (2000), Self et al. (2004) find schooling to be positively correlated with the growth rate of per capita Gross Domestic Product across countries. The differential outcome of education at the cross-country level is due to the existence of influential outliers and measurement errors of the model (Temple, 1999; Hojo, 2003). Most empirical research so far relies on rather traditional models of growth and development, which ignore some of the crucial aspects of the new growth models taking into account the dynamic feedback of the growth affecting variables. The indirect effect of education on economic growth is measured through productivity improvement. The productivity of labor is influenced by the investment in human capital. This line of thought has not only caused reawakening of the field of endogenous growth but has also established the significance of human resource development through the spillover benefits of education in achieving fast economic growth in many countries including the countries in Asia and Africa (McMahon, 1998; Brempong et al., 2004). Using the time series data, Haldar (2009) has observed that among the three growth models (viz. physical capital, human capital and export led growth), the human capital accumulation led growth model is more relevant to Indian economy.

3. Health Human Capital and Economic Growth

It is commonly believed that economic growth leads populations to live better, have longer lives and good health. Firstly, economic growth means rising per capita income and part of this increased income is translated into the consumption of higher quantity and better quality nutrients. Through nutrition, health as measured by life expectancy responds to increases in income (Fogel, 1997). Secondly, economic growth is fuelled by technological progress and part of this progress is reflected in improvements in medical science (Rosen, 1993; Morand, 2005). The state of health in a country affects its economic growth through various channels.[1] When health improves, the country can produce more

1. Good health and nutrition enhance workers' productivity. Healthier people who live longer have stronger incentives to invest in developing their skills, because they expect to reap the benefits of such investments over longer periods. Better health increases workforce productivity by reducing incapacity, debility and number of days lost due to sick leave. Moreover, good health helps to forge

output with any given combination of skills, physical capital and technological knowledge. One way to think about this effect is to treat health as another component of human capital[2] incorporated in formulating the endogenous growth models (Thomas et al., 1997, Bloom et al., 2001). The effects of human capital variables (namely, health and education) imply that the investment rate tends to increase as levels of education and socioeconomic status of health rise. Longer life expectancy encourages larger investments in human capital, which in turn accelerates the per capita income. The explanation of larger investments on human capital due to longer life expectancy is offered by Stark (1995) in terms of intergenerational transfer of assets. The provision of public resources for better health in a developing country can assist the poor to release resources for other investments, such as in education, as a means to escape poverty. The long-term relationship between income and health is examined by Arora (1999) considering the developed countries in the world and has observed the hypotheses that health of the population has influenced economic growth and that it should be an integral component of the productivity of economies and supporting the endogenous growth models. A similar study made by Arora (2001) provides that in the cointegrated relation between health and income, innovations in health lead to economic growth and not vice versa. Arora's findings is found to be similar to those reported by Fogel (1994; 1997) who has carried out a study on Western Economies over the past two centuries, from 1780 to 1979. In analyzing cross-country data over the past 25 years, Bloom and Sachs (1998) have obtained empirical evidence that health and demographic variables play an important role in determining economic growth rates. More recent studies have examined the effects of life expectancy on economic growth in the subsequent 15 to 25 years, which have consistently been found strong positive direct effects as well as indirect ones operating through rates of investment in physical capital or demographic profiles of the populations (Barro, 1997; Sachs and Warner, 1997; Bloom and Williamson, 1998). Bhargava et al. (2001) have assessed the effects of initial health status on growth over a shorter period of 5 years in a panel of countries and likewise found strong effects, but only in low-income countries. A series of macroeconomic cross-country studies have also found evidence for a significant impact of health (measured by life expectancy) on economic growth (Mayer-Foulkes, 2001; Caselli et al., 1996, Gallup and Sachs, 2000). The impact of health on income is an important policy issue that has motivated research at the World Health Organization. Mayer-Foulkes et al. (2001) has observed in the Mexican

improved levels of education by increasing levels of schooling and scholastic performance (Schultz, 1997). Health affects economic growth through its impact on demographic factors. Shorter life expectancies inhibit investment in education and other forms of human capital, since there is greater risk that each individual will not survive long enough to benefit from investment. In addition, a larger proportion of the population which is dependent has a detrimental effect on rates of savings and capital investment and hence on subsequent growth (Kelly and Schmidt, 1996). Healthier workers are more productive for a variety of reasons – increased vigor, strength, attentiveness, stamina, creativity and so forth. Health and malnutrition reduce the physical capacity of the laborer, leading to lower productivity and resulting in lower wages (Zimmer et al., 2000).

2. Zon and Muysken (2005) argued that economic growth is driven by knowledge accumulation in the traditional Lucas Model (1988) and as such is based on on labor services supplied by healthy people. The health state of the population at the aggregate level (the share of healthy people in the population) determines the extent to which potential labor services embodied in the population can be used effectively. Moreover, knowledge accumulation requires the spending of 'healthy hours', wherein the embodiment of knowledge can take hold in individual people.

states that there has been a significant long-term impact (25-30 years) of life expectancy on economic growth. In the very recent period, the empirical validity of the theoretical model on income, health and health expenditure is examined in India by Haldar (2008) at the disaggregate level (state level) considering a longitudinal data for 26 years (from 1980-81 to 2005-06); both ways causality is examined between socio-economic status of health, income and health expenditure using Granger Causality tool and has found different types of results at the state level.

4. Progress of Income, Human Capital Investment and Human Capital Stocks in India

Growth in per capita GNP, public expenditure on education and health; and the outcome or attainment of human capital stocks measured by upper primary enrolment rate (up to class VIII), infant survival rate (ISR) and life expectancy at birth (LE0) are given in Table 1.

Table 1: Growth of per capita GNP, public expenditure on education & health, enrolment and infant survival rate (ISR)

Year	PCGNP	EE*	HE*	Enrl-VIII	ISR	LE_0
1960-61	4421.71	1.69	0.37	22.5	854	41.25
1970-71	5262.17	1.82	0.44	33.4	871	46.35
1980-81	5879.47	2.01	0.64	41.9	980	54.4
1990-91	7855.06	2.44	0.81	62.1	920	60.8
2000-01	11296.35	3.52	1.09	60.2	937	68**

Note: PCGNP=per capita GNP, EE* = education expenditure as a percentage of GNP, HE*= health expenditure as percentage of GNP, Enrl-VIII =Upper primary enrolment rate, ISR=infant survival rate, LE_0= Life expectancy at birth.
Source: GNP and PCGNP are at constant prices obtained from National Accounts Statistics, Government of India, educational statistics are drawn from Ministry of Human Resource Development; expenditure on health and Infant Survival Rate (ISR) are drawn from Ministry of Health and Family Welfare, Government of India, Life expectancy at birth (LE_0) is based on Census Reports, various issues except 2001. LE_0 for the year 2001 is estimated by expert group of population projection, Govt. of India.

Indian economy has been performing well after the 1980s. The average annual growth of real per capita GNP in the last four decades (viz.1961-71, 1971-81, 1981-91 and 1991-2001) were 1.9, 1.17, 3.36 and 4.38 respectively. This growth of GNP is not reflected consistently in the areas of social sector viz. education and health. From Table 1, it is found that the growth of real per capita GNP was higher during 1991-2001 compared to the earlier decades but the proportion of social sector investment, particularly in education and health was very low compared to other developing countries (UNDP, 2005). During the last 40 years, upper primary enrolment has increased only by 4.18 percent per annum. This shows that universalization of primary education (viz. 100 percent enrolment) still remains a distant dream. The magnitude of out-of-school children has been a stumbling block of achieving the universalization of primary education. Universalization of elementary

education, a goal set by the Constitution to be achieved within a ten-year period after the Constitution was framed, still eludes and remains as the most conspicuous failure of the Indian education system (Tilak, 2006). The National Policy on Education of 1986 resolved that by 1995, all children would be provided free and compulsory education up to 14 years of age. Now, in 2001, the Union Government has revised this and announced that the universalization of elementary education with respect to enrolment and retention will be achieved by 2010.

In the years since independence, there have been significant gains in health status in India, but they do not compare favourably with those in many similarly placed developing countries. Life expectancy has gone up from 36 years in 1951 to 68 years in 2001. Infant mortality rate is down from 146 in 1951 to 63 in 2001. These gains have been made possible by the growth and development of health infrastructure and efforts to control communicable diseases such as immunization and improvements in determinants such as water supply and sanitation (Misra et al., 2003). But this gain in health status is too unsatisfactory compared to other developing countries. Life expectancy has increased by 64.84 percent during the last 40 years but it is still well below from many developing countries even from our neighboring country like Sri Lanka; Sri Lanka's life expectancy is 74.8 (UNDP, 2005).

The biggest impediment to analysis of health expenditure is the lack of any systematic compilation of national health accounts. In India, the dominant mode is private; private spending (i.e. out-of-pocket payments and voluntary insurance) contributes as much as 87 percent according to World Health Organization (2000). Poor public health expenditures remain the predominant cause of the unsatisfactory performance of the health system and it has been more or less remaining stagnant since 1951. India's public health expenditure was estimated at 0.9 percent of GDP, well below the average of 2.8 percent of low and middle-income countries, and the global average of 5.5 percent (World Bank, 2001a).

5. Theoretical Framework, Estimation Technique and Data

Endogenous growth theory as developed by Lucas (1988) basically represents an extension of the Solow (1956) neoclassical growth model incorporating positive externalities related to the accumulation of human capital viz. knowledge. Following Schultz (1997), Becker (1993) and Lucas (1988) it can be argued that the production of human capital is possible through education and health sector. The model used in this paper is derived from Lucas (1988) type endogenous growth model:

$$Y_i = A.F(\mu h L_i, K_i).H_a^{\gamma} \quad (1)$$

Where, A is the total factor productivity, Y_i is the output of the i^{th} firm, L_i is the number of workers used by firm i, μ is the proportion of time that each worker devotes to production, h is the human capital of worker employed by the firm i, K_i is the physical capital used by firm i. H_a is the average human capital in the economy and γ is a positive coefficient. Here, effective labor input $\mu h L_i$ replaces the simple labor input L, specified in the standard Solow (1956) growth model. H_a^{γ} term is the externality effect of human capital, which raises economy-wide labor productivity.

Broadly speaking, output in equation (1) is affected by physical capital and human capital. Now, how can we integrate the export led growth mechanism in equation (1)? At

the aggregate level, open economy also considers export as a variable augmenting output, which is determined endogenously through labor productivity. In connection with this argument, Romer (1990) develops 'endogenous technical change' through research and development, as a human capital externality enabling the communication of knowledge inputs as well as facilitating the adaptation of new designs. Wood (1994) has claimed that skill development through education to be a key determinant of comparative advantage and manufacturing export performance. Thus, export led growth strategy is basically driven by endogenous growth.

Following McMahon (1998) and Oketch (2006), we consider the following implicit production function as:

$$Y_t = Y(K_t, H_t, N_t) \tag{2}$$

Where, Y=aggregate output, K=stock of physical capital, H=stock of human capital and N=aggregate employment of the economy and t=time. Totally differentiating the reduced form of equation (2), with respect to time t and dividing through by Y, we have:

$$\frac{1}{Y}\left(\frac{\delta Y}{\delta t}\right) = \frac{1}{Y}\left(\frac{\delta Y}{\delta K}\right)\left(\frac{\delta K}{\delta t}\right) + \frac{1}{Y}\left(\frac{\delta Y}{\delta N}\right)\left(\frac{\delta N}{\delta t}\right) + \frac{1}{Y}\left(\frac{\delta Y}{\delta H}\right)\left(\frac{\delta H}{\delta t}\right)$$

$$y = MPP_K.\frac{I_K}{Y} + MPP_N.n.\frac{N}{Y} + MPP_H.\frac{I_H}{Y} \tag{3}$$

Here, y and n represent rate of growth of output and employment respectively. I_K and I_H stand for investment in physical and human capital respectively. Assume that population grows at an exponential rate: $P_t = P_0.e^{rt}$, now we subtract the population growth rate r, from both sides of equation (3):

$y-r = MPP_K.\frac{I_K}{Y} + MPP_N.n.\frac{N}{Y} + MPP_H.\frac{I_H}{Y} - r$, the left hand side represents the per capita growth rate of output: $\frac{\delta \frac{Y}{P}}{\delta t} \div \left[\frac{Y}{P}\right]$. Finally, we can write the above equation as follows assuming, $\theta = \frac{r}{n}$,

$$y-r = MPP_K.\frac{I_K}{Y} + MPP_H.\frac{I_H}{Y} - r + n.\left(MPP_N - \theta.APP_N\right)/APP_N \tag{4}$$

Assume the equality between r and n. This assumption is more valid and plausible in the developed western economies or may hold good in the planned economy but it is a restrictive assumption for the underdeveloped countries because of population growth rate which is higher than the growth rate of employment. The first and second term of right hand side of equation (4) is positive but the third term is negative. The coefficient of n is negative. This may be explained by considering a generalized Cobb-Douglas production function as:

$$Q = A.L^{\mu_1}K^{\mu_2}H^{\mu_3} \tag{5}$$

where $0 < \mu_1 < 1$. Since $MPP_N = \mu_1.APP_N$, equation (4) can be written as:

$$y-r = MPP_K.\frac{I_K}{Y} + MPP_H.\frac{I_H}{Y} + n.(\mu_1 - 1) \tag{6}$$

Generally, in case of less developed economies, $\theta>1$ i.e., $r>n$, the magnitude of the coefficient of n is much more negative compared to the case, $\theta=1$. This is quite evident in case of the countries in Sub-Saharan Africa where the growth of population has been acting as a retarding factor of per capita growth of GNP.

One can decompose the I_K into two parts: public and private physical capital investment. Similarly, I_H can be decomposed into education and health both for public and private. Due to lack of such private long-term data on education and health expenditure, we only consider public spending on human capital (both for education and health). Since the annual data on employment growth rate (n) was not available for the entire period, we for the sake of simplicity ignore the effect of employment (as well as population) growth rate on per capita GNP for the sake of simplicity.

5.1 Estimation Technique

Now, treating output, investment in physical capital and human capital as endogenous, the following open-ended models are assumed for estimation as:

$$f(\ln PCGNP_t, PCIY_t, HCY_t, ENRLEgr_t \ \& \ D_{open})=0 \quad (7)$$

$$f(\ln PCGNP_t, PCIY_t, EDY_t, ENRLEgr_t \ \& \ D_{open})=0 \quad (8)$$

$$f(\ln PCGNP_t, PCIY_t, HELY_t, ENRLEgr_t \ \& \ D_{open})=0 \quad (9)$$

where,

lnPCGNP = Natual log of real per capita Gross National Product (GNP),

PCIY = Total (public and private) physical capital investment as a percentage of Gross Domestic Product (GDP),

HCY = Human capital expenditure (comprising education and health) as a percentage of GDP,

EDY = Education expenditure as a percentage of GDP,

HELY = Health expenditure as a percentage of GDP,

ENRLEgr = Growth of Gross Enrolment of Class VIII,

Dopen = Dummy Variable for openess[3] = 1 after 1991 and 0 otherwise.

In order to avoid the problem of the specification arising from simultaneity (endogeneity) and to investigate the long-run linkages among the four variables mentioned in equations (7), (8) and (9), we use the cointegration methodology as developed by Johansen (1988) and Johansen and Juselius (1990). Given the endogeneity property among the variables, it would be better and appropriate to employ the Johansen's multivariate cointegration approach, where all variables in the VAR system are assumed to be dynamically related.

The stock of human capital is divided into two parts: education human capital and health human capital. From the above analysis, the education human capital stock can be measured but the problem arises in measuring the stock of health human capital over time. Health is an unobservable variable and its stock at the individual level continuously decreases. However, the health stock, for the time being can be augmented by proper medical treatment. But at the macro-level, over time the health stock can be measured by

3. The Government of India has opened its market in 1991 and from that year the structural adjustment programme has been going on.

life expectancy, infant survival rate, morbidity prevalence rate, disability adjusted life years etc. Incorporating this idea and following Thomas et al. (1997), Bloom et al., (2001), we could incorporate health stock measured by ISR in our model but it does not appear to have any significant relationship with the variables under study. This is quite surprising in our analysis. ENRLE represents upper primary (class V to class VIII) enrolment ratio measured as education human capital stock. We could incorporate the lower primary enrolment ratio in our model but upper primary enrolment ratio is expected to provide a good measure of educational stock since it is less fluctuating and its value throughout the period is less than 100 compared to lower primary enrolment ratio. It is to be mentioned here that the higher enrolment data are unavailable for the entire time period.

Most of the empirical works on endogenous growth consider the output of education human capital measured by enrolment[4]. Our model helps to understand the effect of education stock on economic growth in presence of human capital expenditure, which is assumed to be distinct from earlier empirical growth models.

The essence of Johansen's cointegrating relationship is that the variables in the system share a common unit root process, this approach is appealing because it treats all the variables as endogenous; it thus avoids the arbitrary choice of the dependent variable in the cointegrating equations but it is more applicable in case of large samples. Following Pesaren and Shin (1995), one can use the Auto-Regressive Distributed Lag (ARDL) approach of cointegration which does not involve pre-testing variables, which means that the test on the existing relationship between variables in levels is applicable irrespective of whether the underlying regressors are purely I(0), purely I(1) or a mixture of both.

5.2 Data

We analyze the above open-ended models represented by equation (7), (8) and (9) using annual data from 1960 to 2005. The data sets of the variables like GNP, total investment (i.e., public and private) of physical capital are drawn from Planning Commission, National Accounts Statistics, Government of India. Data on education expenditure and enrolment are drawn from the Ministry of Human Resource Development, Government of India whereas data on health expenditure and infant survival rate are derived from the Ministry of Health and Family Welfare, Government of India. We have used Microfit 4.1 and Eviews 6.0 softwares for the econometric analysis.

6. Results and Discussion

Table 2 shows the summary statistics of the variables understudy. Mean growth of all the variables are ranging from 1.76% for PCIY to 2.96 % for ENRLE. Year eight enrolment is growing at much faster rate than other variables under study. It is also clear from the table that the volatility of the investment on education and health are much higher than other variables,

4. Barro and Sala-i- Martin (1995), McMahon (1998) and Mallick (2002) have used school enrolment rates in measuring the stock of human capital in the endogenous growth model.

Table 2: Summary Statistics

	GNPgr	ENRLEgr	EDYgr	PCIYgr	HCYgr	HELYgr
Mean	2.43	2.96	2.16	1.76	2.01	2.54
Std. Dev.	1.66	3.72	4.84	4.27	4.66	5.19
Skewness	-0.29	0.79	-0.30	-0.17	0.08	0.88
Kurtosis	2.22	4.60	2.83	3.24	3.32	5.93
JB Normality test	1.75 (0.42)	11.34 (0.00)	0.72 (0.70)	0.32 (0.85)	0.24 (0.88)	21.85 (0.00)
Number of observations	45	54	45	45	45	45

Note: p-values in bracket. ENRLE is from 1950-51.

which is not a good sign for long-term development in social sector in India. Health and education investment should be consistent, which in turn, may increase the overall growth of the country through human capital formation.

Before examining the Johansen's cointegration technique, all the variables are to be tested for stationarity as a prerequisite. At the elementary level, stationarity can be tested plotting the correlogram of a time series but at the formal level, this can be examined by finding out if a time series contains a unit root. The stationarity of the data set is examined using Augmented Dickey-Fuller (ADF), Phillips-Perron (PP) and Kwialkowski-Phillps-Schmidt-Shin (KPSS) tests. Unit root test results are given in Table 3.

Table 3: Unit Root test

Different Unit Root Tests						
Variables (in levels & first difference)	ADF		PP		KPSS	
	C	C & T	C	C & T	C	C & T
lnPCGNP	3.29 (2)	0.11 (2)	4.43 (3)	0.50 (3)	1.19 (3)	0.31 (3)

ΔlnPCGNP	-2.89*** (2)	-6.06* (2)	-2.69*** (3)	-4.09** (3)	0.82 (3)	0.10* (3)
PCIY	0.35 (1)	-2.52 (1)	0.55 (3)	-2.20 (3)	1.23 (3)	0.09* (3)
ΔPCIY	-5.74* (1)	-5.81* (1)	-6.09* (3)	-6.16* (3)	0.14* (3)	0.08* (3)
HCY	0.83 (1)	-1.64 (1)	0.99 (3)	-1.33 (3)	1.12 (3)	0.22 (3)
ΔHCY	-3.96* (1)	-4.36* (1)	-5.23* (3)	-5.50* (3)	0.26* (3)	0.05* (3)
EDY	2.22 (1)	0.07 (1)	2.96 (3)	0.57 (3)	1.32 (2)	0.29 (2)
ΔEDY	-3.35** (1)	-4.45* (1)	-4.64* (3)	-5.49* (3)	0.59** (2)	0.12** (2)
HELY	0.52 (2)	-3.29** (2)	0.58 (3)	-3.01 (3)	1.22 (3)	0.10* (3)
ΔHELY	-4.44* (2)	-4.42* (2)	-5.73* (3)	-5.79* (3)	0.13* (3)	0.05* (3)
ENRLE	-1.07 (1)	-2.48 (1)	-0.98 (3)	-1.91 (3)	1.43 (3)	0.10* (3)
ΔENRLE	-4.21* (1)	-4.25* (1)	-4.65* (3)	-4.65* (3)	0.09* (3)	0.06* (3)

Note: *, ** and *** implies significant at 1%, 5% and 10% level respectively. Number within parentheses represents optimum lag determined from AIC Criterion.

It is clear from Table 3 that all variables under study have unit root, or non-stationary or integrated of order one in its level and stationary, or integrated of order zero at its first difference at least at 5% level. Hence all the series are non-stationary and the standard regression analysis may produce spurious results. Once the series are made stationary, they can be used in regression analysis. But the drawback of this method is the possibility of losing long-run information about the variables. This problem can be overcome by applying the cointegration technique, which shows the long-run equilibrium relationship between two or more non-stationary series. The variables are said to be cointegrated if they are integrated of order one. To find out the number of cointegrating vectors we have applied maximum likelihood-based λ-max and λ-trace statistics introduced by Johansen (1988; 1992) and Johansen and Juselius (1990). In a set of m series, if there are 'r' co integrating vectors, then there are (m-r) common stochastic trends. Prior to testing the number of significant vectors we have tested the optimal lag length using the likelihood ratio (LR), AIC and SBC criteria. The Johansen ML procedure is applied to the VAR formed by the non-stationary variables along with two exogenous variables in each of equation (7), (8) and (9). The results of Johansen's test and the normalized cointegrating vectors are presented in Table 4. Based on the λ-max and λ-trace statistics from Table 4 we can conclude that there exists

at least one cointegrating vector for three different relations mentioned in equations (7), (8) and (9).The normalized cointegrating vectors in the co integrating relations are given at the bottom of the λ-max and λ-trace statistics in Table 4. Next we test the significance of each variable in the cointegrating relation by using the LR test statistics given by Johansen, which is asymptotically chi-square with one degree of freedom. The variables that are statistically significant can contribute to the long run relationship. From first panel of Table 4, we observe that lnPCGNP, PCIY and HCY are cointegrated with one cointegrated vector. Similarly, EDY and HELY are also cointegrated with lnPCGNP and PCIY separately at least at 1% level. In all the cases, the eigenvalue statistics drop sharply for alternative hypothesis of third cointegrating vector. Thus, we can conclude that our model with three variables is a fair representation for all three equations.

It can also can be observed from the second part of each panel that, PCIY did not influence lnPCGNP significantly, but HCIY, EDY and HELY influence the per-capita GNP positively and significantly.

Table 4: Johansen's Cointegration Test
Cointegration LR test based on maximum eigenvalue of the stochastic matrix

	Hypothesis	Alternative	Eigen-value	λ -max	λ -Trace
Variables under study: lnPCGNP, PCIY, HCY & ENRLEgr, Dopen					
VAR(3)	r = 0	r =1	0.8402	27.48*	49.77*
	r ≤ 1	r =2	0.3312	16.92	22.29
	r ≤ 2	r =3	0.1200	5.37	5.37
LR estimates	***lnPCGNP= - 0.0129 PCIY + 0.3137* HCY + 0.0126*** t*** ***(-0.68) (4.19) (1.91)***				
Variables under study: lnRPCGNP, PCIY, EDY & ENRLEgr, Dopen					
VAR(2)	r = 0	r =1	0.4516	25.24***	43.11*
	r ≤ 1	r =2	0.2918	14.49	17.87
	r ≤ 2	r =3	0.0773	3.38	3.38
LR estimates	***lnPCGNP= - 0.0040 PCIY + 0.2712* HCY + 0.0200*** t*** ***(-0.17) (2.81) (1.92)***				
Variables under study: lnPCGNP, PCIY, HELY & ENRLEgr, Dopen					
VAR(3)	r = 0	r =1	0.5579	34.32*	61.86*
	r ≤ 1	r =2	0.3478	17.93***	27.54**
	r ≤ 2	r =3	0.2035	9.61	9.61
LR estimates	***lnPCGNP= - 0.0778***PCIY + 4.2678* HELY + 0.0221 t*** ***(-1.92) (2.56) (1.02)***				

Notes: i) *, ** and *** indicate significant at 1%, 5% and 10% levels respectively
ii) Figures in parenthesis represent the t-statistics.

Since lnPCGNP, PCIY and HCY (or EDY or HELY) are found to be cointegrated, we proceed to test their error correction mechanism. Table 5 presents the results of the error correction models for all three models (represented by equations 7, 8, and 9) of real per capita GNP growth (viz. ΔlnPCGNP). The estimated co-efficients show the immediate impact of ΔPCIY and ΔHCY (or ΔEDY or ΔHELY) on ΔlnPCGNP. It also shows the lag effect of three years of year eight enrolment growth and openness. The short-run adjustment coefficient i.e., error correction (ECM) terms of equations (7), (8) and (9) appear to be significant at 5%, 1% and 10% respectively. The ECMs terms of equation (7) and (8) give us that about 7% of the deviation of actual growth of GNP from its long-run equilibrium level is corrected each year whereas it is only 2% for equation (9). The short run coefficients of ΔPCIY are found to be insignificant for all three equations suggesting that PCIY has no effect on the growth of per capita GNP. The short-run relationship between different types of investment expenditure and per capita GNP growth are mostly negative and insignificant for most of the cases. However, third lag of year eight enrolment growth and openness dummy is positive and significant at 1% level for all three equations. The results indicate that enrolment growth before three years significantly enhancing per capita GNP growth. It also shows that the growth has been increased significantly after liberalization of the Indian economy. The findings are very important especially for the policy perspective.

Table 5: Short-run relationships of the variables estimated using cointegrating VAR

Dependent variable GNPgr			
Independent variable	Equation 7	Equation 8	Equation 9
Constant	0.566** (2.31)	0.584* (3.38)	0.238*** (1.83)
$GNPgr_{t-1}$	0.507* (3.38)	0.568* (3.81)	0.687* (4.13)
$GNPgr_{t-2}$	-0.008 (-0.04)	-0.021*** (-1.89)	-0.138 (-0.70)
$GNPgr_{t-3}$	-0.001 (-0.67)	-0.390** (-2.61)	-0.278*** (-1.70)
$PCIYgr_{t-1}$	-0.001 (-0.40)	-0.001 (-0.45)	0.001 (0.01)
$PCIYgr_{t-2}$	0.005 (0.21)	-0.0003 (-0.16)	0.003 (0.13)
$PCIYgr_{t-3}$	-0.001 (-0.67)	-0.002 (-0.89)	-0.001 (-0.49)
$HCYgr_{t-1}$	-0.002 (-1.50)	-----	------

$HCYgr_{t-2}$	-0.012 (-0.79)	-----	-----
$HCYgr_{t-3}$	-0.031*** (-1.85)	-----	-----
$EDYgr_{t-1}$	-----	-0.033*** (-1.89)	-----
$EDYgr_{t-2}$	-----	-0.008 (-0.44)	-----
$EDYgr_{t-3}$	-----	-0.031*** (-1.76)	-----
$HELYgr_{t-1}$	-----	-----	-0.127 (-1.65)
$HELYgr_{t-2}$	-----	-----	-0.036 (0.47)
$HELYgr_{t-3}$	-----	-----	-0.187** (-2.40)
ECM_{t-1}	-0.070** (-2.27)	-0.072* (-3.33)	-0.028*** (-1.75)
$ENRLEgr_{t-3}$	0.001* (2.74)	0.001* (2.71)	0.001 (1.44)
Dopen	0.022* (3.88)	0.022* (4.04)	0.018* (3.18)
$\overline{R}^2$	0.61	0.67	0.61
DW	1.74	1.76	1.67
SC	2.22 (0.14)	1.62 (0.20)	3.56 (0.06)
FF	4.05 (0.04)	3.42 (0.06)	1.54 (0.22)
NORM	1.03 (0.60)	1.86 (0.40)	0.15 (0.93)
HET	1.02 (0.31)	1.11 (0.29)	0.81 (0.37)
Where, GNPgr=ΔlnPCGNP; PCIYgr=ΔPCIY; EDYgr=ΔEDY and HELYgr=ΔHELY			

Notes: i) *, ** and *** indicate significant at 1%, 5% and 10% levels respectively
ii) Figures in parenthesis represent the t-statistics.

Generalised Impulse Response Analysis

In this section we further investigate the statistical significance of innovations of the variables under study by using Generalised Impulse Response Functions (GIRF), introduced by Pesaren and Shin (1998). We have estimated GIRF by

employing VAR, consisting of ΔPCIY, ΔEDY, ΔHELY and ΔlnPCGNP. The number of lags is determined by AIC. The impulse response results are presented in Appendix (Figure 1). Dashed lines indicate two standard error bands representing a 95% confidence region.

Figure 1 shows that the innovation in per capita GNP growth can only explain the movements of ΔEDY and ΔlnPCGNP positively and significantly and the effect lasts for less than three years, but, does not explain the movement of ΔPCIY and ΔHELY. Similarly, the innovation in ΔEDY significantly and positively explains the movements of ΔEDY (itself) for a short period of time. On the other hand the innovations of ΔHELY explain the movements of per-capita education growth and ΔHELY significantly and positively.

7. Conclusion

This study makes an effort to establish a relationship among physical capital investment, investment in education and health on per capita GNP growth using annual data for India. We found that investment in education and health are very important and has a significant positive long run effect on per capita GNP growth. We have also found that the year eight enrolment has positive and significant effect on GNP growth after three years. India has opened its economy in 1991 and the growth has significantly increased after that period. The results are further explained by the Generalised Impulse Response Analysis.

One can conjecture a number of factors. Good health and nutrition enhance workers' productivity. Healthier people who live longer have stronger incentives to invest in developing their skills, which increases workforce productivity by reducing incapacity, debility, and number of days lost to sick leave. Our findings are supported by Schultz's (1997) study where he mentioned about scholastic performance. Zon and Muysken (2005) argued that economic growth is driven by knowledge accumulation in the traditional Lucas Model (1988) and as such is based on labour services supplied by healthy people.

Obviously, investment on health and education work differently for different countries, but it is a fact that for India's health and education i.e., overall human capital expenditure has definitely long run impact on growth. Unfortunately the expenditure on such an important area is not consistently supported by the Government of India. In fact the expenditure on human development is inconsistent and severely inadequate. Public expenditure on education and health is an important policy instrument for realizing social sector development. The Government of India has initiated various policies and programmes in this direction since independence but the progress of human capital in India is very slow compared to many developing countries.

Recognizing the contribution of education to economic development and keeping in line with the human capital investment revolution in economic thought, the Government of India has accepted the concept of 'investment' in education in its 1968 Policy and fixed a target of six percent of national income to be invested on education by 1986. The proportion of GNP invested in education was 3.8 percent in 2005-06. Compared to the very low level of 0.6 percent in 1951-52, this marks a very significant progress but still it is well below the average of many developing countries in the world.

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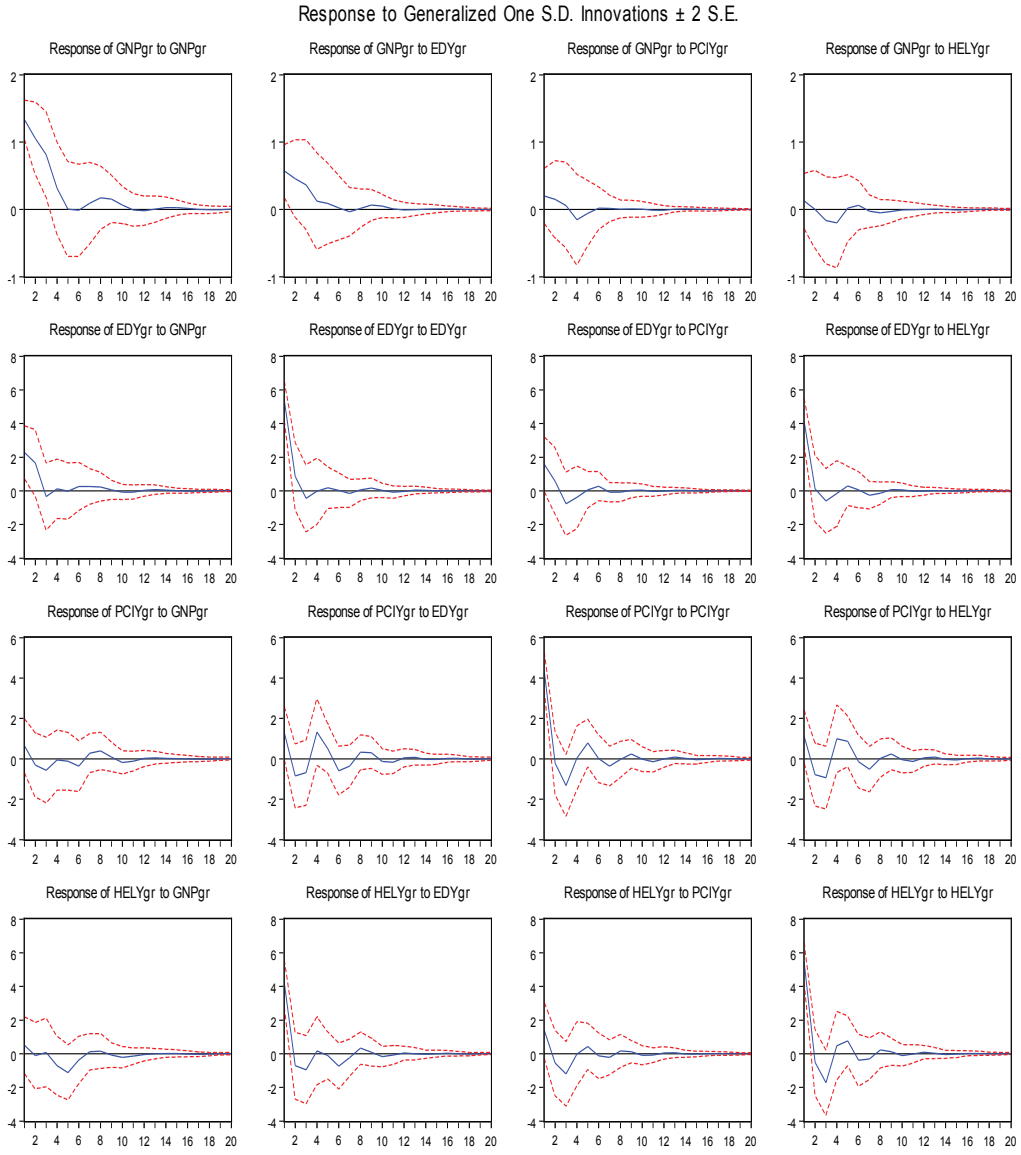
Appendix

Figure 1: Impulse Response Function



Where, GNPgr=ΔlnPCGNP; PCIYgr=ΔPCIY; EDYgr=ΔEDY and HELYgr=ΔHELY

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Euro and Technology Effects on Job Turnover in Greek Manufacturing

Theodore Papadogonas[1] and Fotini Voulgaris[2]

Abstract

This paper investigates the effects of Greece's European Union (EU) accession and European Economic and Monetary Union (EMU) entry, as well as R&D intensity and industry concentration on job creation and job destruction in the Greek manufacturing sector. The study is based on firm-level economic data of 1418 firms and covers the time period from 1995 to 2004. The econometric model, besides other firm-level determinants used in similar studies, incorporates variables that capture the potential impact of EU accession and EMU entry. In addition, the effects of variables, such as R&D, size, age, exports, new investment, profitability and industry concentration ratios are examined. The study reveals that EMU has a substantial negative effect on employment growth in the Greek manufacturing sector. However, it strengthens the effect of exports, new investments in tangible assets and R&D expenditures on the creation of new work positions.

Keywords: Industry study, dynamic growth, manufacturing, financial performance

JEL classification: C23, D21, G32, J23, L11, L6

1. Introduction

Employment growth is a key measure of a country's economic performance. In Greece, for the last 20 years job destruction has been higher than job creation, leaving a net unemployment rate of approximately 10% (IMF, 2009 World Economic Outlook). The issue of unemployment is a big one also on an international level and many empirical studies so far have been undertaken on determinants of employment growth in firms. A growing number of studies have analyzed data at the firm level and have found correlations between employment growth and variables, such as size (Hall, 1987; Singh and Whittington, 1975), age (Audretsch, 1995), ownership structure (Variyam and Kraybill, 1992), research and development (R&D) activities (Hall, 1987), capital structure (Lang, Ofek and Stulz, 1996), human capital and export activities (Liu, Tsou, and Hammitt, 1999).

This study examines the effects of various factors on the employment growth of Greek firms and especially the Euro effect after the European Monetary Unification of Greece, through the use of econometric models based on panel data analysis.

The main contribution of this paper is the investigation of the Euro effect, besides

1. Technological Educational Institute of Chalkis, GR-34400 Psachna, Evia, Greece - email: tpapadogonas@yahoo.com

2. Technological Educational Institute of Crete, GR_72100 Agios Nikolaos, Crete, Greece - email: fvoulgari@finance-ins.teicrete.gr

other factors on employment growth in the Greek manufacturing sector, which has not been analyzed so far to our knowledge. The fact that firm level economic data of a very large number of Greek manufacturing firms (1418) are used enables the investigation of firm specific factors determining the employment growth. Our data are based on ICAP, the largest firm database in Greece.

Greece has experienced significant economic changes during the 1995-2004 period, following its accession to the EU and the European Economic Unification. The policy of the hard drachma affected adversely the competitiveness of the Greek industry in the years 1997-1999, followed by the stable currency effect of the single currency. This is indicated in Table 1, with the decrease of Greek exports. Furthermore, the tight fiscal and monetary policy followed in order to meet the Maastricht requirements, resulted in a substantial decrease of the inflation rate and labor cost. This resulted in an increase of GDP compared to EU, as shown in Table 2.

Table 1: Percentage of Greek Exports

Year	Exports of Goods (% of GDP)
1995	9.4
1996	9.4
1997	9.2
1998	8.2
1999	8.2
2000	9.3
2001	8.7
2002	7.0
2003	6.9
2004	6.6
2005	7.0
2006	7.7
2007	7.5

Source: Eurostat

Table 2: Economic indicators for the Greek economy, 1995-2004 (Percentage changes)

Year	GDP Greece	GDP Euro Area (12 countries)	Inflation	Real unit labour cost
1995	2.1	-	9.0	3.5
1996	2.4	1.5	8.2	-0.6

1997	3.6	2.6	5.4	3.4
1998	3.4	2.8	4.5	-0.6
1999	3.4	3.0	2.1	1.1
2000	4.5	3.8	2.9	-1.8
2001	4.5	1.9	3.7	0.0
2002	3.9	0.9	3.9	1.5
2003	5.0	0.8	3.4	-1.6
2004	4.6	2.1	3.0	-2.3
2005	3.8	1.6	3.5	0.2
2006	4.2	2.7	3.3	1.9
2007	4.0	2.6	3.0	-

Source: Eurostat, OECD

The hard drachma resulted in an increase in employment in Greece for the period under study, as shown in Table 3, with an average annual growth rate of 1.40 %. However, the employment in the manufacturing sector shows a decreasing trend in that period indicated by the share of manufacturing to total employment. Consequently, it is obvious that for the period under study, there is a reallocation of jobs from the manufacturing to the service sector in the Greek economy (see Table 3).

Table 3: Employment in Greece, 1995-2004 (in thousands)

Year	Total (1)	Manufacturing (2)	(2)/(1)
1995	3820.5	577.4	15.11%
1996	3868.3	575.3	14.87%
1997	3853.3	558.6	14.50%
1998	4023.7	585.8	14.56%
1999	4040.4	577	14.28%
2000	4097.9	571.5	13.95%
2001	4103.2	580.3	14.14%
2002	4190.2	579.2	13.82%
2003	4286.6	565	13.18%
2004	4330.5	569.7	13.16%
2004	4368.9	561.4	12.85%
2004	4452.3	561.6	12.61%
2004	4509.8	560.5	12.43%

Source: Eurostat

2. Theory and Empirical Findings

In the theory of the Growth of the Firm, Penrose (1959) examined the internal processes that determine a firm's rate of growth. Penrose sees the firm as a coherent administrative organization where managerial resources are critical. It is the manager's entrepreneurial skills that provide the inducement for growth and determine the rate of expansion. However, for Penrose, managers are not primarily interested in profitability per se, but in the profitable expansion of the activities of their firms. In the long run, the profitability, the survival and the growth of a firm do not depend so much on the efficiency the firm organizes its production, but on its ability to detect external opportunities and threats and align internal resources to take advantage of the expected business environment.

The neo-classical view of the firm states that profits are a necessary condition for growth and determine the rate of growth. The higher the retention rate (which is the percent of non distributed profits, calculated as one minus dividend rate), the higher the growth rate of the firm, and the higher the profitability (Net Profits over Total Assets or return on assets, symbolized by ROA) of the firm the higher the growth rate (g), according to the equation:

$$g = (\text{retention rate}) \times (\text{return on assets}) \quad (1)$$

A comprehensive theory of the firm must be able to explain not only the incentive for firms to expand their horizontal boundaries, but also why firms within the same industry grow to different sizes and why for some firms growth is negative. The economies of scale and the stage in the life cycle of a firm do not explain the varying growth performance of individual firms. The competency approach theory places great emphasis on the entrepreneurial ability of the firm's senior management to perceive new productive opportunities and to utilize the firm's accumulated knowledge to exploit them (Rickard, 2006). According to Jovanovic's (1982) life-style model, managerial efficiency and learning by doing are the key factors for firm growth. The most efficient firms grow and survive and some of the inefficient ones do not. Jovanovic also showed that young firms grow faster than older ones and, since young firms are usually small, this confirms the negative correlation between firm size, age and growth. Based on this theory, firm size and age are considered as determinants of growth.

According to Gibrat's Law of Proportional Effect, the growth rate of a firm is independent of its current size and its past growth history. The Law has been tested in numerous studies, but the findings are conflicting. Gibrat's law fails to hold for small firms (Hart and Oulton, 1996; Audretsch, Santarelli and Vivarelli, 1999), where empirical results show that growth is inversely related to size.

There is considerable evidence that smaller firms grow faster than larger firms, not altogether surprising when smaller firms are growing from a small base. Empirical research in EU and in other developed countries has shown that small and medium sized enterprises (SMEs) play a major role in job creation and job destruction. Birch (1981) was the first one to find that large firms are no longer the major providers of new jobs for Americans, and that the bulk of new jobs has emanated from small enterprises in the USA. Gallagher and Stewart (1986), Storey and Johnson (1987), Dunne and Hughes, (1994) and Konings (1995) found similar results for the United Kingdom. Evans (1987a) found that growth declines with age.

Broesma and Gautier (1997) for Dutch manufacturing firms, and Klette and Mathiassen (1996) for Norwegian manufacturing firms, also found that employment

creation is negatively related to size and age, with newly established firms having the greatest creation rates. However, the evidence is less compelling for Germany. Wagner (1995) found that there is no dramatic job generation by small firms in Germany. Regarding Greek manufacturing, empirical findings suggest that job creation and job destruction rates are substantially higher in small firms (1-20 employees) but decrease with the size of the firm, (Voulgaris, Papadogonas and Agiomirgianakis, 2005). The large-sized firms have the lowest rates of employment growth with the medium-sized firms having rates somewhere in between. Further analysis shows that for continuing firms, job destruction rate was the highest for large firms and the lowest for the small firm class.

The empirical literature, though, indicates that firm characteristics besides size and age, may play an important role in the growth of firms. These characteristics are capital structure (Lang, Ofek and Stulz, 1996), research and development (Hall, 1987), human capital and export activities (Liu, Tsou and Hammitt, 1999).

The growth of a firm is directly connected to employment growth through job creation and job destruction. Job destruction occurs either because firms go out of business or because they reduce their workforce. In general, closing establishments represent a small share of total employment (Lee and Rudick, 2006). It is job losses at continuing business that play a more important role in aggregate employment changes. An increase in the job destruction rate in the manufacturing sector does not necessarily suggest that the economy has been less competitive. This might be the result of creative destruction with workers placed from old jobs and less efficient firms to jobs that better fit the needs of the economy. This is a natural and necessary step to economic growth making the economy more competitive in the long run. In the case of Greece, the job reshuffling is basically among manufacturing and service firms and in the manufacturing sector, from labor intensive to new technology and heavy industry firms (Voulgaris, Papadogonas and Agiomirgianakis, 2005).

Exports are an indication of competitiveness in a firm and a determinant of growth. R&D expenditures are perceived as an indicator of innovation by researchers (Wakelin, 1998; Willmore, 1992). Therefore, both must have an impact on the growth of the firm and the net job creation. However, the level of the exchange rate and its volatility will certainly affect export performance in a firm and consequently its growth.

3. Data and Methodology

The purpose of this paper is to identify the factors affecting employment growth in the Greek manufacturing sector.

The period of study is of particular interest, because it allows us to evaluate the effects of Greece's European Union (EU) accession and European Economic and Monetary Union (EMU) entry on job creation and job destruction in the Greek manufacturing sector. The research is based on panel data, covering the period 1995-2004 broken down by the sub-periods 1995-99 and 1999-2004 on a sample, which includes all private firms of corporate forms (societés anonymes and limited liability companies), while sole proprietorships and partnerships are excluded. The database, which also contains information on financial data for those firms, in addition to the number of employees, is provided by ICAP Hellas S.A., a Greek private research company. Data was carefully treated for mergers, acquisitions, changes in legal status etc. The time span covered in

the database is from 1995 to 2004 due to lack of available reliable data before 1995. Data are on a firm level, instead of an establishment level. This causes a downward bias to job creation and destruction, because jobs created and lost by different establishments of the same firm will cancel out. However, this bias should be considered negligible for Greek manufacturing, since, as Droucopoulos and Papadogonas (1999) report, the proportion of multiplant firms to uniplant firms in Greek manufacturing is 1 to 27. As a result, our measure of job creation and destruction slightly underestimates the true magnitude of job creation and destruction.

Regression Analysis

While simple OLS estimations are often used in growth research, their application on data having a cross-section and a time dimension may provide biased and inconsistent estimates. For this reason, we performed the analysis using panel data estimation techniques. In the econometric specification models, we estimated employment growth rate as a function of several independent factors.

Based on the theory and empirical findings for Greece and abroad, we hypothesized that positive effects on the employment growth of the Greek manufacturing firms are expected from the following variables:

1. Deflated sales growth taken as a proxy for activity growth. Sales are measurable and for the short run they can serve as a more practical goal versus profits which are residual and can be influenced by events beyond a firm's control. Sales also can act as a proxy for diversification, since the higher the rate of diversification, the faster the rate of growth of demand for a firm's products.
2. Relative investment (Relinv), calculated as (gross fixed assets in year t_1 - gross fixed assets in year t_0)/(gross fixed assets in year t_0 over the same ratio for the 2-digit industry where the firm belongs). This is a relative efficiency ratio and is taken as a proxy for application of new technology through new investments in fixed assets. The growth in net Capital expenditures, including machinery, equipment and buildings, embody past innovations and influence the marginal cost of production of the firm. As a result, a positive relationship between capital expenditures and firm growth is expected.
3. Leverage (Debt to Total Liabilities) measured at the base year. Financial leverage increases firm risk. Lang, Ofek and Stulz (1996) studied how capital structure affects the future growth at the firm level and found a negative relation between financial leverage and both investment intensity and employment growth. As of that, a negative relationship is expected between leverage and employment growth.
4. Two performance variables showing a firm's efforts for efficiency and profitability, namely Net Profit to Total Assets (ROI) as well as its changes between 1995-99 and 1999-2004 (ΔROI). The reasoning behind those variables is that a growing firm needs additional resources, therefore, a high ROI must contribute to growth and new jobs. Additionally, these variables are expected to capture the response of firms to new conditions, and indicate that by their own efforts they can affect their job creation in the industry and the economy. According to the neo-classical

view of the firm, profits are a necessary condition for growth and determine the rate of growth.

5. R&D intensity (R&D expenditures divided by sales) at the base year. An innovative environment (as approximated by a high R&D intensity) is expected to affect positively employment growth.
6. Industry Herfindahl index of concentration. It is assumed that highly concentrated industries do not offer many opportunities for employment growth.
7. EMU effect: The significant improvement in most of the macroeconomic variables of the Greek economy had as a result the meeting of the criteria for joining the EMU in 2000. This development improved the investment climate, but also removed the possibility of increasing competitiveness through currency devaluation. Using a dummy variable in an attempt to capture the EMU effect, its effect on employment growth should be regarded as indeterminate a priori, since a positive effect should be expected, if firms took advantage of the more stable economic environment, or a negative effect should be expected, if the adverse effects of reduced competitiveness dominate.
8. The remaining independent variables were designed to examine the correlation of job creation to export activity, expected to be positive, and to age and size (measured by the number of employees), both expected to correlate negatively with the dependent variable, based on other empirical findings from the international literature.

According to Rickard (2006), it is possible that exogenous factors are in part responsible for the stochastic growth paths of firms, but the weight of academic study puts the emphasis on endogenous factors.

The model was estimated only for those firms which were active in all three years under examination (1995, 1999 and 2004), i.e. we excluded from the regression analysis firms that closed down or were created during this period, firms that underwent some merger/acquisition and firms that changed legal status. There were 1418 continuing firms in our database.

The results of the analysis are presented in Table 4 (since the White test detected the existence of heteroskedasticity, the standard errors reported below have been corrected for heteroscedasticity).

In Equation 1, we added as independent variables the products of the EMU variable with all others independent variables, in order to distinguish whether the effects of these variables have changed significantly between the two sub-periods. In the case where the product of EMU with the variable is statistically significant, the effect of the Euro is strong for the specific variable. In the case where the product sign is insignificant, the EMU effect for the specific variable is weak.

Table 4: Determinants of Employment Growth
Estimation method: Pooled EGLS with cross-section weights

	(a)	(b)
Empl	-0.0002**	-0.0002***
	(2.32)	(5.90)
Age	-0.0048***	-0.0040***
	(5.83)	(5.18)
Exports	0.0658***	0.0347**
	(3.49)	(2.62)
Relinv	0.0004***	0.0003***
	(3.468)	(3.84)
R&D	0.0942***	0.0522***
	(5.06)	(3.89)
SalesGrowth	0.0110	0.0667***
	(1.55)	(3.85)
Leverage	0.0582	0.1011**
	(1.54)	(2.28)
ROI	0.6774***	0.6303***
	(5.97)	(4.88)
ΔROI	0.2998***	0.2154***
	(3.96)	(3.13)
Herf	0.1583	0.0141
	(0.74)	(0.65)
EMU	-0.0806***	-0.0658***
	(4.42)	(4.07)
EMU×Empl	-	0.0002***
	-	(4.68)
EMU×Age	-	-0.0004
	-	(0.75)

EMU×Exports	-	0.0472***
	-	(5.18)
EMU×Relinv	-	0.0082***
	-	(3.28)
EMU×R&D	-	0.0520**
	-	(2.11)
EMU×SalesGrowth	-	-0.0675***
	-	(4.69)
EMU×Leverage	-	-0.1081***
	-	(2.83)
EMU×ROI	-	-0.0574**
	-	(2.18)
EMU×ΔROI	-	-0.0146**
	-	(2.15)
EMU×Herf	-	0.1591
	-	(1.27)
Adj. R-squared	0.602	0.841

Notes: * Significant at the 10% level (two-tailed test), ** Significant at the 5% level (two-tailed test), *** Significant at the 1% level, (two-tailed test), t ratios are in parentheses. Standard errors are White Heteroscedasticity consistent.

As mentioned before, the model was estimated only for the firms that existed in both periods i.e. 1995-99 and 2000-04. We excluded from the analysis firms that closed or were established during those periods. As a result, the number of firms was 1418 in our database.

4. Results

The variables found to affect significantly employment growth in the Greek manufacturing sector, for the first model, are:

- Negatively, as expected, *the size of the firm,* measured with the number of employees,
- Negatively, as expected, *the age of the firm*
- Positively, as expected, *the investments in new productive assets,*
- Positively, as expected, *the R&D expenditures*

- Positively, as expected, *the profitability measurement (ROI) and its changes* and
- Negatively, the effect of EMU, indicating that the adverse effects of reduced competitiveness dominated in that period, over the increase in investments and growth due to the more stable economic environment and the hard currency positive effects. It can be argued that the positive effect of the latter did not have yet enough time to develop and show their results for the period under study.

In the second model, the effects of EMU on employment growth are indicated more clearly. The product of EMU with exports suggests that the effect of exports on employment growth was strengthened by the EMU. The same holds for the new capital investments and the R&D expenditures. On the contrary, the EMU weakens the effect of the size of the firm, Sales Growth, financial leverage and profitability of the firm on its employment growth.

The difference between the two models is also the fact that all variables, except the industry concentration index and the effect of EMU on the age variable, came out as significant in the second model.

The R^2 and the standard error of the variables indicate that the variables in the model explain well the variation in employment growth in the Greek manufacturing sector.

The first model could be easily used to forecast employment growth for a Greek manufacturing firm, especially in the case of large amount of data where other methods of forecasting are time consuming and cumbersome.

5. Conclusions

Although, overall empirical studies suggest that a firm's growth tends to follow a random walk over the long run, this paper, besides defining some factors affecting significantly the employment growth in the Greek manufacture, sheds some light on the EMU effect on the growth of those firms. This type of research for the Greek manufacturing sector, which, to the best of our knowledge, has not been done so far, reveals some interesting results.

Basically, our findings agree with those of other empirical studies abroad in line with the literature, specifically, that employment growth is positively affected by exports, new capital investments, asset profitability and R&D expenses and negatively by size and age. However, the findings also suggest that EMU has overall adversely affected employment growth. Furthermore, we found that after the EMU Greek firms became even more dependent on exports for their growth, on new investments in fixed assets and technology. Size also came out to be a significant determinant of growth after the EMU. This is explained by the fact that after EMU, Greece became part of a big unified market where firms must become competitive through new investments and application of new technology, in order to be able to export and thus survive and grow. They have to take advantage of new opportunities and sales in the global market, in order to create job positions. Small manufacturing firms show to be more competitive in the Greek manufacturing sector given their flexibility and specialization in the unified market place. Financial leverage and Sales Growth did not come out to be very significant determinants of employment growth or affected by the Euro.

According to literature, the main way in which diversified growth is accomplished is by merger or acquisition, since it offers not only a rapid increase in scale but also a wider range of growth opportunities in the future. It remains a topic for our future research to find what the situation is in the Greek manufacture and compare employment growth rates.

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Test of an Inverted J-Shape Hypothesis between the Expected Real Exchange Rate and Real Output: The Case of Ireland

Yu Hsing[1]

Abstract

Applying an open-economy macroeconomic model, incorporating the monetary policy reaction function and uncovering interest parity, this paper finds that the expected real exchange rate and real output exhibit an inverted J-shape relationship, suggesting that expected real depreciation increases real output during 1999.Q2-2001.Q3 whereas expected real appreciation raises output during 2001.Q4-2009.Q1. Other findings show that a higher real financial stock price, a higher world real interest rate, or a lower expected inflation rate would increase real output. Fiscal prudence may be needed as the coefficient of the government borrowing/GDP ratio is insignificant at the 10% level.

Keywords: Expected Real Depreciation or Appreciation, Monetary Policy Reaction Function, Fiscal Policy, Financial Stock Price, Uncovered Interest Parity

JEL classification: E52, F31, F41, O52

1. Introduction

Known as the Celtic Tiger for more than a decade, Ireland had enjoyed rapid economic growth, budget surpluses, low inflation, low unemployment, and other positive developments. However, since 2008 Ireland's economy has been hit hard by the global financial crisis and world economic recession. According to the International Monetary Fund (2009), Ireland was faced with high dependence on construction, overvaluation of housing prices, over expansion of the banking sector, global competitive disadvantages, falling international market shares, high unit labor costs, declining share of FDI, risks associated with falling inflation, vulnerability in the financial sector, low interest margins, lack of growth in deposits, concentration of loan portfolios in residential mortgages, commercial properties, and real estate developments, and other challenges. According to the forecast for Ireland in 2009 made by the Economist (2009), its real GDP would suffer a decline of 7.7%, the government would have a budget deficit of 12.9% of GDP, and the current account balance would have a deficit of 3.1%. The short-term interest rate would drop to 1.4% from 4.6% in 2008. Due to a weak demand, the inflation rate would decline 3.6%.

This paper attempts to examine the roles of the expected real exchange rate and other related macroeconomic variables affecting output fluctuations. First, it incorporates

1. Professor of Economics, Department of Business Administration & Finance, College of Business, Southeastern Louisiana University, Hammond, Louisiana 70403, USA. email: yhsing@selu.edu

the monetary policy reaction function in the formulation of the model. It is appropriate as the central bank of Ireland determines its short-term interest rate based on an inflation targeting of less than 2%. Second, the paper examines whether expected real depreciation or appreciation and real output may exhibit different relationships over time. The dummy variable technique will be employed to test if the intercept and/or the slope of the expected real exchange rate may have changed. Third, comparative static analysis will be applied in order to determine the possible response of equilibrium real GDP to a change in one of the exogenous variables.

There are several major studies examining the impact of currency depreciation or devaluation on output. Krugman and Taylor (1978) state that one of the conditions for currency devaluation to have a contractionary impact is whether exports are initially less than imports. Edwards (1986), Upadhyaya (1999), Bahmani-Oskooee, Chomsisengphet, Kandil (2002) and Christopoulos (2004) find that currency devaluation or depreciation could have a contractionary, an expansionary, or no effect depending upon the countries or time periods in empirical work. Chou and Chao (2001) and Bahmani-Oskooee and Kutan (2008) indicate that depreciation or devaluation is ineffective or has little impact in the long run.

Studies reporting depreciation or devaluation expansionary include those of Gylfason and Schmid (1983) except for the U.K. and Brazail, Gylfason and Risager (1984) for developed countries, and Bahmani-Oskooee and Rhee (1997). On the other hand, studies showing that depreciation or devaluation is contractionary include Gylfason and Risager (1984) for LDCs, Rogers and Wang (1995), Moreno (1999), Kamin and Rogers (2000), Chou and Chao (2001) in the short run, and Bahmani-Oskooee and Miteza (2006) for 24 non-OECD countries.

These previous studies have made significant contributions to the understanding of the subject. These findings suggest that the impact of real depreciation could be expansionary, contractionary, or neutral and depends on the countries, time periods, specifications of a model, and methodologies employed in empirical work. To the author's best knowledge, few of the previous studies have focused on the hypothesis that the impact of the real exchange rate on real output may exhibit an inverted J-shape relationship during different time periods.

2. The Model

Suppose that aggregate expenditures are a function of real output, domestic real interest rate, real government spending, real government tax revenues, real financial stock price, and real exchange rate. Also, suppose that real interest rate is determined by the inflation rate, real output, the real exchange rate, and the world real interest rate, that real exchange rate is affected by the domestic real interest rate, the world real interest rate, and the expected real exchange rate, and suppose that inflation rate is determined by the expected inflation rate, the output gap, and real exchange rate. Applying and extending Taylor (1993; 1995), Romer (2000; 2006), Svensson (2000), and other previous studies, we can express the open-economy IS function, the monetary policy reaction function, uncovered interest parity, and the augmented aggregate supply function as:

$$Y = X(Y,R,G,T,W,\varepsilon) \quad (1)$$

$$R = Z(\pi, Y, \varepsilon, R') \tag{2}$$
$$\varepsilon = E(R, R', \varepsilon^e) \tag{3}$$
$$\pi = \pi^e + \delta_1(Y - Y^*) + \delta_2 \varepsilon \tag{4}$$

where

Y	= real GDP in Ireland,
R	= the domestic real interest rate,
G	= government spending,
T	= government tax revenues,
W	= the real financial stock price,
ε	= the real exchange rate measured as the euro per U.S. dollar times the relative prices in the U.S. and the EU (An increase means real depreciation of the euro),
π	= the inflation rate,
R'	= the world real interest rate,
ε^e	= the expected real exchange rate,
π^e	= the expected inflation rate,
Y^*	= potential output for Ireland, and
δ_1, δ_2	= parameters.

Solving for four endogenous variables Y, R, ε, and π simultaneously, we can express equilibrium real GDP as:

$$\overline{Y} = \overline{Y}(\varepsilon^e, G, T, W, R', \pi^e; \delta_1, \delta_2, Y^*). \tag{5}$$

The Jacobian for the endogenous variables is given by:

$$\begin{aligned} |J| &= (1 - X_Y) - E_R X_\varepsilon Z_Y - X_R Z_Y - E_R Z_\varepsilon (1 - X_Y) \\ &\quad - Z_\pi [\delta_2 E_R (1 - X_Y) + \delta_1 X_R + \delta_1 E_R X_\varepsilon] > 0. \end{aligned} \tag{6}$$

We expect that the sign of $(\partial \overline{Y} / \partial G - \partial \overline{Y}) / \partial T$ or $\partial \overline{Y} / \partial W$ is positive. The effect of depreciation of the expected real exchange rate on equilibrium real GDP is unclear because the positive impact of increased net exports may be less or greater than the negative impacts of a higher inflation rate and a higher real interest rate due to monetary tightening:

$$\partial \overline{Y} / \partial \varepsilon^e = E_{\varepsilon^e} (X_\varepsilon + X_R Z_\varepsilon + \delta_2 X_R Z_\pi) / |J| > or < 0. \tag{7}$$

Spencer and Kulkarni (2010) and McKinlay and Kulkarni (2010) study the J-curve hypothesis for four Central American countries and five African countries and show that multiple or consistent devaluations of a currency would shift the J-curve rightward and continuously deteriorate the trade balance.

The effect of a higher world real interest rate on equilibrium real GDP is ambiguous as the first term in the parenthesis in (8) is positive whereas the remaining terms in the parenthesis in (8) are negative:

$$\partial \overline{Y} / \partial R' = (E_{R'} X_{\varepsilon} + E_{R'} X_R Z_{\varepsilon} + E_R X_{\varepsilon} Z_{R'} + X_R Z_{R'} + \delta_2 E_{R'} X_R Z_{\pi}) / |J| > or < 0. \quad (8)$$

A higher expected inflation rate would cause equilibrium real GDP to decline partly because the central bank would raise the real interest rate to contain inflation and partly because a higher real interest rate would cause real appreciation and reduce net exports:

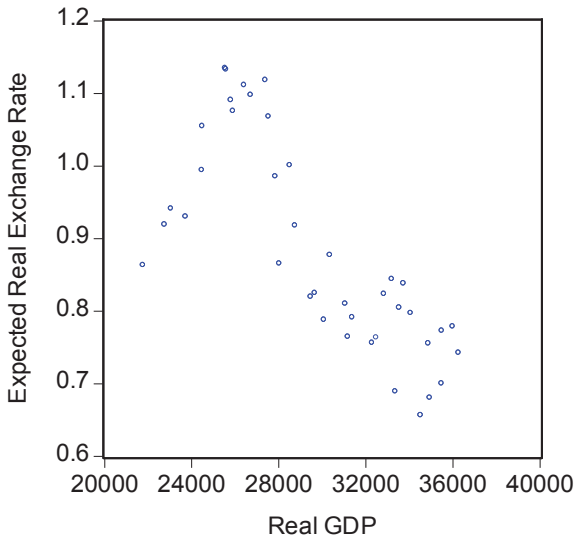
$$\partial \overline{Y} / \partial \pi^e = (E_R X_{\varepsilon} Z_{\pi} + X_R Z_{\pi}) / |J| < 0. \quad (9)$$

3. Empirical Results

The data were collected from the *International Financial Statistics* (IFS), which is published by the International Monetary Fund. Real GDP is an index number with 2005 as the basis year. The real exchange rate is represented by the units of the euro per U.S. dollar times the relative prices in the U.S. and the EU. Thus, an increase means real depreciation of the euro, and vice versa. The expected real exchange rate is represented by the lagged real exchange rate. The simple lagged value is selected in order to have as many observations as possible to capture the relationship between the expected real exchange rate and real output. Due to lack of complete data for budget deficits, the ratio of government borrowing to nominal GDP is selected to represent fiscal policy. Both government borrowing and nominal GDP are measured in billions. The share price index is divided by the consumer price index to derive the real stock price index. The world real interest rate is represented by the refinancing rate of the European Central Bank (ECB) minus the inflation rate in the EU. The inflation rate is the percent change in the harmonized consumer price index in Ireland. The expected inflation rate is the lagged inflation rate. Except for the dummy variable, the real refinancing interest rate, and the expected inflation rate with zero or negative values, all other variables are measured in the log scale. The sample ranges from 1999.Q2-2009.Q1 with a total of 40 observations. The quarterly data for the refinancing rate beyond 2009.Q1 were not available.

The relationship between the expected real exchange rate and real GDP is presented in Graph 1. It seems that the relationship is nonlinear and exhibits an inverted J-shape. In other words, they have a positive relationship during 1999.Q2-2001.Q3 and a negative relationship during 2001.Q4-2009.Q1. Therefore, a dummy variable is generated with a value of 0 during 1999.Q2-2001.Q3 and 1 otherwise. An interactive dummy variable is also generated to test whether the slope coefficient of the expected real exchange rate may have changed.

Graph 1: Scatter Diagram between the Expected Real Exchange Rate and Real GDP: 1999.Q2-2009.Q1



Estimated parameters, standard errors, t-statistics, and other related information are presented in Table 1. Because a reduced form equation is estimated, endogeneity would not pose a concern. The Newey-West method is applied in order to yield consistent estimates for the covariance and standard errors. As shown, 92.8% of the behavior of real GDP can be explained by the right-hand side variables with significant coefficients. Except for the coefficient of ratio of government borrowing to GDP, all other coefficients are significant at the 1% or 5% level. Real GDP is positively associated with the intercept dummy variable, the real exchange rate, the real stock price and the real refinancing rate set by the ECB and negatively influenced by the interactive variable $DUM \times \log(\varepsilon^e)$ and the expected inflation rate. The coefficient of the expected real exchange rate is estimated to be 0.550 during 1999.Q2-2001.Q3 and -0.536 (=0.550-1.086) during 2001.Q4-2009.Q1.

Table 1: Estimated Regression of Real GDP for Ireland

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	3.852880	0.121155	31.80129	0.0000
DUM	0.173057	0.013988	12.37218	0.0000
log(ε^e)	0.550477	0.068031	8.091627	0.0000
DUM x log(ε^e)	-1.086338	0.092368	-11.76101	0.0000
BY	0.000444	0.000895	0.495782	0.6234
log(W)	0.107052	0.027469	3.897227	0.0005
R'	0.005952	0.002651	2.245130	0.0318
π^e	-0.022129	0.009213	-2.401821	0.0223
Adjusted R^2	0.928309			
F-statistic	73.14297			
AIC	-3.495893			
SC	-3.158177			
MAPE	2.762605			
Sample	1999.Q2-2009.Q1			
N	40			

Notes:
The Dependent Variable is Log(Y).
DUM is the dummy variable with a value of 0 during 1999.Q2-2001.Q3 and 1 during 2001.Q4-2009.Q1.
ε^e is the expected real exchange rate defined as the lagged value of the units of the euro per U.S. dollar times the relative prices in the U.S. and the EU.
BY is the ratio of government borrowing to GDP.
W is the real stock price index.
R′ is the real refinancing rate set by the European Central Bank (ECB).
π^e is the expected inflation rate.
AIC is the Akaike information criterion.
SC is the Schwarz criterion.
MAPE is the means absolute percent error.

To determine whether these time series in Table 1 are cointegrated, the ADF unit root test on the regression residuals e_t is performed. The lag length of one is selected based on the AIC. In the regression $\Delta e_t = \alpha e_{t-1} + \beta \Delta e_{t-1}$, the test statistic is estimated to be -2.044,

and the critical value is -1.950 at the 5% level. Hence, these variables have a long-run equilibrium relationship.

Several different versions are tested. When the intercept and interactive dummy variables are not included in the estimated regression, the adjusted R^2 is estimated to be 0.589, the coefficient of the expected real exchange rate is negative and significant at the 1% level, and the positive coefficient of the real refinancing rate is insignificant at the 10% level. This result may be misleading as the positive portion of the relationship is overlooked. When the ECB's refinancing rate is replaced by the U.S. real federal funds rate, its coefficient is positive and significant at the 5% level. When both interest rates are included, their coefficients become insignificant at the 10% level mainly due to a high degree of multicollinearity. When the expected inflation rate is represented by average inflation rate of the past four quarters, its coefficient is positive and insignificant at the 10% level. To save space, these results are not printed here and will be made available upon request.

There are several comments. The inverted J-shape relationship between the expected real exchange rate and real GDP suggests that the recent trend of real appreciation of the euro against the U.S. dollar would work in favor of Ireland due to its positive impact on real output. The insignificant coefficient of the ratio of government borrowing to GDP implies that the Ricardian equivalence hypothesis (Barro, 1989) may apply and that expansionary fiscal policy may be pursued with caution as it may not be effective in raising real output. As the stock market has shown a rising trend, the wealth effect and the balance-sheet effect of a higher stock price would increase household consumption and business investment. It would be desirable for the central bank of Ireland to maintain transparency and effective communications in order to reduce inflationary expectations.

4. Summary and Conclusions

This paper examined the impacts of expected real depreciation or appreciation and changes in other related variables on output fluctuations in Ireland based on a simultaneous equation model incorporating the open-economy IS function, the monetary policy reaction function, uncovered interest parity, and an augmented aggregate supply. Real GDP is postulated to be a function of the dummy variable, the expected real exchange rate, the interactive dummy variable with the expected real exchange rate, the ratio of government borrowing to GDP, the real financial stock price, the real refinancing rate of the ECB, and the expected inflation rate. A generalized least squares method is employed in empirical work to yield consistent estimates for the covariance and standard errors.

There is evidence of an inverted J-shape relationship between the expected real exchange rate and real output, suggesting that expected real depreciation would increase real output up to 2001.Q3 whereas expected real appreciation would raise real output after 2001.Q3. Besides, a higher real stock price index, a higher refinancing rate, or a lower expected inflation rate would help raise real output. Expansionary fiscal policy represented by a higher ratio of government borrowing to GDP is found to be insignificant.

There may be areas for future study. The quadratic function may be applied to test the nonlinear relationship between the expected real exchange rate and real output. If the data are available, the ratio of government deficit to GDP can be selected to represent fiscal policy. Other macroeconomic theories such as the IS/LM model may be considered.

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Internet Addiction among Greek University Students: Demographic Associations with the Phenomenon, using the Greek version of Young's Internet Addiction Test

Christos C. Frangos[1], Constantinos C. Frangos[2] and Apostolos P. Kiohos[3]

Abstract

Internet addiction (IA) is a new disorder described in 1996 by the psychologist Kimberly Young. The aim of this paper is to estimate the percentage of IA among Greek university students. Results of a sample survey among 1876 Greek university students, 18-27 years old, are presented. The questionnaire consisted of eight questions from Young's Diagnostic Test for Internet Addiction (YDTIA) as well as an inventory including demographic factors and questions about academic performance, computer and Internet use. YDTIA had a good reliability and diagnostic accuracy, tested with Cronbach's alpha (0.71) and sensitivity analysis. Results show that the percentage of IA (5-8 YDTIA criteria) is 11.6%, while problematic Internet users were (3-8 YDTIA criteria) 34.7%. Men were more likely to be addicted to the Internet than women, and Internet addicted students were associated with poorer academic performance. Multiple logistic regression showed that significant predictors of IA included increased hours of daily Internet use, increased hours visiting chat rooms, sex pages and blogs, male gender, divorced status, poor grades, and accessing the Internet outside of the home. The results of this study will allow health officials to recognise students who are Internet addicted or on the verge of becoming addicted and stress risk factors indicating a need for intervention in order to prevent the appearance of IA.

Keywords: Greece, university students, Internet addiction, gender, academic performance, sex pages

JEL classification: C83, I10, I21

1. Introduction

1.1 Definition: Internet Addiction

The Internet is a widely recognized channel for information exchange, academic research, entertainment, communication and commerce (Moore, 1995; Widyanto and Griffiths, 2006; Douglas et al., 2008; Byun et al., 2009). Although the positive aspects of the

1. Department of Business Administration, Technological Educational Institute of Athens, Athens, Greece - e-mail: cfragos@teiath.gr
2. Division of Medicine, University College London, London, UK
3. Department of Business Administration, Technological Educational Institute of Athens, Athens, Greece

Internet have been readily praised, there is a growing amount of literature on the negative side of its excessive and pathological use (Chou and Hsiao, 2000; Caplan, 2003; Beard, 2005; Frangos and Frangos, 2009). Byun et al. (2009) estimate that 9 million Americans could be labelled as pathological Internet users with unpleasant consequences for their social life, their professional status and their psychological condition (Shapira et al., 2000; Shapira et al., 2003; Young, 2004; Walker, 2006).

In the scientific literature, several terms have been proposed to describe pathological Internet use: Internet addiction, cyberspace addiction, Internet addiction disorder, online addiction, Net addiction, Internet addicted disorder, pathological Internet use, high Internet dependency, problematic Internet use and others (Widyanto and Griffiths, 2006; Byun et al., 2009). To date, there is neither a conclusive nor a consistent definition for this disorder, making it difficult to establish a coherent picture of this disorder throughout the world. Nevertheless, efforts are being made to reach one uniform definition, which might also be included in the DSM V, the authoritative guidebook for the diagnoses of psychiatric disorders by the American Psychological Association (Block, 2008).

For purposes of this study, we chose the term Internet Addiction (IA) because it was the first term used to describe this phenomenon and for which the first proposed diagnostic criteria were based on an addictive disorder, that of pathological gambling (Young, 1998; Widyanto and Griffiths, 2006). Although the term addiction was combined with technology in England before 1996 (Griffiths, 1995), and even earlier the term 'computer addiction' had been used (Shotton, 1991), IA had been mentioned only as an informal phrase by Ivan Goldberg, MD in 1995 (Federwisch, 1997; YouTube, 2008), in order to describe excessive use of the Internet. However, it was not until 1996 when the psychologist Kimberly Young gave a first serious account of this disorder, proposing diagnostic criteria and describing the collateral consequences of it on specific groups (Young, 1996a; 1998). The major objections concerning this term were in the use of the word "addiction": although Young (1998) uses it to define the compulsiveness accompanying this disorder, Internet addiction is also accompanied with underlying maladaptive cognitions, which would be better described psychologically if the term 'problematic Internet use' was used (Davis, 2001; Beard and Wolf, 2001). Moreover, some researchers argue that a person's overuse or abuse of the Internet is a behavioural manifestation of other things that may be problematic in their lives (Thatcher et al., 2008). Nevertheless, the term Internet addiction is frequently used in scholarly journals, such as *CyberPsychology & Behavior* and *Computers in Human Behavior*. In a recent attempt to meta-analyse quantitative data on IA, Byun et al. (2009, p. 204) note that the matter of the definition of IA is the first challenge to address and suggest developing "a complete definition of Internet addiction that is not only conclusive but decisive, covering all ages, gender, and educational levels".

We follow the definition of IA, according to Beard's holistic approach wherein "an individual is addicted when an individual's psychological state, which includes both mental and emotional states, as well as their scholastic, occupational and social interactions, is impaired by the overuse of the medium" (Beard, 2005, pp. 8-9). We use the eight-item questionnaire as an assessment tool, proposed by Young (1996a; 1998) in her first papers. Young's Diagnostic Test for Internet Addiction (YDTIA) consists of eight yes or no questions about the use of the Internet. Respondents who answered 'yes' to five or more of

the eight criteria were classified as Internet addicted, and the rest were classified as non-addicted (Young, 1998).[1]

1.2 University Students and Internet Addiction

A common group for studying IA has been students. University students are considered as a high risk group for IA (Kandell, 1998; Young and Rogers, 1998; Nalwa and Anand, 2003; Niemz et al., 2005). Possible reasons for this are: (a) students have huge blocks of unstructured time, (b) schools and universities provide free and unlimited access to the Internet, (c) students from the ages of 18 – 22 years are for the first time away from parental control without anyone monitoring or censoring what they say or do online, (d) young students experience new problems of adapting to university life and finding new friends, and often end up seeking a companionship by using different applications of the Internet, (e) students receive full encouragement from faculty and administrators in using the different Internet applications, (f) adolescents are more trained to use the different applications of technological inventions and especially the Internet, (g) students desire to escape university sources of stress resulting from their obligations to pass exams, compose essays and complete their degrees in the prescribed time with reasonable marks, and finally (h) students feel that university life is alienated from social activities, and when they finish their studies, the job market with all its uncertainties is a field where they must participate and succeed in finding employment (Young, 2004).

Internet addiction in university students has been recorded through academic research in the USA (Mitchell, 2000; Fitzpatrick, 2008), South Africa (Thatcher and Goolam, 2005a,b), South Korea (Hur, 2006; Kim et al., 2006; Ko et al., 2006), Taiwan (Chou and Hsiao, 2000; Lin and Tsai, 2002; Tsai and Lin, 2001; 2003), Norway (Johansson and Götestam, 2004), England (Griffiths, 1995; 1996a,b; 1997; 2000; Griffiths et al., 1999), Italy (Ferraro et al., 2007), Switzerland, China (Byun et al., 2009), and Cyprus (Bayraktar and Gün, 2007). However, in Greece, no study has examined IA among university students. Several studies have been carried out among adolescents, and several other studies have examined Internet use among high school students in Greece (Aslanidou and Menexes, 2008; Siomos et al., 2008; Tsitsika et al., 2009). Thus, we conducted an extensive literature review and discovered the demographic factors associated with IA among university students.

1.3 Demographic Risk Factors for Internet Addiction

Gender

Studies indicate that the use of computers and the Internet differs between men and women. Weiser (2000) gave an extensive review and executed a study on gender differences in Internet use patterns and Internet application preferences in a sample of 1190 surveys. He concluded that there were numerous gender differences in preferences for specific Internet applications. Results had shown that men use the Internet mainly for purposes related

1. The questions of YDTIA in English are included in Table 2. The Greek version for these eight questions have been validated in earlier publications of ours and others (Siomos et al., 2008; Frangos and Frangos 2009; Frangos et al., 2009).

to entertainment and leisure, whereas women use it primarily for interpersonal communication and educational assistance. However, additional analyses showed that several gender differences were mediated by differences in age and Internet experience. His results were in accordance with many previous results which had shown mainly that women were less familiar with the use of the Internet (Georgia Tech GVU WWW survey, 1994), suggesting at some period that men comprised 95 % of Internet users and women just 5%. Explanations for this gender gap have been given and rely on gender differences in self-efficacy and attitudes toward computers (Busch, 1995). Male students are generally considered more experienced in programming and computer games than females and report having had more encouragement from parents and friends previously, in contrast to women who might have been discouraged from using modern technologies (Busch, 1995, p. 147). However, this gender gap is predicted to decrease over the years, due to the fact that technology spreads widely towards all available channels (Morahan-Martin, 1998; Sherman et al., 2000; Shaw and Gant, 2002).

In Greece, two studies of high school pupils similarly mention that boys use computers more than girls (Papastergiou and Solomonidou, 2005; Aslanidou and Menexes, 2008). Interestingly, Papastergiou and Solomonidou (2005) mention that boys have more opportunities to access the Internet and use the Internet for entertainment and Web page creation than girls do, with no other differences in other activities. Specifically, the percentages of boys in their sample who used their computer and accessed the Internet from home were 50% and 29.4% respectively compare to 31.8% and 11.8% among girls ($p<0.001$). Boys accessed the Internet more frequently than girls did (44% vs. 5%, $p<0.001$), while, a higher percentage of boys than girls used the Internet in places outside the home (73.5% vs. 55.3%, $p< 0.001$) (Papastergiou and Solomonidou, 2005).

The same gender gap has been noticed with IA. Morahan-Martin and Schumacher (2000) reported that males were more likely than females to be pathological users (12% vs. 3%), whereas females were more likely than males to have no symptoms (28% vs. 26%) or have limited symptoms (69% vs. 61%) of behavioural pathology. Scherer (1997) reported that dependent Internet users included a significantly larger proportion of men to women (71% men and 29% women, respectively) than non-dependent users (50% men and women). Thus, these studies, and several more, demonstrate that at least male college students are more prone to IA (Chou et al., 2005; Widyanto and Griffiths, 2006). The reasons for male predominance in IA have been proposed to be overuse of pornography sites and online gaming addiction. Tsai et al. (2009, p. 298) give a satisfactory explanation supporting the view that pornographic sites leads to more frequent IA:

> "A study on gender differences in sexual arousal found that men tend to be more visual with respect to sexual fantasies while women are more process or verbally oriented. As the cost of bandwidths decreased drastically in recent years, the Internet has become more abundant with graphical information. The increased availability of pornography in cyberspace may be one of the reasons for the higher prevalence rate of Internet addiction in males".

Thus, we hypothesize that:

H1: Men are more likely to belong to the IA group than women.

Academic performance

From the beginnings of research on IA, poor academic performance has been associated with this disorder. Young (1998, p. 241) originally described this:

> "Although the merits of the Internet make it an ideal research tool, students experienced significant academic problems when they surfed irrelevant web sites, engaged in chatroom gossip, conversed with Internet pen pals, and played interactive games at the cost of productive activity. Students had difficulty completing homework assignments, studying, or getting enough sleep to be alert for class the next morning due to such Internet misuse. Oftentimes, they were unable to control their Internet use, which eventually resulted in poor grades, academic probation, and even expulsion from the university."

This initial conclusion was consequently replicated in many studies with university students. Griffiths (2000) described a case of a Greek university student in the UK whose studies had suffered considerably because he spent so much time on the Internet, which left him little time to get on with his degree work. Morahan-Martin and Schumacher (2000) later measured pathological Internet use, including now a new question on the extent to which academic obligations suffered as a result of Internet usage; they found that 27.3% of students with pathological Internet use had missed classes because of online activities. Kubey et al. (2001) evaluated Internet dependency in a sample of 542 university students and found that 9% of the participants classified themselves as being psychologically dependent on the Internet, and also identified themselves as having trouble with schoolwork, missing class time, and having a sense of guilt and lack of control over their Internet use. Internet dependent users seem to be more likely to damage their academic careers due to excessive usage. The results support greater use of the Internet by dependent users and increased probability for them to miss class (Scherer, 1997).

Two very large studies from Asia demonstrated yet again the negative effect of excessive Internet use on academic performance. Chen and Peng (2008) conducted an online survey on 49,609 students from 156 universities in Taiwan. They defined heavy Internet users as those who used the Internet over 33.9 hours per week and those under this threshold as non-heavy users. Differences in academic grades and learning satisfaction between heavy and non-heavy Internet users were statistically significant. Non-heavy users had better grades and greater learning satisfaction than heavy users. Although the authors did not study IA per se, the data suggested that students who spend a significant amount of time online, experience academic and learning difficulties. A more recent study by Huang et al. (2009) on a sample of 4,400 college students from China investigated IA, measured by YDTIA, and examined whether poor academic achievement is a risk factor of IA. Multiple logistic regression showed that poor academic achievement was a significant risk factor of IA ($OR=1.54$, $p<0.001$). The two factors of IA that cause poor academic attendance, are the maladaptive cognitions related to Internet addiction (shyness, depression, low self-esteem) (Davis, 2001; Yuen and Lavin, 2004), as well as the physical element of time loss. Internet addicted users spend excessive amounts of time in front of their computers. Moreover, these abnormal patterns of use cause lack of sleep because the user stays awake during late night hours in order to surf different web pages. This lack of sleep causes a lack of concentration and loss of interest in everyday lectures leading to reduced reading of course material and,

consequently, poor marks during the exam period (Lavin et al., 1999; Yuen and Lavin, 2004). Thus, we formed the following working hypothesis:

H2: Internet addicted students will present a poorer academic performance than non-addicted Internet users. Additionally, this variable may be a risk factor of IA.

Family status

University students can be single, married or divorced. Although the possibility of marriage among university students might seem low and even lower for divorce, we could argue the opposite for Greek university students. In Greece circumstances could be different because students are allowed to attend undergraduate courses on a free basis, giving them a greater opportunity to graduate or to complete their studies at a relatively older age. Moreover, many students return to the university to complete another degree or because they didn't access higher education when they were younger. So, among Greek universities we could expect an existing percentage of married or even divorced students. Unfortunately, there are not any studies on percentages on this topic in Greece.

Married university students have always been regarded as a group with increased stressors who might seek sources of social support much more than single or dating students (Bayer, 1972). Until now, most results stem from research on graduate students. McRoy and Fisher (1982) comment on the increasing number of married students attending universities and note, "If appropriate support services are to be available for college students who are married, it is important to understand the stresses on the marriages and on the students. Otherwise, we can expect the dropout rate for students and the divorce rate for student marriages to increase". A recent review on marital satisfaction among graduate students suggested that married students in graduate study experience marital strain that may affect their successes in their marriage or graduate study (Gold, 2006).

The unique educational circumstances in Greece allow a certain degree of extrapolation of these results to married undergraduate students. Taking into account as well that IA is rather prevalent among university students, the combination of marriage and IA would significantly increase the stressors in a family. It has been reported that cybersex addiction among couples, which is a variant of IA, has lead to serious interpersonal problems and even to divorce (Hertlein and Piercy, 2006). Results from a survey on 94 subjects who had experienced cybersex in their couple relationships, indicated that 22% of the respondents had separated or divorced as a result of the compulsive cybersex (Schneider, 2000).

So, there could be a possible link between IA and family status, with worst family status (e.g. divorced) being associated with IA. The question of IA and family status has not yet been studied extensively in IA studies and among university students. Greek higher education conditions afford the opportunity to explore this topic. Thus, we hypothesize:

H3: Divorced students are more likely to develop IA than married couples.

Location of Computer Usage and Internet Addiction

The presence of a computer with Internet access in a person's environment is necessary for the person to develop IA. Davis (2001) suggests that this is *a necessary contributory cause* for the subject to develop pathological Internet use, which is similar to

IA. This was part of his argument in the development of the cognitive behavioural model of pathological Internet use (Davis, 2001)[2]. Research has shown that the environments of Internet usage differ among each student. Some students prefer to access the Internet from home, while others prefer to go outside of their home to places such as the school library or an Internet café. Additionally, it has been proven that the location for accessing the Internet has many times been associated with the development of IA (Young, 2004; Ceyhan, 2008). Places where Internet access is unlimited or free, where there is no guardian or parental supervision increase the possibility for a subject to remain on the Internet. As mentioned above, university students are most prone to this, because in their dorms or in the university, free and unlimited access to the Internet is available with no parental supervision, enabling them to use it without restriction. In two studies on Greek adolescents, regression analyses showed that the primary location of Internet access was a significant risk factor for predicting IA (Siomos et al., 2008; Tsitsika et al., 2009). Their results replicated those of previous studies on adolescents from Norway (Johansson and Götestam, 2004). Thus, we hypothesize:

H4: The location of Internet access is a significant predictor of Internet addiction among Greek university students.

1.4 Aim

This is the first study of IA among Greek university students. In this paper, we analyse the properties of the questionnaire used, which is the first Greek questionnaire for IA in university students, and give sociodemographic correlates. Furthermore, we assess the prevalence of IA among Greek university students and find possible risk factors of IA.

2. Methods

2.1 Sample

For the purposes of our study, we selected by randomized stratified selection a sample of 1,876 students, from 18 to 27 years old (mean age 19.52 ± 2.38), studying in 36 classes among 9 university and technological educational institute (TEI) departments in Athens, Greece (TEI of Athens, TEI of Piraeus, Athens University of Economics and Business, National & Kapodistrian University of Athens, Agricultural University of Athens). Of the studied sample, 878 (47%) were male and 997 were female (53%). The desirable accuracy of the sample or the maximum sampling error E, derived from the formula $n = \left(z_{a/2}\right)^2 / 4E^2$

2. In brief, Davis (2001) proposed a model of the aetiology of pathological Internet use using the cognitive behavioural approach. The main assumption of the model was that pathological Internet use resulted from problematic cognitions coupled with behaviours that intensify or maintain maladaptive response (Widyanto and Griffiths, 2006). It emphasized the individual's thoughts/cognitions as the main source of abnormal behaviour. Davis specified that the cognitive symptoms of pathological Internet use might often precede and cause the emotional and behavioural symptoms rather than vice versa. Similar to the basic assumptions of cognitive theories of depression, it focused on maladaptive cognitions associated with pathological Internet use. Davis next ascribed to specific psychopathologies and conditions, concepts of necessary, sufficient, and contributory causes. For a more extensive description of each cause, see Davis (2001) and Widyanto and Griffiths (2006).

(Tabachnick and Fidell, 2000), was E = 0.02, where n = 1876, $z_{\alpha}/2 = 1.96$ is the 97.5 quintile of the Normal Distribution, and $\alpha = 0.05$. Table 1 summarizes additional demographic information.

Table 1: Demographic information of the sample

	Frequencies	**Percentages**
Gender		
Female	997	53.1
Male	878	46.8
NA*	1	0.1
Age		
$18 \leq x < 20$	751	40.0
$20 \leq x < 22$	637	34.0
$22 \leq x < 24$	305	16.1
$24 \leq x < 26$	108	5.8
$26 \leq x < 28$	74	4.0
NA	1	0.1
Personal family status		
Married	63	3.4
Not married	1742	92.9
Divorced	66	3.5
NA	5	0.2
Highest title of studies obtained		
Lykeion Diploma	1632	87.0
Public or Private IEK	46	2.5
Ptychion from Tech. Ed. Inst.(TEI)	148	7.9
B.Sc. from University	12	0.6
Diploma of Postgraduate Studies	8	0.4
Private College (Inst. of Liberal Studies)	10	0.5
NA	20	1.1
Average mark of studies during the last semester		
$x < 5$	94	5.0
$5 \leq x < 6.5$	576	30.7
$6.5 \leq x < 8$	737	39.3
$8 \leq x \leq 10$	148	7.9
NA	321	17.1
Average Mark of entrance exams of 1st year of studies		
$x < 10$	38	2.0

	Frequencies	Percentages
$10 \leq x < 12$	42	2.2
$12 \leq x < 14$	56	3.0
$14 \leq x < 16$	184	9.8
$16 \leq x < 18$	179	9.5
$18 \leq x \leq 20$	137	7.3
NA	1240	66.1
Staying with parents or not		
No	717	38.2
Yes	1145	61.0
NA	14	0.7
Are you working full time?		
No	1065	56.8
Yes	355	18.9
NA	456	24.3
Are you unemployed?		
No	810	43.2
Yes	861	45.9
NA	205	10.9

* NA: not answered

2.2 Questionnaire

The questionnaire contained three parts: demographic information, computer or Internet use information and the YDTIA. The demographic section collected information about gender, age, employment status, and family status. The computer or Internet use portion reported information on the Internet applications that are most frequently used, the location of the computer and the frequency of time spent in certain Internet applications. Young's Diagnostic Test for Internet Addiction (YDTIA) was presented in the introduction. It consists of eight yes or no questions regarding the use of the Internet. In this study, "at-risk Internet users" (ATRIU) were categorised as those who answered 3 to 4 criteria of the YDTIA positively. The category of users who answered yes in 3 to 8 questions were classified as "problematic Internet users" (PIU). This definition has been followed by Siomos et al. (2008), Johannson and Götestam (2005) and Tsai et al. (2009). YDTIA was translated into Greek and back into English by two independent translators. The two versions were then compared, choosing finally the best versions for each question.

Characteristics of YDTIA

The eight items of YDTIA were subjected to principal component analysis (PCA). Prior to performing PCA, the suitability of data for factor analysis was assessed.

Inspection of the correlation matrix revealed the presence of many coefficients of 0.300 and above and Spearman's correlations calculated between the eight items were statistically significant at the 0.001 level of significance ($p<0.001$). The Kaiser-Meyer-Oklin value was 0.81, exceeding the recommended value of 0.6 and Bartlett's Test of Sphericity reached statistical significance, supporting the factorability of the correlation matrix (Pallant, 2007). PCA revealed the presence of two components with eigenvalues exceeding 1, explaining 34.3% and 13.9% of the variance respectively. An inspection of the screeplot revealed a clear break after the second component. Using Catell's scree test, it was decided to retain two components for further investigation. This was further supported by the results of parallel analysis, which showed only two components with eigenvalues exceeding the corresponding criterion values for a randomly generated data matrix of the same size (8 variables x 1876 respondents). The two-component solution explained a total of 48.2% of the variance, with Component 1 contributing 34.3% and Component 2 contributing 13.9%. These values are acceptable because other authors have mentioned similar values of eigenvalues for YDTIA (Johansson and Götestam, 2005; Siomos et al., 2008).

The reliability of YDTIA was tested with Cronbach's alpha (0.71) and Cronbach's alpha based on standardized items (0.72); also the Spearman-Brown coefficient was 0.72, all values indicating satisfactory reliability. Thus, the YDTIA has a good reliability and dimensionality.

Specificity, Sensitivity and Diagnostic Accuracy of the YDTIA for the Study Participants

The eight diagnostic criteria of YDTIA are considered in this section. The sensitivity of a Diagnostic Criterion "A" refers to the probability of a positive answer in A by participants who are addicted according to YDTIA. It measures how well A detects the addiction.

The specificity of a Diagnostic Criterion A refers to the probability of a negative answer in A by participants who are not addicted according to YDTIA. It measures how well the Diagnostic Criterion A excludes addiction. Diagnostic accuracy refers to the overall probability of the detection or exclusion of the addiction due to the answer to Diagnostic Criterion A of the test (American Psychiatric Association, 1994; Riffenburgh, 2005). The positive prognostic value of Diagnostic Criterion A refers to the percentage of participants who answered A positively and are addicted, from all the participants who answered positively in Criterion A. Finally, the negative prognostic value refers to the percentage of participants who answered negatively in A and are not addicted, from all the participants who answered negatively in Criterion A. From Table 2 we find that the fourth diagnostic criterion of Young, *"Do you feel restless, moody, depressed or irritable when attempting to cut down or stop Internet use?"* has the highest diagnostic accuracy (88.4%).

Table 2: Specificity, Sensitivity and Diagnostic Accuracy of YDTIA for the Study Participants

	Answers of addictive users		Answers of non addictive users		Sensitivity	Specificity	Diagnostic Accuracy	Positive prognostic value	Negative prognostic value
	YES	NO	YES	NO					
(1) Do you feel preoccupied with the Internet (i.e., think about previous online activity or anticipate next online session)?	201	34	478	1127	85.5%	70.4%	72.1%	29.6%	97.1%
(2) Do you feel the need to use the Internet with increasing amounts of time in order to achieve satisfaction?	196	44	290	1324	81.7%	82.0%	81.9%	40.3%	96.8%
(3) Have you repeatedly made unsuccessful efforts to control, cut back, or stop Internet use?	141	95	113	1497	59.7%	92.9%	88.1%	55.5%	94.0%
(4) Do you feel restless, moody, depressed, or irritable when attempting to cut down or top Internet use?	157	79	133	1472	66.5%	91.7%	88.4%	54.1%	94.9%
(5) Do you stay online longer than originally intended?	208	28	909	690	88.1%	43.2%	48.9%	18.6%	96.1%
(6) Have jeopardized or risked the loss of a significant relationship, job, educational, or career opportunity?	143	98	135	1472	59.3%	91.6%	87.4%	51.4%	93.8%

	Answers of addictive users		Answers of non addictive users		Sensitivity	Specificity	Diagnostic Accuracy	Positive prognostic value	Negative prognostic value
	YES	NO	YES	NO					
(7) Have you lied to family members, a therapist, or others to conceal the extent of your involvement with the Internet?	141	99	141	1465	58.8%	91.2%	87.0%	50.0%	93.7%
(8) Do you use the Internet as a way of escaping from problems or of relieving a distressed mood (e.g., feelings of helplessness, guilt, anxiety, depression)?	182	60	375	1227	75.2%	76.6%	76.4%	32.7%	76.6%

2.3 Statistical Analysis

We performed univariate analysis to examine the factors of our questionnaire associated with Internet addiction. Chi-square values, degree of freedom and levels of significance are reported. Next, we performed multiple logistic regression with IA as the dependent variable and independent variables including several demographic variables. In all calculations, p values under 0.05 were considered significant. All figures and graphs were produced with SPSS 16.0, Stata 10.0 and SigmaPlot 10.0.

3. Results

3.1 Internet Use and Internet Addiction According to YDTIA

The patterns of computer and Internet use are shown in Table 3 and Table 7 in Appendix. It is evident that 93.2% had knowledge of computers and a similar percentage had knowledge of computer applications (90.8%). Most of the students in the sample accessed their computer from home, followed by Internet cafés (5.8%) and finally at the university at which they studied (4.8%). The great majority of students did not pay for their own Internet subscription (64.7%). Only one-third of our sample (31.3%) had the European Computer Driving License (ECDL) diploma.

Table 3: Computer and Internet Use

	Frequencies	Percentages
Computer knowledge		
No	88	4.7
Yes	1748	93.2
NA*	40	2.1
Computer applications knowledge		
No	110	5.9
Yes	1704	90.8
NA*	62	3.3
Computer access location		
Home	1527	81.4
School	90	4.8
Internet Café	109	5.8
Friends' house	70	3.7
Elsewhere	47	2.5
NA*	33	1.8
Do you pay for your own Internet subscription?		
No	1213	64.7
Yes	472	25.2
NA*	191	10.2
Have you obtained an ECDL diploma?		
No	1102	58.7
Yes	587	31.3
NA*	187	10.0
Internet experience		
1 year	323	17.2
2 years	298	15.9
3 years	334	17.8
4 years	230	12.3
5 years	207	11.0
more than 5 years	447	23.8
NA*	37	2.0
Hours of Internet use daily (hs)		
$x < 0.5$	318	17.0
$0.5 \leq x < 1$	388	20.7
$1 \leq x < 2$	282	15.0
$2 \leq x < 3$	221	11.8
$3 \leq x < 4$	191	10.2
$4 \leq x < 5$	140	7.5

	Frequencies	Percentages
$5 \leq x < 6$	98	5.2
$6 \leq x < 7$	58	3.1
$7 \leq x < 8$	41	2.2
$8 \leq x < 9$	17	0.9
$9 \leq x < 10$	15	0.8
more than 10 hs	76	4.1
NA*	31	1.7

* NA: not answered

The percentage of Internet addicted students was 11.6% and the percentage of at-risk Internet users was 23.1%. The percentage of problematic Internet users (who present 3 to 8 criteria of YDTIA) was 34.7%.

We were also interested in determining the Internet use time patterns according to the criteria satisfied in YDTIA. We designated very frequent (VFIU) and frequent (FIU) Internet users, the ones who used the Internet for more than 28 hours per week and for 8 to 27 hours per week respectively. Table 4 shows the following: a) The percentage of VFIU was 24.1% b) The percentage of FIU was 37.6%. c) It is evident that students who satisfy 5-8 criteria of YDTIA (which signifies that they are addicted Internet users), are in a much greater percentage (45.3%) VFIU than those who satisfy fewer criteria.

Table 4: Percentages of users classified according to positive YDTIA criteria among categories of Internet usage per week

	YDTIA				
	0 Criteria N (%)	1-2 Criteria N (%)	3-4 Criteria N (%)	5-8 Criteria N (%)	Total N (%)
Non frequent Internet users (0-7 h / week)	225 (56.8)	295 (38.6)	122 (28.1)	61 (25.1)	703 (38.2)
Frequent Internet users (8-27 h / week)	127 (32.1)	326 (42.6)	167 (38.5)	72 (29.6)	692 (37.6)
Very frequent Internet users (> 27 h / week)	44 (11.1)	144 (18.8)	145 (33.4)	110 (45.3)	443 (24.1)

3.2 Sociodemographic and Academic Performance Associations with IA

In Table 5 the associations of IA with regard to gender, family condition, academic performance and location of computer of the study participants are displayed. The statistical significance of differences in percentages was done using chi-square statistics.

Table 5: Sociodemographic and academic characteristics of the sample of university students

	Positive Diagnostic Criteria (yes) in YDTIA				
			At risk Internet users	*Addicted Users*	
	0 Positive criteria N (%)	1-2 Positive criteria N (%)	3-4 Positive criteria N (%)	5-8 Positive criteria N (%)	Total N (%)
Section 1 Gender differences	χ^2=45.38, df=3, p<0.001				
Male	160 (40.4%)	329 (43%)	220 (50.7%)	156 (64.2%)	877 (47%)
Female	236 (59.6%)	436 (57%)	214 (49.3%)	87 (35.8%)	990 (53%)
Section 2 Location of computer differences	χ^2=37.34, df=15, p<0.001				
Home	311 (77.9%)	651 (85.1%)	374 (86.0%)	187 (78.6%)	1523 (83%)
School	23 (5.8%)	35 (4.6%)	20 (4.6%)	11 (4.6%)	89 (5%)
Internet Café	26 (6.5%)	40 (5.2%)	23 (5.3%)	20 (8.4%)	109 (5.9%)
Friend's house	30 (7.5%)	23 (3.0%)	10 (2.3%)	7 (2.9%)	70 (3.8%)
Elsewhere	9 (2.3%)	16 (2.1%)	8 (1.8%)	13 (5.5%)	46 (2.5%)

	Positive Diagnostic Criteria (yes) in YDTIA				
			At risk Internet users	*Addicted Users*	
	0 Positive criteria N (%)	1-2 Positive criteria N (%)	3-4 Positive criteria N (%)	5-8 Positive criteria N (%)	Total N (%)
Section 3 Academic performance differences	χ^2=31.45, df=9, p<0.0001 AVEMARK=Average mark in the last semester				
AVEMARK < 5	16 (4.9%)	26 (4.1%)	28 (7.4%)	23 (11.1%)	93 (6%)
5 ≤ AVEMARK < 6.5	116 (35.5%)	234 (36.9%)	137 (36.1%)	87 (41.8%)	574 (37.1%)
6.5 ≤ AVEMARK < 8	159 (48.6%)	325 (51.3%)	178 (46.8%)	71 (34.1%)	733 (47.3%)
8 ≤ AVEMARK ≤ 10	36 (11.0%)	49 (7.7%)	37 (9.7%)	27 (13.0%)	149 (9.6%)
Section 4 Family condition differences	χ^2=31.2, df=12, p<0.001				
Married	15 (3.7%)	25 (3.2%)	16 (3.7%)	8 (3.3%)	64 (3.4%)
Single	380 (92.7%)	732 (94.6%)	408 (93.6%)	213 (87.7%)	1733 (93.1%)
Divorced	15 (3.7%)	17 (2.2%)	12 (2.8%)	22 (9.1%)	66 (3.5%)

There is a statistically significant difference in gender for Internet addicted users (5 to 8 positive criteria in YDTIA). Males were dependent at a higher percentage than females (64.2% vs. 35.8% among Internet addicted users, p<0.0001). Concerning family condition, there was a significant association with Internet addiction. Moreover, we can see that the percentage of divorced students who are addicted to the Internet (9.1%) is greater than that of married students who are Internet addicted (3.3%). In the other categories of positive

diagnostic criteria, the percentage of married and divorced is generally similar; however, the small percentages do not allow for a causal deduction of conclusions.

Regarding *academic performance*, in Internet addicted users (5-8 YDTIA) the percentage of students who failed in the last semester (11.1%) is significantly higher than those who failed in the group of normal Internet users (0 and 1-2 YDTIA) (4.9% and 4.1% respectively, $p<0.05$ in both differences). Moreover, in the group of addicted users, students with grades under 6.5 (52.9%) are slightly higher than students grades over 6.5 (47.1%) ($p = 0.23$). The percentage of addicted users who achieved marks in the scale "very good" or "excellent" (6.5 to 10) is 47.1%, and it is lower than the corresponding percentage of the normal Internet users with 0 positive criteria in YDTIA (59.6%) ($p = 0.005$).

The location of computer usage was also associated significantly with Internet addiction ($p<0.001$). It is worth noting that the group of students addicted to Internet is more likely to visit Internet cafés than the other three groups (8.4% vs. 5.3%, 5.2%, 6.5%), although these proportion differences are not significantly different ($p = 0.12$, $p = 0.07$, $p = 0.37$ respectively).

3.3 Predicting Factors of Internet Addiction

We performed multiple logistic regression with Internet addiction as the dependent variable to assess the impact of a number of factors on the likelihood of developing IA. The model contained nine independent categorical variables: gender, location of computer usage, family status, staying with parents, Internet daily use (hs), average marks during last semester, viewing sex pages, viewing chatrooms, and viewing blogs. The full model containing all predictors was statistically significant, $\chi^2 = 192.09$, $df = 37$, $p<0.0001$, indicating that the model was able to distinguish between Internet addicted and non-addicted students. The model as a whole explained between 14.6% (Cox and Snell R square) and 26.6% (Nagelkerke R square) of the variance in IA, and correctly classified 87.4% of cases. The odds ratios are presented in Table 6 and in Figure 1. All of the independent variables (in various categories) were significant predictors of IA, except for the variable "staying with parents" (Table 6). Although the odds ratio (OR) for gender is not significant, this result is only borderline ($p = 0.067$). So, male gender is most likely a positive predictor of IA, but given this model, we cannot produce an effect. Moreover, students who accessed the Internet from Internet cafés were more likely to develop IA than students who accessed it through their homes (OR = 2.11, 95% CI 1.06-4.20). In regard to the family condition of students, divorced students were significantly more likely to develop IA than married students (OR = 4.33, 95% CI 1.23-15.29). With reference to academic performance, students who had an average grade during the last semester between 5 and 8 out of 10 were about half as likely to develop IA, compared to students who had grades under 5. Concerning general patterns of Internet use, students who used the Internet for more hours during the day and visited sex pages, chat rooms and blog sites, were more likely to become Internet addicted.

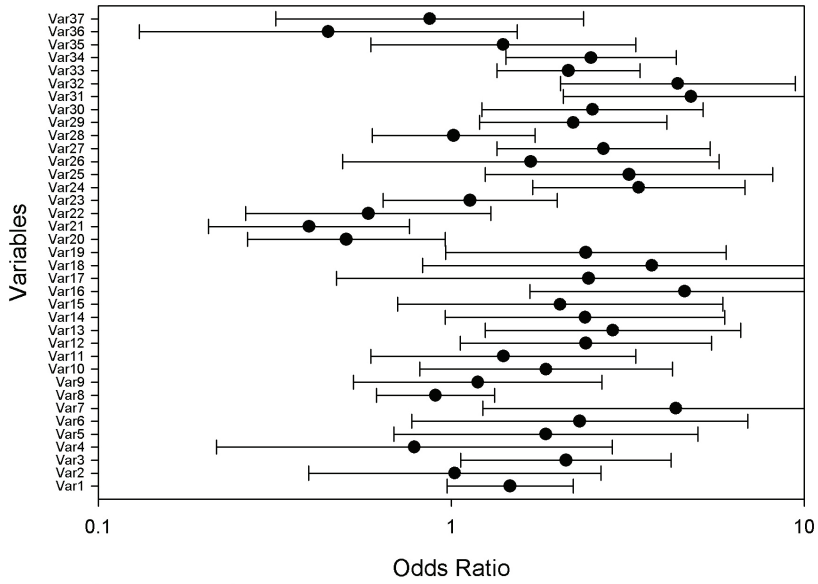
Table 6: Multiple logistic regression with Internet addiction as the dependent variable

Code	Variables	Odds Ratio	p-value	OR 95% CI	
Gender[*]					
Var1	Male	1.47	0.067	0.97	2.21
Computer access location[†]					
Var2	School	1.02	0.961	0.39	2.66
Var3	Internet Café	2.11	0.033	1.06	4.20
Var4	Friends' house	0.79	0.714	0.22	2.86
Var5	Elsewhere	1.85	0.222	0.69	5.00
Personal family Status[‡]					
Var6	Not married	2.31	0.134	0.77	6.91
Var7	Divorced	4.33	0.023	1.23	15.29
Staying with parents or not[§]					
Var8	Yes	0.90	0.598	0.61	1.32
Internet daily use (hs)[**]					
Var9	$0.5 \leq x < 1$	1.19	0.677	0.53	2.68
Var10	$1 \leq x < 2$	1.86	0.141	0.81	4.23
Var11	$2 \leq x < 3$	1.40	0.441	0.59	3.33
Var12	$3 \leq x < 4$	2.40	0.036	1.06	5.46
Var13	$4 \leq x < 5$	2.87	0.013	1.25	6.60
Var14	$5 \leq x < 6$	2.39	0.061	0.96	5.96
Var15	$6 \leq x < 7$	2.03	0.189	0.71	5.87
Var16	$7 \leq x < 8$	4.58	0.003	1.67	12.55
Var17	$8 \leq x < 9$	2.45	0.285	0.47	12.69
Var18	$9 \leq x < 10$	3.70	0.086	0.83	16.53
Var19	more than 10 hs	2.41	0.060	0.96	6.00
Average mark of studies during the last semester[††]					
Var20	$5 \leq x < 6.5$	0.50	0.037	0.26	0.96

Code	Variables	Odds Ratio	p-value	OR 95% CI	
Var21	$6.5 \leq x < 8$	0.39	0.005	0.21	0.76
Var22	$8 \leq x \leq 10$	0.58	0.185	0.26	1.29
Viewing Sex pages[‡‡]					
Var23	$1 \leq x < 3$	1.13	0.671	0.64	1.99
Var24	$3 \leq x < 5$	3.40	0.001	1.70	6.80
Var25	$5 \leq x < 7$	3.19	0.015	1.25	8.15
Var26	$7 \leq x < 9$	1.68	0.408	0.49	5.73
Var27	$x \geq 9$	2.70	0.005	1.34	5.41
Viewing chat rooms[§§]					
Var28	$1 \leq x < 3$	1.01	0.956	0.60	1.72
Var29	$3 \leq x < 5$	2.22	0.011	1.20	4.08
Var30	$5 \leq x < 7$	2.51	0.012	1.22	5.17
Var31	$7 \leq x < 9$	4.78	0.000	2.07	11.00
Var32	$x \geq 9$	4.38	0.000	2.04	9.43
Viewing blogs[***]					
Var33	$1 \leq x < 3$	2.15	0.001	1.35	3.43
Var34	$3 \leq x < 5$	2.49	0.001	1.43	4.33
Var35	$5 \leq x < 7$	1.40	0.441	0.59	3.32
Var36	$7 \leq x < 9$	0.45	0.202	0.13	1.54
Var37	$x \geq 9$	0.87	0.785	0.32	2.37

Notes: i. CI: confidence interval. ii. Reference values for each category: [*]female; [†]home; [‡]married; [§]No; [**]$x < 0.5$; [††]AVEMARK < 5; [‡‡, §§, ***]$0 \leq x < 1$

Figure 1: A scatter plot of the odds ratios produced from multiple logistic regression. The variables Var1-Var37 are explained in Table 6



4. Discussion

We performed the first cross-sectional study of university students in Greece to estimate the percentage of Internet addiction. The diagnostic tool used was Young's Diagnostic Test for Internet Addiction (Young, 1996a; 1998). We tested the reliability and dimensionality of YDTIA and it was in satisfactory accordance with the results of other studies (Johansson and Götestam, 2004; Siomos et al., 2008). The most significant result was that the percentage of IA was 11.6% among our sample, while that of at-risk Internet users was 23.1%. We further defined problematic Internet users as the ones who fulfil 3 to 8 criteria of YDTIA, and found a percentage of 34.7% students met the criteria. Siomos et al. (2008) examined Internet addiction among Greek adolescents (12-18 years of age) and found that 8.2% were addicted to the Internet (6.2% for males and 2% among females), a percentage relatively close to that of this study. This classification allows health officials to recognise students who are on the verge of becoming addicted and signifies a point of intervention in order to prevent the appearance of IA.

Additionally, we found significant associations of IA with gender, location of computer usage, family status, and academic performance. The profile of the user addicted to the Internet is a male person, who accesses the most likely from Internet public spots, has poor academic achievement and might be divorced. We performed multiple logistic regression with Internet addiction as the dependent variable, and results showed that increased hours of daily Internet use, increased hours visiting chat rooms, sex pages and blogs, male gender, being divorced, poor grades, and accessing the Internet outside of the home were significant predictors of IA. We set four hypotheses in the Introduction and we tested them to examine their validity.

Concerning the first hypothesis, we truly are in accordance with other researchers, because we found that male students were more likely to be addicted to the Internet and male gender predicted marginally IA on multiple logistic regression. This gender difference is explained by the preference of men to use the Internet for sexual satisfaction (e.g. viewing sex pages) more than women do as well as the increased frequency of online gaming compared to that among females (Young, 1998; 2004; Kraut et al., 2002; Ybarra and Mitchell, 2005; Tsai et al., 2009;). Accordingly, we found that viewing sex pages predicted IA, but our results do not support online gaming as a risk factor of IA. An explanation for the lower percentage of IA among females, involves the fact that female college students often receive more family supervision than males, which may prevent females from spending as much time on the Internet (Tsai et al., 2009).

Concerning our second hypothesis, we found that academic performance was significantly associated with IA, and poorer grades were a predictor. This result is in accordance with other studies put forward in the introduction. Usually, IA causes this outcome because the student loses his capacity to concentrate, most possibly because of late-night Internet sessions. Our third and fourth hypotheses involved the association of IA with family status and the point of accessing the Internet. Being divorced was associated with IA and predicted the phenomenon, and the location of using the computer was also associated with IA. Students who accessed the Internet from Internet cafés were more likely to develop IA than those who accessed it from home. Impaired family status leading to IA could be explained by the cognitive behavioural model of Davis (2001). This model suggests that the presence of maladaptive cognitions, as a result of personal or social disappointments, is a necessary cause to create IA. A divorced person possibly experiences negative feelings resulting from his divorce, such as "I have failed my marriage", "I might not get married again", "It is my fault we divorced", "I feel lonely". This low self-esteem and self-accusatory attitude may find sympathy from others in Internet forums or chat rooms. Hence, they will experience positive emotions from this use, such as feeling more qualified, more social and more comfortable, and these positive feelings play a reinforcing role in the continued use of the Internet.[6] However, it could be that IA addiction leads to divorce in married couples. This has been readily described in studies of online infidelity and cybersex experiences (Schneider, 2000). The cross-sectional nature of this study does not allow us to support whether divorce among students with IA was a result of this behavioural addiction or a cause of it. A prospective design of following up with a group of students with IA could distinguish this.

Overall, IA is a serious behavioural addiction. There is a need for a campaign to inform parents, teachers and state officials about the dangers of the Internet, which are apart from IA, online gambling, trafficking of pornographic material, cybersex and cyberbullying (Young, 2004; Patchin and Hinduja, 2006).

6. This situation is indicative of the conflict described in many addictions. On the one hand, the person is harmed by the behaviour he is addicted to, and on the other hand he experiences the enhancing emotional changes that lead to the recurrence of the addictive behaviour.

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Appendix

Table 7: Time use of certain Internet applications

Time (hs)/week	MSN		Forums		YouTube		Sex pages		Chat	
	F	P	F	P	F	P	F	P	F	P
$0 \leq x < 1$	552	29.4	947	50.5	553	29.5	1173	62.5	966	51.5
$1 \leq x < 3$	424	22.6	323	17.2	514	27.4	178	9.5	292	15.6
$3 \leq x < 5$	252	13.4	168	9.0	278	14.8	62	3.3	132	7.0
$5 \leq x < 7$	167	8.9	74	3.9	175	9.3	40	2.1	77	4.1
$7 \leq x < 9$	90	4.8	35	1.9	84	4.5	25	1.3	44	2.3
$x \geq 9$	251	13.4	48	2.6	111	5.9	93	5.0	69	3.7
NA[*]	140	7.5	281	15.0	161	8.6	305	16.3	296	15.8

Advertisements		Google		Yahoo!		Email		Ftp		Games		Blogs	
F	P	F	P	F	P	F	P	F	P	F	P	F	P
1157	61.7	349	18.6	740	39.4	488	26.0	1185	63.2	809	43.1	992	52.9
253	13.5	550	29.3	440	23.5	516	27.5	169	9.0	374	19.9	287	15.3
87	4.6	391	20.8	256	13.6	316	16.8	76	4.1	182	9.7	145	7.7
59	3.1	211	11.2	116	6.2	167	8.9	50	2.7	85	4.5	60	3.2
19	1.0	122	6.5	79	4.2	104	5.5	16	0.9	63	3.4	36	1.9
23	1.2	147	7.8	61	3.3	132	7.0	29	1.5	99	5.3	39	2.1
278	14.8	106	5.7	184	9.8	153	8.2	351	18.7	264	14.1	317	16.9

[*] NA: not answered

F: Frequency, P: percentage

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Financial development and economic growth an empirical analysis for Ireland

Antonios Adamopoulos[1]

Abstract

This study investigated the relationship between financial development and economic growth for Ireland for the period 1965-2007 using a vector error correction model (VECM). Questions were raised whether financial development causes economic growth or reversely taking into account the positive effect of industrial production index. Financial market development is estimated by the effect of credit market development and stock market development on economic growth. The objective of this study was to examine the long-run relationship between these variables applying the Johansen cointegration analysis taking into account the maximum eigenvalues and trace statistics tests. Granger causality tests indicated that economic growth causes credit market development, while there is a bilateral causal relationship between stock market development and economic growth. Therefore, it can be inferred that economic growth has a positive effect on stock market development and credit market development taking into account the positive effect of industrial production growth on economic growth for Ireland.

Keywords: financial development, economic growth, Granger causality

JEL classification: O11, C22

1. Introduction

The relationship between economic growth and financial development has been an extensive subject of empirical research. The question is whether financial development causes economic growth or reversely. The main objective of this study was to investigate the causal relationship between economic growth and financial development taking into account the positive effect of industrial production index.

The recent revival of interest in the link between financial development and growth stems mainly from the insights and techniques of endogenous growth models, which have shown that there can be self-sustaining growth without exogenous technical progress and that the growth rate can be related to preferences, technology, income distribution and institutional arrangements. This provides the theoretical underpinning that early contributors lacked: financial intermediation can be shown to have not only level effects but also growth effects.

The financial repressionists, led by, McKinnon (1973) and Shaw (1973) – often re-

1. Department of Applied Informatics, University of Macedonia, Economic and Social Sciences, 34 Solonos street, P.O. 54644, Thessaloniki, Greece - email: adamant@uom.gr

ferred to as the "McKinnon-Shaw" hypothesis contend that financial liberalization in the form of an appropriate rate of return on real cash balances is a vehicle of promoting economic growth. The essential tenet of this hypothesis is that a low or negative real interest rate will discourage saving. This will reduce the availability of loanable funds for investment which in turn, will lower the rate of economic growth. Thus, the "McKinnon - Shaw" model posits that a more liberalized financial system will induce an increase in saving and investment and therefore, promote economic growth.

The endogenous growth theory has reached to similar conclusions with the McKinnon-Shaw hypothesis by explicitly modelling the services provided by financial intermediaries such as risk-sharing and liquidity provision. This theory also suggests that financial intermediation has a positive effect on steady-state growth (Greenwood and Jovanovic, 1990; Shan et al., 2001), while the government intervention in the financial system has a negative effect on economic growth (King and Levine, 1993b).

Pagano (1993) suggests three ways in which the development of financial sector might affect economic growth under the basic endogenous growth model. First, it can increase the productivity of investments. Second, an efficient financial sector reduces transaction costs and thus increases the share of savings channelled into productive investments. An efficient financial sector improves the liquidity of investments. Third, financial sector development can either promote or decline savings.

Many models emphasize that well-functioning financial intermediaries and markets ameliorate information and transactions costs and thereby foster efficient resource allocation and hence faster long-run growth (Greenwood and Jovanovic, 1990; Bencivenga and Smith, 1991; Bencivenga, Smith and Starr, 1996; King and Levine, 1993a).

In the models of Levine (1991) and Saint-Paul (1992) financial markets improve firm efficiency by eliminating the premature liquidation of firm capital, enhancing the quality of investments and therefore increasing the economic growth. Enhanced stock market liquidity reduces the disincentives for investing in long-duration and higher-return projects, since investors can easily sell their stake in the project before it matures, and is expected to boost productivity growth (Bencivenga et al., 1996).

During liquidity shocks, investors can sell their shares to another agent. Financial markets may also promote growth by increasing the proportion of resources allocated to firms. Through the diversification of productivity risk, even risk-averse investors can invest in firms. Portfolio diversification, through the stock market, may have an additional growth effect by encouraging specialization of production (Saint-Paul, 1992).

Saint-Paul (1992) develops a model where financial markets affect technological choice. In this model, agents can choose between two technologies: One technology is highly flexible and allows productive diversification, but has low productivity; the other is rigid, more specialized, and more productive. Financial markets, in contrast, allow individuals to hold a diversified portfolio to insure themselves against negative demand shocks and, at the same time, to choose the more productive technology.

Under Saint-Paul's (1992) model, productivity growth is achieved through a broader division of labour and specialization of enterprises. Specialization, however, carries risk. Financial intermediaries support specialization by permitting investors to hedge with a diversified portfolio. Specialization in the absence of a properly functioning financial sector, however, may be too risky individual investor. If it is, financing for efficiency improving projects dries up.

King and Levine (1993b) employ an endogenous growth model in which the financial intermediaries obtain information about the quality of individual projects that is not readily available to private investors and public markets. This information advantage enables financial intermediaries to fund innovative products and productive processes, thereby inducing economic growth. Levine (1997) proposed that financial development promotes economic growth through the two 'channels' of capital accumulation and technological innovation, while King and Levine (1993b) have identified innovation as the main channel of transmission between finance and growth. Financial markets evaluate the potential innovative projects, and finance the most promising ones through efficient resource allocation.

The issue of causal relationship between financial development and economic growth has been an intensive subject of interest for many theoretical and empirical studies. Therefore, this study tries to fill the theoretical and empirical gaps created by the different economic school of thoughts related to the impact of financial development on economic growth for a developed European Union member-state such as Ireland. Ireland consists one of the most important developed countries of European Union characterized by a high rate of economic growth, a constant monetary and fiscal economic policy and very low inflation and unemployment rates, a healthy and competitive economy avoiding the negative effects of financial crisis in an unstable economic environment.

The model hypothesis predicts that economic growth facilitates financial market development taking into account the positive effect of industrial production index on economic growth.

This study has two objectives:

- To apply Granger causality test based on a vector error correction model in order to examine the causal relationships between the examined variables taking into Johansen cointegration analysis
- To examine the effect of stock and credit market development on economic growth taking into account the positive effect of industrial production index on economic growth.

The remainder of the paper proceeds as follows:

Initially the data and the specification of the multivariate VAR model are described. For this purpose stationarity test and Johansen cointegration analysis are examined taking into account the estimation of vector error correction model. Finally, Granger causality test is applied in order to find the direction of causality between the examined variables of the estimated model. The empirical results are presented analytically and some discussion issues resulted from this empirical study are developed shortly, while the final conclusions are summarized relatively.

2. Data and methology

In this study the method of vector autoregressive model (VAR) is adopted to estimate the effects of stock and credit market development on economic growth through the effect of industrial production. The use of this methodology predicts the cumulative effects taking into account the dynamic response among economic growth and the other examined variables Pereira and Hu (2000).

In order to test the causal relationships, the following multivariate model is to be estimated

$$GDP = f(SM, BC, IND) \quad (1)$$

where

GDP is the gross domestic product,
SM is the general stock market index,
BC are the domestic bank credits to private sector,
IND is the industrial production index.

Following the empirical studies of King and Levine (1993a), Vazakidis and Adamopoulos (2009b,d) the variable of economic growth (GDP) is measured by the rate of change of real GDP, while the credit market development is expressed by the domestic bank credits to private sector (BC) as a percentage of GDP.

This measure has a basic advantage from any other monetary aggregate as a proxy for credit market development. Although it excludes bank credits to the public sector, it represents more accurately the role of financial intermediaries in channeling funds to private market participants (Levine et al., 2000; Vazakidis and Adamopoulos, 2009a).

The general stock market index is used as a proxy for the stock market development. The general stock market index (SM) expresses better the stock exchange market, while the industrial production index (IND) measures the growth of industrial sector and its effect on economic growth (Katsouli, 2003; Nieuwerburgh et al., 2005; Shan, 2005; Vazakidis, 2006; Vazakidis and Adamopoulos, 2009b; Vazakidis and Adamopoulos, 2009c). The data that are used in this analysis are annual covering the period 1965-2007 for Ireland, regarding 2000 as a base year. All time series data are expressed in their levels and are obtained from *International Financial Statistics,* (International Monetary Fund, 2007). The linear model selected as the better for statistical estimations than a logarithmic one. The tested results of the logarithmic model proved to be statistical inferior.

Unit root tests: Augmented Dickey- Fuller unit root tests are calculated for individual series to provide evidence as to whether the variables are stationary and integrated of the same order. Augmented Dickey-Fuller (ADF) test involves the estimation one of the following equations respectively:

$$\Delta X_t = \delta X_{t-1} + \sum_{j=1}^{p} \delta_j \Delta X_{t-j} + \varepsilon_t \quad (2)$$

$$\Delta X_t = \alpha_0 + \delta X_{t-1} + \sum_{j=1}^{p} \delta_j \Delta X_{t-j} + \varepsilon_t \quad (3)$$

$$\Delta X_t = \alpha_0 + \alpha_1 t + \delta X_{t-1} + \sum_{j=1}^{p} \delta_j \Delta X_{t-j} + \varepsilon_t \quad (4)$$

The additional lagged terms are included to ensure that the errors are uncorrelated. The maximum lag length begins with 3 lags and proceeds down to the appropriate lag by examining the AIC and SC information criteria.

The null hypothesis is that the variable X_t is a non-stationary series (H_0: δ=0) and is rejected when δ is significantly negative (Ha: δ<0). If the calculated ADF statistic is higher

than McKinnon's critical values, then the null hypothesis (H_0) is not rejected and the series is non-stationary or not integrated of order zero I(0). Alternatively, rejection of the null hypothesis implies stationarity (Dickey and Fuller, 1979).

In order to find the proper structure of the ADF equations, in terms of the inclusion in the equations of an intercept (α_0) and a trend (t) and in terms of how many extra augmented lagged terms to include in the ADF equations, for eliminating possible autocorrelation in the disturbances, the minimum values of Akaike's (1973) information criterion (AIC) and Schwarz's (1978) criterion (SC) based on the usual Lagrange multiplier LM(1) test were employed. The Eviews 4.1 (2000) software package which is used to conduct the ADF tests, reports the simulated critical values based on response surfaces.

The results of the Dickey-Fuller (DF) and Augmented Dickey-Fuller (ADF) tests for each variable appear in Table 1. If the time series (variables) are non-stationary in their levels, they can be integrated with integration of order 1, when their first differences are stationary.

Cointegration test: Since it has been determined that the variables under examination are integrated of order 1, then the cointegration test is performed. The testing hypothesis is the null of non-cointegration against the alternative that is the existence of cointegration using the Johansen maximum likelihood procedure (Johansen and Juselious, 1990; 1992).

Johansen (1988) and Johansen and Juselius (1990) propose two test statistics for testing the number of cointegrated vectors (or the rank of Π): the trace (λ_{trace}) and the maximum eigenvalue (λ_{max}) statistics. The likelihood ratio statistic (LR) for the trace test (λ_{trace}) as suggested by Johansen (1988) is

$$\lambda_{trace}(r) = -T \sum_{i=r+1}^{p} \ln(1 - \hat{\lambda}_i) \tag{5}$$

where $\hat{\lambda}_i$ is the largest estimated value of ith characteristic root (eigenvalue) obtained from the estimated Π matrix, r = 0, 1, 2,…….p-1, and T is the number of usable observations.

The λ_{trace} statistic tests the null hypothesis that the number of distinct characteristic roots is less than or equal to *r* (where *r* is 0, 1 or 2) against the general alternative. In this statistic λ_{trace} will be small when the values of the characteristic roots are closer to zero (and its value will be large in relation to the values of the characteristic roots which are further from zero).

Alternatively, the maximum eigenvalue (λ_{max}) statistic as suggested by Johansen is

$$\lambda_{max}(r, r+1) = -T \ln(1 - \hat{\lambda}_{r+1}) \tag{6}$$

The λ_{max} statistic tests the null hypothesis that the number of r cointegrated vectors is *r* against the alternative of *(r+1)* cointegrated vectors. Thus, the null hypothesis r=0 is tested against the alternative that r=1, r=1 against the alternative r=2, and so forth. If the estimated value of the characteristic root is close to zero, then the λ_{max} will be small.

It is well known that Johansen's cointegration tests are very sensitive to the choice of lag length. Firstly, a VAR model is fitted to the time series data in order to find an appropriate lag structure. The Schwarz Criterion (SC) and the likelihood ratio (LR) test

are used to select the number of lags required in the cointegration test and suggested that the value p=3 is the appropriate specification for the order of VAR model for Ireland. Table 2 presents the results from the Johansen (1988) and Johansen and Juselius (1990) cointegration test.

Vector error correction model: Since the variables included in the VAR model are found to be cointegrated, the next step is to specify and estimate a vector error correction model (VECM) including the error correction term to investigate dynamic behaviour of the model. Once the equilibrium conditions are imposed, the VEC model describes how the examined model is adjusting in each time period towards its long-run equilibrium state.

The dynamic specification of the model allows the deletion of the insignificant variables, while the error correction term is retained. The size of the error correction term indicates the speed of adjustment of any disequilibrium towards a long-run equilibrium state (Engle and Granger, 1987). The error-correction model with the computed t-values of the regression coefficients in parentheses is reported in Table 3. The final form of the Error-Correction Model (ECM) was selected according to the *general to specific* methodology suggested by Hendry (Hendry and Richard, 1983; Maddala, 1992).

The general form of the vector error correction model (VECM) is the following one:

$$\Delta GDP = \beta_0 + \sum_i^n \beta_1 \Delta GDP_{t-i} + \sum_i^n \beta_2 \Delta BC_{t-i} + \sum_i^n \beta_3 \Delta SM_{t-i} + \sum_i^n \beta_4 \Delta IND_{t-i} + \lambda EC_{t-i} + \varepsilon_t \qquad (7)$$

where Δ is the first difference operator, EC_{t-1} is the error correction term lagged one period, λ is the short-run coefficient of the error correction term ($-1<\lambda<0$), ε_t is the white noise term.

Granger causality tests: Granger causality is used for testing the long-run relationship between financial development and economic growth. The Granger procedure is selected because it consists the more powerful and simpler way of testing causal relationship (Granger, 1986). The following bivariate model is estimated:

$$Y_t = a_{10} + \sum_{j=1}^{k} a_{1j} Y_{t-j} + \sum_{j=1}^{k} \beta_{1j} X_{t-j} + u_t \qquad (8)$$

$$X_t = a_{20} + \sum a_{2j} X_{t-j} + \sum \beta_{2j} Y_{t-j} + u_t \qquad (9)$$

where Y_t is the dependent and X_t is the explanatory variable and u_t is the white noise error term in (8), while X_t is the dependent and Y_t is the explanatory variable in (9).

The hypotheses in this test may be formed as follows:

H_0: X does not Granger cause Y, i.e. $\{\alpha_{11}, \alpha_{12}, \ldots..\alpha_{1k}\}=0$, if $F_c <$ critical value of F
H_a: X does Granger cause Y, i.e. $\{\alpha_{11}, \alpha_{12}, \ldots\ldots\alpha_{1k}\}\neq 0$, if $F_c >$ critical value of F. (10)
and
H_0: Y does not Granger cause X, i.e. $\{\beta_{21}, \beta_{22}, \ldots\beta_{2k}\}=0$, if $F_c <$ critical value of F.
H_a: Y does Granger cause X, i.e. $\{\beta_{21}, \beta_{22}, \ldots\beta_{2k}\}\neq 0$, if $F_c >$ critical value of F. (11)
(Katos, 2004, p. 1043).

In order to test the above hypotheses the usual Wald F-statistic test is utilised, which has the following form

$$F = \frac{(RSS_R - RSS_U)/q}{RSS_U/(T-2q-1)}$$

where RSS_U= is the sum of squared residuals from the complete (unrestricted) equation,

RSS_R= the sum of squared residuals from the equation under the assumption that a set of variables is redundant, when the restrictions are imposed, (restricted equation)

T = the sample size and q = is the lag length.

Examining this model the following cases can be distinguished

1. If $\{\alpha_{11}, \alpha_{12},\ldots\ldots\alpha_{1k}\}\neq 0$ and $\{\beta_{21}, \beta_{22},\ldots\beta_{2k}\}=0$, there exists a unidirectional causality from X to Y, denoted as X→Y
2. If $\{\alpha_{11}, \alpha_{12},\ldots\ldots\alpha_{1k}\}=0$ and $\{\beta_{21}, \beta_{22},\ldots\beta_{2k}\}\neq 0$, there exists a unidirectional causality from Y to X, denoted as Y→X
3. If $\{\alpha_{11}, \alpha_{12},\ldots\ldots\alpha_{1k}\}\neq 0$ and $\{\beta_{21}, \beta_{22},\ldots\beta_{2k}\}\neq 0$, there exists a bilateral causality between Y and X, denoted as X↔Y.

(Seddighi et al., 2000, p. 310).

The validity of the test depends on the order of the VAR model and on the stationarity or not of the variables. The validity of the test is reduced if the variables involved are non-stationary (Geweke, 1984). The results related to the existence of Granger causal relationships among economic growth, stock market development, credit market development and productivity appear in Table 4.

3. Empirical results

The observed t-statistics fail to reject the null hypothesis of the presence of a unit root for all variables in their levels confirming that they are non-stationary at 1% and 5% levels of significance (Table 1). However, the results of the DF and ADF tests show that the null hypothesis of the presence of a unit root is rejected for all variables when they are transformed into their first differences (Table 1). Therefore, all series that are used for the estimation of ADF equations are non-stationary in their levels, but stationary in their first differences (integrated of order one I(1)). Moreover, the LM(1) test shows that there is no correlation in the disturbance terms for all variables in their first differences. These variables can be cointegrated as well, if there are one or more linear combinations among the variables that are stationary.

The number of statistically significant cointegration vectors for Ireland is equal to 1 (Table 2) and is the following:

$$GDP_t = 1.15\ SM_t + 0.05\ BC_t + 0.42\ IND_t \qquad (12)$$

The cointegration vector of the model of Ireland has rank r<n (n=3). The process of estimating the rank r is related with the assessment of eigenvalues, which are the following for Ireland: $\hat{\lambda}_1 = 0.63,\ \hat{\lambda}_2 = 0.20,\ \hat{\lambda}_3 = 0.07,\ \hat{\lambda}_4 = 0.02.$

For Ireland, critical values for the trace statistic defined by (6) are 39.89 and 45.58 for Ho: r = 0 and 24.31 and 29.75 for Ho: r ≤ 1, 12.53 and 16.31 for Ho: r ≤ 2 at the significance level 5% and 1% respectively as reported by Osterwald-Lenum (1992), while critical values for the maximum eigenvalue test statistic defined by (7) are 23.80 and 28.82 for Ho: r = 0, 17.89 and 22.99 for Ho: r ≤1, 11.44 and 15.69 for Ho: r ≤ 2 (Table 2).

It is obvious from the above cointegrated vector that stock market development, credit market development and industrial production index have a positive effect on economic

growth in the long-run. According to the signs of the vector cointegration components and based on the basis of economic theory the above relationship can be used as an error correction mechanism in a VAR model for Ireland respectively.

The results of the estimated vector error correction model suggested that a short-run increase of stock market index per 1% induces an increase of economic growth per 0.08% in Ireland and also an increase of bank lending per 1% induces an increase of economic growth per 0.007% in Ireland, while an increase of productivity per 1% induces an increase of economic growth per 0.2% in Ireland) (Table 3).

The estimated coefficient of EC_{t-1} is statistically significant and has a negative sign, which confirms that there is not any problem in the long-run equilibrium relation between the independent and dependent variables in 5% level of significance, but its relative value (-0.02) for Ireland shows a satisfactory rate of convergence to the equilibrium state per period (Table 3).

In order to proceed to the Granger causality test the number of appropriate time lags was selected in accordance with the VAR model. According to Granger causality tests there is a bilateral causality between stock market development and productivity, a bilateral causality between stock market development and economic growth, a unidirectional causal relationship between economic growth and credit market development with direction from economic growth to credit market development, a unidirectional causal relationship between productivity and credit market development with direction from productivity to credit market development, and a unidirectional causal relationship between stock and credit market development with direction from credit market development to stock market development (Table 4). Therefore, it can be inferred that a well functioning financial system accelerates economic growth taking into account the positive effect of industrial production growth.

4. Discussion

The model of financial system is mainly characterized by the effect of stock market development and credit market development. However, credit market development is determined by the banking growth through the size of bank lending directed to private sector at times of low inflation rates. Stock market development is determined by the trend of general stock market index. The significance of the empirical results is dependent on the variables under estimation.

The results of this paper are consistent with the studies of Levine and Zervos (1998), Nieuwerburgh et al. (2005) and Shan (2005). Guiso et al. (2004) found that financial development has a positive effect on economic growth for 14 European Union member states including Ireland. King and Levine (1993) suggested that financial development leads to economic growth for a sample of 80 countries using a cross country analysis, while Hondroyannis et al. (2004) found a bilateral causal relationship between financial development and economic growth for Greece applying time series analysis.

The results of many empirical studies examining the relationship between financial development and economic growth differ relatively to the sample period, the examined countries, the measures of financial development and the estimation method. The direction of causal relationship between financial development and economic growth is regarded as

an important issue under consideration in future empirical studies. However, more light should be shed on the comparative analysis of empirical results for the rest of European Union members-states.

5. Conclusions

This paper concerns the relationship between financial development and economic growth for Ireland, using annually data for the period 1965-2007. The empirical analysis suggested that the variables that determine economic growth present a unit root. Once a cointegrated relationship among relevant economic variables is established, the next issue is how these variables adjust in response to a random shock. This is an issue of the short-run disequilibrium dynamics. The short run dynamics of the model is studied by analysing how each variable in a cointegrated system responds or corrects itself to the residual or error from the cointegrating vector. This justifies the use of the term error correction mechanism. The error correction (EC) term, picks up the speed of adjustment of each variable in response to a deviation from the steady state equilibrium. The VEC specification forces the long-run behaviour of the endogenous variables to converge to their cointegrating relationships, while accommodates the short-run dynamics. The dynamic specification of the model suggests deletion of the insignificant variables while the error correction term is retained.

The results of Granger causality tests indicated that there is a bilateral causal relationship between economic growth and stock market development and a unidirectional causal relationship between economic growth and credit market development with direction from economic growth to credit market development, a unidirectional causality between credit market development and stock market development with direction from credit market development to stock market development for Ireland. Therefore, it can be inferred that stock market development has larger effect on economic growth than credit market development in Ireland.

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Appendix

Table 1: DF/ADF unit root tests

Variables	In levels					In first differences				
	lag eq_f	adf_ test stat	cr_val 1% 5% 10%	SBC AIC	LM [prob]	lag eq_f	adf_ test stat	cr_val 1% 5% 10%	SBC AIC	LM [prob]
GDP	(p=1) (1)	3.20 [0.99]	-2.62 -1.94 -1.61	-4.95 -5.04	0.32 [0.72]	(p=0) (1)	-3.25 [0.00]	-3.24 -3.15 -3.04	-4.41 -4.56	0.32 [0.72]
BC	(p=0) (2)	5.05 [1.00]	-3.59 -2.93 -2.60	-2.45 -2.54	0.20 [0.81]	(p=0) (1)	-4.06 [0.01]	-3.94 -3.52 -3.19	-2.27 -2.40	0.50 [0.60]
SM	(p=1) (1)	1.93 [0.98]	-2.62 -1.94 -1.61	-2.25 -2.34	1.66 [0.20]	(p=0) (1)	-2.95 [0.00]	-2.62 -1.94 -1.61	-2.25 -2.29	0.40 [0.66]
IND	(p=1) (2)	1.02 [0.91]	-2.62 -1.94 -1.61	-4.75 -4.83	0.12 [0.88]	(p=0) (1)	-5.38 [0.00]	-2.66 -1.95 -1.60	-4.24 -4.29	0.14 [0.86]

Notes:
Eq_f = equation form
Cr_val = critical values
AIC = Akaike criterion
SBC = Schwarz Bayesian criterion,
LM = Langrage Multiplier test

Table 2: Johansen and Juselious Cointegration Tests (GDP, BC, SM, IND)

Country	Ireland			
Testing Hypothesis	Johansen Test Statistics			
	λ_{trace}	Cr_v 5% 1%	λ_{max}	Cr_v 5% 1%
H_0: r = 0 and r=1	53.89	39.89 45.58	40.58	23.80 28.82

H_0: r ≤ 1 and r=2	13.31	24.31 29.75	9.31	17.89 22.99
H_0: r ≤ 2 and r=3	4.00	12.53 16.31	3.04	11.44 15.69
Cointegrated vectors	1		1	

Notes: Cr_v = critical values

Table 3: Vector Error Correction Model

Independent Variable	**Estimated coefficients**
Constant	0.001[0.06]
ΔGDP_{t-1}	0.17[0.37]
ΔSM_{t-1}	0.08[0.04]
ΔBC_{t-1}	0.007[0.87]
ΔIND_{t-1}	0.20[0.11]
ECT_{t-1}	-0.02[0.002]
R^2	0.88
DW	2.28
Diagnostics tests	
Serial Correlation	8.53[0.003]
Functional Form	2.48[0.11]
Normality	76.23[0.00]
Heteroskedasticity	0.74[0.38]

Notes:
[ ]= Denotes the probability levels,
Δ= Denotes the first differences of the variables.
R^2 = Coefficient of multiple determinations adjusted for the degrees of freedom (d.f),
DW= Durbin-Watson statistic

Table 4: Granger causality tests

Countries	Dependent variable	Independent variable	F1	F2	Causal relations
Ireland	**GDP**	**SM**	8.30	16.24	GDP $\Leftrightarrow$ SM
		BC	0.39	3.96	GDP $\Rightarrow$ BC
		IND	2.85	2.01	No causality
	SM	**BC**	5.99	0.86	BC $\Rightarrow$ SM
		IND	5.69	3.95	SM $\Leftrightarrow$ IND
	BC	**IND**	3.40	0.22	IND $\Rightarrow$ BC

Critical values: 3.25 for Ireland
Estimated lags = 3

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Differences in Management accounting between family enterprises and non-family enterprises: A Statistical Approach

Christine Duller[1]

Abstract

Management accounting deals with the subject family enterprises rather little in spite of its high economical relevance. This paper questions, weather general objectives of family enterprises differ from those of non-family enterprises. Based on the hypothesis that family enterprises aim at humane objectives to a greater extent and at financial objectives to a lesser extent than non-family enterprises the results of an empirical study for the region Upper-Austria are presented. The conclusion is that apart from the extent of return on equity objectives of family enterprises do not differ much from those of non-family enterprises. The second point of interest is to analyse differences in objectives between medium and large sized enterprises.

Keywords: Business administration, empirical research, correspondence analysis

JEL classification: L21, M41

1. Introduction

According to the definition for SME (small and medium sized enterprises) given by the European Union only 0.5 % of the Austrian enterprises are classified as large enterprises (Commission of the European Communities, 2003, p. 39). Therefore the vitality, customization and competitiveness of the national economy are borne by small and medium sized enterprises. Moreover these enterprises are of special importance for the national labour market, because 65.5 % of the Austrian employees are part of those enterprises.

Most of the small and medium sized enterprises costitute family enterprises simultaneously. In Austria about 75% of all enterprises are family enterprises, and approximately 70% of all employed persons are working in family enterprises (Pichler, Bornett, 2005, p. 125; Feldbauer-Durstmüller et al., 2007, p. 428; Hasch et al., 2000, p. 62).

In spite of the high economical relevance management accounting deals with the subject family enterprises in empirical research rather little. Theoretical research in management accounting in family enterprises is focused either on foundations or successions of enterprises or on the special socio-economic aspects given by the combination of enterprise and owner family (Feldbauer-Durstmüller et al., 2007, p. 428; Klein, 2004, p. 54 f.).

1. University Linz, Department for Applied Statistics, Altenberger Straße 69, 4040 Linz, Austria - email: Christine.duller@jku.at

This paper questions, weather general objectives of family enterprises differ from those of non-family enterprises. Based on the hypothesis that family enterprises aim at humane objectives to a greater extent and at financial objectives to a lesser extent than non-family enterprises the results of an empirical study for the region Upper-Austria are presented.

2. Prior literature

Besides, practical orientated articles (e.g. Schröder, 1998; Schäfer-Kunz, 2006) there are only few scientific and theoretical orientated papers or books dealing with the topics small and medium sized enterprises, management accounting and family enterprises simultaneously.

This work is based on following theoretical approaches:

Hahn argues that due to serious changes in business environment more coordination and management in medium-sized family enterprises is needed. Controller ship – seen as management assistance – is suitable to perform this task (Hahn, 1994, p. 125 f.).

Horváth uses the Three-Circle Model built up by Tagiuri & Davis, developed by Gersick et al., to describe the management system in medium sized family enterprises as an extensive interaction of business, family and ownership (Tagiuri, Davis, 1992, p. 49; Gersick, Davis, McCollom Hampton, 1997, p. 5 f.; Horváth, 1999, p. 121 f.). Based on Horváth's conception for controller ship Feldbauer-Durstmüller and Haas elaborated a system for information, planning and controlling in medium sized family enterprises (Horváth, 2009, p. 91 f.; Feldbauer-Durstmüller, Haas, 2008, p. 107 f.).

Neither Hahn nor Horváth have conducted empirical research to verify their theoretical work, but empirical research on this topic is published for Germany (e.g. Ossadnik, et al., 2004, p. 622 f; Berens, Püthe, Siemes, 2005, p. 186 f.).

For Anglo-American countries empirical research usually deals either with objectives of enterprises in general or micro and small enterprises (e.g. Upton et al., 2001; Peel, Bridge, 1999; Gibson, Cassar, 2002; Stonehouse, Pemberton, 2002), but there is no empirical research in the special context of management accounting in small and medium sized family enterprises so far (Duller, Haas, 2009, p. 33f.).

3. Hypothesis Development

Previous research indicates that business objectives in family enterprises are less infuenced by monetary objectives, but more determined by interests of stakeholders and human objectives (Fröhlich, Pichler, 1988, p. 95 f.). Moreover, descriptive empirical research for Germany indicates that in family enterprises liquidity protection, employee satisfaction and entrepreneurial independence are more important objectives than in non-family enterprises (Günther, Gonschorek, 2006, p. 7).

Using exploratory qualitative empirical methods Spence and Rutherfoord looked at social responsibility and profit maximisation in small firms in UK. One result out of twenty face-to-face interviews was the conclusion, that most small firms are likely to be dominated by objectives concerning subsistence or social issues (Spence, Rutherford, 2002, p. 137 f.).

Due to the fact, that the distinction between family and non-family enterprises differs and the classification concerning size is ambiguous, research results from other countries and samples are possibly not adequate for Austria.

Therefore, the following hypotheses will be tested in this survey:

- Family enterprises aim at humane objectives to a greater extent than non-family enterprises.
- Family enterprises aim at financial objectives to a lesser extent than non-family enterprises.
- Medium sized enterprises aim at humane objectives to a greater extent than large sized enterprises.
- Medium sized enterprises aim at financial objectives to a lesser extent than large sized enterprises.

Furthermore, Fröhlich and Pichler argue that family enterprises' biggest interest is to survive (Fröhlich, Pichler, 1988, p. 98). For this reason it is indicated that family enterprises aspire to a smaller return of equity than non-family enterprises. This will be tested with the hypotheses:

- Family enterprises aspire to a smaller return of equity than non-family enterprises.
- Medium sized enterprises aspire to a smaller return of equity than large sized enterprises.

4. Research method and results

The research method is based on a standardized questionnaire, which was available via internet. All enterprises in Upper Austria with 50 or more employees (1180 enterprises) were invited to take part in the survey. Each enterprise got an individual link, which ensured that the completion of the questionnaire was possible for interesting enterprises exclusively. After completion the individual link was locked automatically to guarantee once-only participation.

The usable return was 236 enterprises or 20%, 189 of them declared themselves as family enterprises (80.1%). Due to the fact that the proportion of family enterprises in Austria is about 70-80%, the sample can be treated as representative.

The main point for further discussions is how a family enterprise is defined. There are many different approaches to define it. Some of the popular criterions are the following (Feldbauer-Durstmüller et al., 2007, p. 430):

- Level of equity held by a single family
- Degree of implication of the family in the management structure
- More than 50% of ownership is held by a family
- A family group controls the business

In this survey the enterprises had to decide themselves weather they are a family enterprise or not according to (at least one of) the following criteria:

- Arbitrary legal structure
- More than 50% ownership is held by family members or family close foundations
- Family members are part of management
- Syndications of families or branches of families

In order to verify the given hypotheses concerning management accounting classical statistical tests were used (Chi-squared-Test, Fisher Exact Test). Family enterprises are more often than not small and medium enterprises, too. Therefore, each of the above hypotheses was tested with respect to structure and size.

Testing the given hypotheses with respect to structure (family versus non-family enterprises) and size (medium enterprises versus large enterprises) had the following results: There was no significant difference in human objectives, neither for structure nor for size. The same result was found for financial objectives in general. Only the aspired return on equity showed significant differences for structure ($p = 0.023$) and size ($p = 0.007$).

Figure 1: Detailed results for aspired return on equity in medium and large sized enterprises

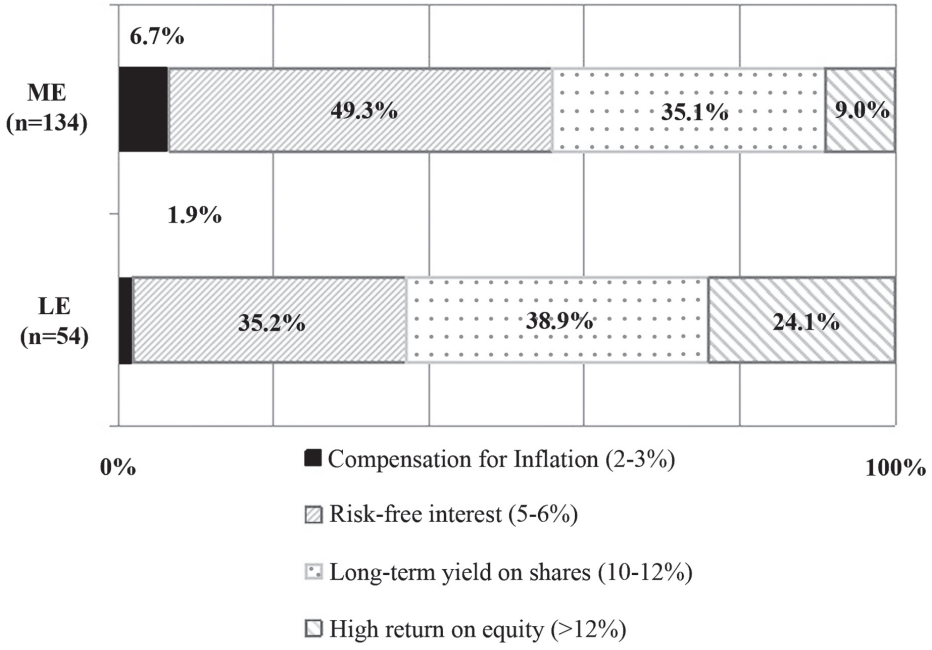

Table 1: Results for testing differences in the aspired return of equity between medium and large sized enterprises

	ME (50 - 249 empoyee)	LE (≥ 250 employee)
ROE ≤ 12%	91.0 %	75.9 %
ROE > 12%	9.0 %	24.1 %

n = 188 significant p = 0.007

This means that there is a significant difference in the aspired return of equity between medium sized and large enterprises (Figure 1 and Table 1) and also between family and non-family enterprises.

From this result the question weather the structure (family or non-family enterprises) or the size or any other criterion is the reason for the different aspired returns of equity arose. Are there some common factors, which can be extracted to explain the different aspired returns?

With the aim of extracting common explanatory factors a correspondence analysis was employed, which is a principal component analysis for categorical data (Greenacre, 2007, p. 154).

The starting point of a principal component analysis is the correlation matrix. The purpose is to create a model for data with fewer factors. The mathematical background for extracting factors is an eigenvalue decomposition. For the complete solution the number of factors is equal to the number of variables, the optimal number of factors is determined by the screetest or the Kaiser criterion (Greenacre, 2007, p. 154; Greenacre, Blasius, 2006, p. 12 f.).

The starting point of a correspondence analysis is the matrix of standardized residuals. The purpose is the same as for the principal component analysis. The mathematical background for extracting factors is the singular value decomposition. For the complete solution the number of factors is again equal to the number of variables, the optimal number of factors is determined by the screetest or the Kaiser-criterion.

With notation:

P = Correspondence matrix (relative frequencies p_{ij})
r = Mass of rows (marginal frequencies r_j)
c = Mass of columns (marginal frequencies c_i)
A = Matrix of standardized residuals

$$a_{ij} = \left(p_{ij} - r_i c_j\right) \Big/ \sqrt{r_i c_j}$$

$A = U \Gamma V^T$: Singular value decomposition
U = left singular vectors (columns), orthonormal
G = singular values (descending), diagonal matrix
V = right singular vectors (columns), orthonormal

the Singular Value Decomposition gives:

$$A^T A = V \Gamma \underbrace{U^T U}_{I} \Gamma V^T = V \Gamma^2 V^T \text{ and } A A^T = U \Gamma^2 U^T$$

and therefore we get the right singular vectors as eigenvectors of $A^T A$, the left singular vectors as eigenvectors of $A A^T$ and the squared singular values, which are the eigenvalues of $A^T A$ and $A A^T$. The squared singular values are also called principal inertias, and the proportion of the inertias to the total inertias gives the explained variance.

Similar to the principal component analysis the calculation gives the factors and the loadings for each variable on each factor. The result can be viewed in a plot, if two factors are extracted.

The input variables for the correspondence analysis were owner-structure (family enterprises versus non-family enterprises), branches of trade, number of employees, turnover, structure (national or international operating enterprises) and aspired equity yield rate. Due to the fact that sample size was rather small and available information on branches was rather poor, the variable branches had to be cancelled.

The correspondence analysis extracted two factors, the first factor was mainly determined by size (number of employee), the second factor was less important and was mainly determined by size (turnover of enterprise). The structure (family business or non family business enterprise) was nearly completely determined by the first factor. So the most important variable for prediction of the aspired equity rate is the size of an enterprise expressed by the number of employee.

5. Conclusions

Apart from the extent of the aspired return on equity the objectives of responding family enterprises do not differ from those of non-family enterprises. Moreover multivariate analyses showed that for the aspired return of equity the determining factor is not structure, but size.

This result does not verify common theoretical research. Assuming the correctness of the theoretical statements at least two possible explanations can be given for the mismatch:

1. The situation for family enterprises has changed, because nowadays their owners are better educated in business administration than some years ago. Therefore more and more family enterprises act in a similar manner like non-family enterprises to keep up their chances in the market.
2. The sample size in this work is very small, especially for multivariate analyses. Splitting the sample according to structure and size causes small frequencies in some categories, in particular large family-enterprises are very rare in the sample (and in Austria). So it is hard to find evidence for any complex statement. More and even more detailed results could be found in a bigger sample.

To clarify the results a second survey has started in August 2009. This time the population is given by all medium and large enterprises in Austria. Moreover in cooperation with universities in Germany data for some federal states of German will be compared with Austrian data.

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Patent as a motivation of starting a new entrepreneurial activity of high potential

Iraklis Goniadis[1] and Yannis Goniadis[2]

Abstract

This paper entitled "Patent as a motivation of starting a new entrepreneurial activity of high potential" based on a research that was held by the Greek Industrial Property Organization (O.B.I.), investigates the fate of Patents that the organization granted to residents of the country during the period 1995-2005. Attempts to reveal the ways of exploitation of the patents by the inventors and tries to answer the question whether the patent can be a strong motive for the patentee to start a new venture. The main results summarized as follows: 1) a significant number of patentees started a new business with most of them being optimistic of new job creation, 2) a smaller number of patentees transferred or sold their patent rights to third persons directly contributing to the technological upgrade of established enterprises or, indirectly, to the advancement of entrepreneurship in Greece, 3) the biggest proportion of the patent holders remained inactive, without any exploitation of their patent, alleging several reasons for that.

Keywords: Entrepreneurship, Patent Rights, and Innovation

JEL classification: L26, O31, O34

1. Introduction

Today, perhaps more than in any other period of development of the economic system and the formation of international economic co-operation, the role of entrepreneurship and innovation in the formation of economic conditions is supported, discussed and judged, as well as their consequences in the field of employment and income distribution internationally.

Economic policy designers acknowledge the significant role played by entrepreneurship in economic growth (Baumol, 1990; 2002; Audrech and Thurik, 2001). The European Union (E.U., 2003) as the best mechanism of enhancing competitiveness has evaluated the innovative enterprises. In the Green Book about competitiveness, the E.U. has set a goal and been committed to shaping a fertile environment of entrepreneurship aiming at the increase in the number of new, successful and innovative enterprises (E.U., 2003). However, how the above-mentioned goal is feasible for each member-state and what sort of ventures could be implemented through?

1. Department of International Economic Relations & Development, Democritus University of Thrace, University Campus, 61 100, Komotini, Greece - email: igoniadis@ierd.duth.gr
2. MSc in Management Information Systems.

The present study focuses on demonstrating the way in which the patentee manages to utilize his patent, as well as the possible outlets in the exploitation of intellectual property in a small economy, Greece. Our study is based on facts arising from a survey carried out by the Industrial Property Organization (O.B.I.). For the needs of the present study, we use a small fraction of the results of the above-mentioned survey. We use statistical methodology in order to evaluate the factors that prompted the patentees to establish a new venture ("exploitation of patent", "market study" and "subsidy exploitation") and the impact of those factors on the expectation of the new entrepreneur to establish high potential enterprise[1].

This paper is organized as follows. The first part offers a literature review. The second part discusses methodology and facts. The third part presents and discusses the results of the statistical analysis. The fourth part offers some concluding remarks and some policy implications regarding the formation of political support to the entrepreneurship of the patentees.

2. Literature Review

Entrepreneur is defined as the individual who can create or distinguish the opportunity whose exploitation he pursues, regardless of the possession of the required means for its implementation (Timmons and Spinelli, 2007).

The factors which seem to influence entrepreneurship are (Autio, 2005; 2007; Schreyer, 2000; Berger and van Winden, 2007) are the following: the satisfaction from the acquisition of the patent certificate, the opposition to the idea of entrepreneurship, the inappropriate business environment, the lack of recognition of entrepreneurial activity, the insufficient institutional framework to protect patent holdings, the inadequate infrastructure of exploitation of patent holdings, the potential funding to establish a new venture, the tax motives for starting and maintaining the new venture, the difficulty in technology transfer, the absence of mechanisms to support the entrepreneurial activity, the lack of opportunities or gaps in the market for starting the entrepreneurial activity and finally, the immaturity of the market regarding the patent exploitation.

Individual entrepreneurship, according to Global Entrepreneurship Monitor (IOBE, 2004), leads either to the direct employment of the entrepreneur, because of his need for work (self-employment), or to the exploitation of the opportunity for higher income and to the quest for outlets of his own creativity. Individual entrepreneurship may also lead to an increase in total employment through the creation of additional jobs and incomes. This last possibility can lead to high potential entrepreneurship, which seems to be the utmost objective of every society (Autio, 2005) so that it could satisfy its members' need for employment.

The attitude of the individual towards entrepreneurship, the desire for ownership of an enterprise, and the role of social and cultural environment, affect significantly the decision to start an entrepreneurial activity (Pfeffer and Salancik, 1978). In other words,

1. High Potential Entrepreneurship or expectations, as it was initially defined by GEM (Reynolds et al., 2003) refers to that by which the entrepreneur expects to create over 19 jobs in the next five years or will expand his market share and will command a percentage of production abroad. Later, (Autio, 2005) the second part was withdrawn from the definition, perhaps because the need for increase in employment overshadows every other need.

entrepreneurship is incorporated within a social framework and it is formed and facilitated by the position of the aspiring entrepreneur within a network of relations and contacts (Freeman, 1996). The level of entrepreneurship varies depending on the region and the time it is expressed (Grilo and Thurik, 2004).

The support infrastructure and facilitation of entrepreneurial activity is essential for investment decision, whether domestic or overseas and hence influences the decision on undertaking entrepreneurial initiatives (Gartner, 1985; Verheul, et al., 2006). The supporting mechanisms of entrepreneurial activity are (Van den Berg et al., 2004) the provision of diagnostic services of the entrepreneurial idea and the cost and procedures of establishing a venture. The marketing support that the new established venture is not able to cover by its own resources (Hunger, et al., 2002). The advancement of co-operation between new and established enterprises and the quest for investment capital has an impact on the development of entrepreneurship (OECD, 2006).

The more opportunities or gaps in the market, the greater the expected entrepreneurial activity (Shane and Venkataraman, 2000) on condition, of course, that their exploitation is considered feasible. Equally important is the perception of the market opportunities in combination with incentives and exploitability (Bygrave, et al., 2002). The economic climate prevailing in the market defines the opportunities for entrepreneurial initiatives and the risks or the profits resulting from their undertaking (Verheul, et al., 2006). A barrier to entrepreneurship is the small spending power of consumers (Wong, et al., 2005; Van den Berg, et al., 2004) and the lack of well-trained executives in the market.

The existence of technological opportunity - that is to say, the possibility to supply products or services, or even processes, at prices higher than those of their cost of production - has an impact on entrepreneurship (Schumpeter, 1934; Shane and Venkataraman, 2000). How entrepreneurs and patentees discover and exploit these opportunities does not seem to be a subject of exhaustive research in literature (Shane and Venkataraman, 2000).

The individual inventor has defined as one of the greatest sources of radical innovations (Schumpeter, 1934; Dahlin, et al., 2004) and has considered contributing a lot to regional economic development (Astebro, 2003). The acquisition of a patent certificate seems to have an impact on the undertaking of entrepreneurial initiative by the inventor (Levin, et al., 1987). The entrepreneurs are based on the technical knowledge, with which they probably acquired their patent, begin their activity because they believe in the merit of their idea (opportunity driven entrepreneurship, Bhave, 1994) and are capable of transforming it into a commercially exploitable opportunity.

3. Methodology and Facts

The present study is based on the data from a survey contacted by Organization of Industrial Property (OBI) the Greek patent office. The survey held through questionnaires sent by O.B.I. to 3,312 patentees -that have gotten their patent between 1995 and 2005- throughout the country, between 20 and 30 of March 2007. Of these, 2,890 were individuals who responded at a percentage of 15% (434) and 422 were enterprises and institutions who responded at a percentage of 13.27% (56).

The regional distribution of the patentees in the individual patentees' population and the corresponding participation in the survey are similar as Table 1 shows.

Table 1: Patentee's Region Classification

Region	Country Individual Inventors		Participants	
	Number	%	Number	%
Municipality of Attiki	1658	57.37%	193	47.89%
Municipality of Thessaloniki	373	12.91%	55	13,65%
Rest of Country	859	29.72%	155	38.46%
Total	2890	100.00%	**403**	**100.00%**

The questions discussed in this paper constitute part of a more extensive questionnaire. The individual patentees firstly asked if they proceeded to the exploitation of their patent. Out of the 434 responded patentees, 148 (34.10%) reply that they established a venture following the acquisition of their patent certificate, 49 (11.29%) assigned or conceded their rights to other entrepreneurs and finally, 237 (54.61%) preferred not to proceed to any sort of exploitation of their patent.

In the light of the previous information, we continue with the analysis of the reasons, which led the 148 patentees to establish a new venture. From their responses, it can be inferred that the patentees rank the "in order to exploit the patent certificate" first (47.30%). What follows, is "for other reasons" (39.19%), "the exploitation of development project" that means holding any subsidy (20.95%) and finally, "market study" (20.27%). The aggregation of the partial numbers of the responses shows that the size is bigger (189) than that of the patentees who established a venture (148), because, obviously, there was a combination in their tactical moves.

Next, the aim is to define whether the entrepreneur is new, that is whether he established the venture in the last three years and moreover, whether the new venture is characterized as of high potential, that is whether he intends to create twenty job positions within the first five years of its operation.

Focusing on the 37 entrepreneurs-patentees of our study who express high expectations of creating new jobs, we realize that as a percentage (75.51%) it is significantly higher compared to corresponding average percentage of European Union (9.1%) and that of GEM (9.2%). It should be noted that the percentage of both the E.U. and GEM concern the entrepreneurship resulted from any cause and not only from the patent itself. In our country, in particular, the percentage of high potential ventures is only 1.4% of the total entrepreneurship.

The percentage of GEM (9.2%) decreases to 0.5% for some members, Italy, Japan, Spain, Belgium, Finland and Greece. The new entrepreneurship, which represents something less than 25% of ventures, claims the creation of new jobs at a percentage of over 90%.

Out of the 434 patentees, 237 (54.61%) did not proceed to the exploitation of their patent. The reasons for this decision appear in Table 2, in a declining rank. There probably was a combination of 'counter-motives' which deterred them from undertaking the initiative, either of entrepreneurial nature or of an alternative way of exploitation of their asset.

Table 2: Factors influencing entrepreneurship

α/α	Factors	Answers	Percentage
1	Lack of Infrastructures	219	92.41%
2	Lack of Supporting Mechanisms	177	74.68%
3	Weakness of Financing	165	69.62%
4	Not Recognized Entrepreneurship	122	51.48%
5	Immature for the Exploitation Market	119	50.21%
6	Insufficient Patent Protection	111	46.84%
7	Lack of tax motives for the new business activity	93	39.24%
8	Technology Transfer Difficulties	92	38.82%
9	Disadvantageous Entrepreneurial Environment	83	35.02%
10	Opportunity Lack to start a new business	54	22.78%
11	Satisfied from the patent reception	38	16.03%
12	Opposition to idea of entrepreneurship	10	4.22%

Table 2 shows that the main reason for not exploiting the patent is the lack of infrastructure (94.41%) and secondly the lack of supporting mechanisms (74.681%). Literature has emphasized the significance of these factors to the decision for a new entrepreneurial activity and to the assignment or concession also of the utilization rights of the patent too. Financial is third in ranking (69.62%). The possibility of financing a new entrepreneurial activity is almost non-existent in Greece unless the individual patentee offers some collateral otherwise only the already established businesses are favoured by the Greek banking system. The creation of a technology market by bringing together patentees, ventures and investors or financers may contribute to the financing of the entrepreneurial activity.

The society does not recognize entrepreneurship (51.48%). This cultural problem requires a constant effort on behalf of the state and the entrepreneurial unions to change the society's attitude towards entrepreneurship. Greek society anticipates a fairer distribution of income, which results from the entrepreneurial activity of others, regardless of its participation or not in the creation of the product to be, distributed (IOBE, 2006).

The 50.21% of the respondents consider that the market is immature for the exploitation of a patent. However, nobody is banned from seeking a better treatment of their patent in other markets so that he can achieve the most appropriate attention and exploitation. In addition, many people consider the patent protection insufficient (46.84%). At this point, government should pursue policies to enforce the appropriate inventions.

Some of the respondents (39.24%) attribute their inactivity to the absence of tax incentives for start-up business activity. In addition, patentees, like the established entrepreneurs, confront an almost erratic tax environment, which does not permit long run planning.

Technology transfer difficulties (38.82%), disadvantageous entrepreneurial environment (35.02%) and opportunity lack (22.78%) follow in the list of reasons that prevented the patentee form exploiting its patent.

The 16.03% of the respondents replied that personal fulfillment from the patent certificate granted is sufficient and they do not intent on further exploitation of their idea. In case the patentee contents himself with his personal moral satisfaction, or his social

recognition from the mere acquisition of the patent certificate, it is likely that these feelings can be enhanced when -in terms of suggested technology market- he adopts the practice of Creative Commons[2] (Papadopoulos, 2007) which constitutes a step to further diffusion of technology and knowledge (Von Hippel, 2005).

Finally, some of the entrepreneurs are opposed to the idea of entrepreneurship (4.22%) which, as regards Greece, is attributed to the fact that individuals are more reluctant to start a new venture after an old failure because of the society's condemnation of failures that follows (IOBE, 2006), as well as to the Uncertainty Avoidance[3] (UA) –(Hofstede, 1980).

4. Evaluations

In the statistical analysis we focus only to those respondents who started a new venture, we examine whether the three variables "patent exploitation", "market study" and "subsidy exploitation" are independent to the variable "new entrepreneur" by using the methodology of contingency tables as shown in Tables 3, 4 and 5.

Table 3: Patent exploitation and new entrepreneurship

Entrepreneurs	**Patent Exploitation**		
	No	**Yes**	**Total**
New	17	31	48*
	35.42	64.58	100
Old	61	38	99
	61.62	38.38	100
Total	78	69	147
	53.06	46.94	100
Phi Coefficient	0.246184		
Cramer's V	0.246184		
Contingency Coefficient	0.239046		
Pearson X^2 (1)	8.909143 (p=0.0028)		
Likelihood Ratio G^2 (1)	8.984498 (p=0.0027)		

*one did not dictate any variable

As it is showed in Table 3, there is a correlation between the variable "new entrepreneur" and "patent exploitation" for the establishment of a venture through which he pursued its implementation. This finding is similar to those found in literature, which states that the acquisition of a Patent Certificate seems to have an impact on the undertaking of business initiative, by the patentee (Levin, et al., 1987; Bhave, 1994).

2. Creative Commons is a process and practice according to which, without selling out the rights of the patentee, provide their potential use to anybody who is interested and without any extra charge.
3. According to Hofstede who introduced this term in 1980, the tolerance or not to uncertainty or doubt shows the attitude of the individual towards its future.

Table 4 shows that that there is a correlation between the variable "new entrepreneur" and "market study". In other words, it appears to function rationally, it does not develop selfishly or somehow arrogantly because of the consolidation of his patent, but it investigates the conditions prevailing in the market and seeks the chance or the proper environment of implementing his patent.

Table 4: Market study and new entrepreneurship

Entrepreneurs	Market Study		
	No	Yes	Total
New	34	14	48
	70.83	29.17	100
Old	82	17	99
	82.83	17.17	100
Total	116	31	147
	78.91	21.09	100
Phi Coefficient		0.137888	
Cramer's V		0.137888	
Contingency Coefficient		0.136596	
Pearson X^2 (1)		2.79493 (p= 0.0946)	
Likelihood Ratio G^2 (1)		2.695353 (p= 0.1006)	

From Table 5 we infer that there is a correlation between the variable "new entrepreneur" and "subsidy exploitation". This finding supports previous literature that considers the support of the new venture significant, whether it concerns financing or subsidizing (Van den Berg, et al., 2004; Verheul, et al., 2006; Bates, 1995; Van Auken, 1999; De, 2006).

Table 5: Subsidy exploitation and new entrepreneurship

Entrepreneurs	Subsidy Exploitation		
	No	Yes	Total
New	30	18	48
	62.5	37.5	100
Old	89	10	99
	89.9	10.1	100
Total	119	28	147
	80.95	19.05	100
Phi Coefficient		0.327205	
Cramer's V		0.327205	
Contingency Coefficient		0.310981	
Pearson X^2 (1)		15.7383 (p= 0.0001)	
Likelihood Ratio G^2 (1)		14.83751 (p= 0.0001)	

Next, we test for independence between the three variables "patent exploitation", "market study" and "subsidy exploitation" and the variable "high potential firm".

Table 6: High potential firm and patent exploitation

Entrepreneurs	Patent Exploitation		
	No	**Yes**	**Total**
High Potential	11	26	37
	29.73	70.27	100.00
Not High Potential	68	43	111
	61.26	38.74	100.00
Total	79	69	148
	53.38	46.62	100.00
Phi Coefficient	0.273697		
Cramer's V	0.273697		
Contingency Coefficient	0.263987		
Pearson X^2 (1)	11.08665 (p= 0.0009)		
Likelihood Ratio G^2 (1)	11.26272 (p= 0.0008)		

As shown in Table 6, there is a correlation between the variable "patent exploitation" and the variable "high potential". In other words, the ability to utilize the patent creates an expectation in the new entrepreneur towards the establishment of a high potential venture.

Table 7: High potential firm and market study

Entrepreneurs	Market Study		
	No	**Yes**	**Total**
High Potential	24	13	37
	64.86	35.14	100.00
Not High Potential	93	18	111
	83.78	16.22	100.00
Total	117	31	148
	79.05	20.95	100.00
Phi Coefficient	0.201319		
Cramer's V	0.201319		
Contingency Coefficient	0.197359		
Pearson X^2 (1)	5.998346 (p=0.0143)		
Likelihood Ratio G^2 (1)	5.547452 (p=0.0185)		

Table 7 shows that the variable "high potential" correlates with variable "market study" and Table 8 shows that the variable "subsidy exploitation" correlates to variable

"high potential". Hence, the existence of subsidies enhances the expectation of the new entrepreneur towards the creation of a high potential venture.

Table 8: High potential firm and subsidy exploitation

Entrepreneurs	Subsidy Exploitation		
	No	Yes	Total
High Potential	20	17	37
	54.05	45.95	100.00
Not High Potential	99	12	111
	89.19	10.81	100.00
Total	119	29	148
	80.41	19.59	100.00

Phi Coefficient	0.383294
Cramer's V	0.383294
Contingency Coefficient	0.357904
Pearson X^2 (1)	21.74326 (p=0)
Likelihood Ratio G^2 (1)	19.34669 (p=0)

The findings of this paper lead to the view that a focused public policy to support the above mentioned parameters, which appear to affect positively the perspective of creating new jobs by the patentees who establish new ventures and especially high potential ventures. For instance, "market study", (the investigation of the prevailing market conditions, the existence of any chance or proper environment) which is correlated with the establishment of high potential businesses, could be carried out by small and medium enterprises supporting institutions. These institutions could foresee future opportunities and direct new entrepreneurs to sectors of more efficient exploitation of their patent. In addition, patentees should be encouraged and supported in their effort to establish a new venture, through development projects, which is correlated with high potential employment instead of subsidizing unemployment. This policy, like the aforementioned examples, could encourage a lasting effort for innovation and an intentionally transformation of innovation to a new business venture.

5. Conclusion and Suggestions

This paper uses statistical techniques in a sample of individual patentees participated in a survey contacted by Organization of Industrial Property in Greece. The 148 out of the 434 patentees, respondent to the survey undertook a new business initiative. The 49 are new entrepreneurs and 37 of them expect to create several jobs, that is they are characterized as dynamic entrepreneurs.

From the empirical findings it appears that 34.10% of patentees proceeded to the establishment of a new venture with the aim of exploiting the patent certificate, another 11.29 % assigned their rights to other people and 54.61% of them preferred not to proceed to any sort of exploitation.

The government should apply a more focused policy in order to promote entrepreneurship in the patentees' population. The encouragement for patent exploitation, owned or bought; the secure conditions and means of exploitation; the proper orientation of technology or products and services, dictated by increasingly up-to-date studies and market analyses, and the robust and realistic funding by means of appropriate projects should comprise the basic elements of that policy. The basic aim is the employment's increase through entrepreneurship's growth. Achieving this means that the policy tools should include among others the following: a) Higher subsidies and funding with more favorable terms than those received by general entrepreneurship. b) Patent's exemption from any extra charge to keep it valid. c) Conducting best patent competitions. d) Subside the cost of buying the rights or the development of the patent. e) Establishment of a technology market analogous to the secondary bond markets, which facilitate the corresponding transactions between inventors, entrepreneurs and investors.

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The Impact of Stock, Energy and Foreign Exchange Markets on the Sugar Market

Nikolaos Sariannidis[1]

Abstract

This study examines the effect of financial factors on the sugar market by using Generalized Autoregressive Conditional Heteroskedasticity (GARCH) models. The results show that changes in capital and energy markets returns have a positive impact on the mean returns of Sugar futures as opposed to changes in volatility returns of the exchange rate of the U.S. Dollar/ Yen that affect it negatively. Finally, the structural analysis of volatility with the GARCH model has shown that current volatility is more influenced by past volatility rather than by the previous day shocks.

Keywords: GARCH model, Sugar futures, Crude oil, Ethanol, Exchange rates

JEL classification: G15, Q13, Q14

1. Introduction

Sugar is widely produced, traded and consumed around the world. Sugar is produced from either sugar cane or sugar beets in more than 120 countries and consumed in every country. Sugar cane is primarily grown in tropical and sub-tropical climates while sugar beets are grown where the climate is more temperate. Some countries (e.g., the United States) produce significant amounts of both crops while others specialize in the production of either cane (e.g., Brazil) or beets (e.g., European Community (EC)).

Sugar is one of the most heavily traded agricultural commodities in the world markets and has long been characterized by volatile prices and widespread intervention. There are many factors that contribute to these unstable and high volatile prices. Specifically, per capita income, population and economic growth greatly influence the demand for sugar and hence the relative price. Besides, a key factor of sugar price variations is weather conditions, as successful crops yields presuppose an annual minimum of around 600 mm. Apart from adverse weather conditions, another factor that can disturb sugar prices is crop infestation by pests (Koo and Taylor, 2009).

Another crucial factor that affects most sectors of economies and hence sugar market, as a basic cost variable, is oil price fluctuations. Baffes (2007) claimed that crude oil prices affect the price of agricultural commodities on the supply side, as it enters in the aggregate production function through the use of various energy inputs (fertilizer and fuel) and in the transportation process of these goods.

1. Technological Education Institute (TEI) of West Macedonia, Department of Financial Applications, Kila 50100, Kozani, Greece - email: sarn@hol.gr

Moreover, the biofuels demand is a new factor that has influenced the food market and hence the sugar market whereas food prices were previously linked to oil prices only on the supply side (Piesse and Thirtle, 2009). Global biofuels production has expanded rapidly in recent years, playing an increasingly important role in the sugar markets and appears set to continue on this growth path. The market is dominated by ethanol, which grew threefold from 2000 to 2007, mainly in the US (world leader with production of 30 billion litres) and Brazil (19 billion litres).

Furthermore, the movements of exchange rates influence the price of all world traded goods and hence the price of sugar, because they are related to the price of imported/ exported goods, substitutes, raw materials and other cost variables (Piesse and Thirtle, 2009). Also, the volatility of exchange rates affects traders and investors as they seek to operate and invest their money in stable economies with stable currency (Kwek and Koay, 2006; Bloningen, 2005).

Finally, there has been a great deal of conversation regarding the effect of alternative trade liberalization policies on sugar prices. Particularly, in most recent years, over 70% of world sugar production is consumed domestically, implying that only a small portion of production is traded internationally. Since only a small proportion of world production is traded freely, small changes in production and government policies tend to have large effects on world sugar markets (Devadoss and Kropf, 1996; Yang et al., 2001; Huan-Niemi and Kerkela, 2005; Koo and Taylor, 2009).

The presented study is limited to capture the effect of financial factors on the price and volatility of sugar, as they concern substantially integrated and mature world markets with available daily data. Specifically, the factors that we have finally used are the crude oil, the ethanol, the exchange rate of the U.S. Dollar/ Yen and the SP500. We have chosen the Dollar/ Yen exchange rate for the following reasons. First of all, the U.S. Dollar is the biggest traded invoice currency, so it is considered as the predominant currency (McKinnon and Schnabl, 2002). Also, the majority reserve of currency is in U.S Dollars and hence the variability of the U.S Dollar could disturb the economic environment. In addition, Yen is one of the currencies of carrying trade (investors borrow low-yielding currencies and lend-invest in high-yielding currencies) and consequently its level relative to dollar plays a crucial role to all world markets. The SP500, the index of the largest economy in the world which augurs the future of other economies, has been used as a proxy for the world economic growth (activity), a fact which agrees with the conclusion of international bibliography (Fama, 1981; Fama, 1990; Schwert, 1990; Barro, 1990; Hassapis and Kalyvitis, 2002; Mauro, 2003; Enisan and Olufisayo 2009)

2. Data

For the empirical analysis, daily observations of the Sugar World No 11 (Sugar)[1], S&P 500 Stock Index (SP)[2], CL Crude Oil Light Sweet (Crude)[3], Denatured Fuel Ethanol

1. The contract size for #11 world raw sugar futures traded at Intercontinental Exchange (ICE, formerly the New York Board of Trade) is 112,000 pounds (50 long tons).
2. The S&P 500 is a stock market index containing the stocks of 500 American Large-Cap corporations.
3. Light Sweet Crude Oil futures are traded on the New York Mercantile Exchange under ticker symbol CL in U.S. dollars and cents per barrel.

Pit (Ethanol)[4] and U.S Dollar/Yen exchange rate (D/Y) are used. These data have been obtained from the Reuters DataLink database of Thomson Reuters Company. The sample period covers January 1, 2002 to August 31, 2009. It should be noted that the Ethanol variable, as a proxy for the price of biofuels, has available prices from 23/03/2005 and consequently it takes zero values before this period. Moreover, preliminary diagnostic tests have shown that the previous day volatility of the Dollar/Yen exchange rate returns (Var(D/Y)) affect the returns series of sugar.

Daily continuously compounded returns for the selected data are calculated as, $R_t=100*\log (p_t/p_{t-1})$ where R_t and p_t are the daily returns and prices respectively.

3. Methodology and Empirical Findings

Table 1 presents the summary statistics for Sugar, SP, Crude, Ethanol and Var(D/Y) series. The sample mean returns of Sugar, SP, Crude, and Ethanol series are close to zero and we cannot reject the null hypothesis that the mean returns are not statistically different from zero. Also, the coefficients of skewness and kurtosis indicate that the return series have asymmetric and leptokurtic distribution. Moreover, the augmented Dickey - Fuller (ADF) test, allowing for both an intercept and a time trend, showed that the sample series had been produced by stationary series.

Table 2 shows the sample autocorrelation function (ACF) and partial autocorrelation function (PACF) for daily returns and squared daily returns of Sugar series. It can be observed that while there is no significant autocorrelation in simple returns at any lag, on the contrary there is generally a significant autocorrelation in squared daily returns at all lags.

Table 1: Sample statistics

Statistics	Sugar	SP	Crude	Ethanol	VAR(D/Y)
Observations	1883	1883	1883	1883	1883
Mean	0.000811	0.000004	0.000534	0.000087	0.000045
Median	0.000000	0.000600	0.000400	0.000000	0.000014
Std. Dev.	0.020941	0.014089	0.025761	0.017614	0.000112
Skewness	0.126927	0.115439	-0.031454	-0.938708	12.285220
Kurtosis	6.351455	15.840720	7.700961	23.980370	271.398700
Jarque-Bera	886.32	12940.72	1734.16	34812.02	5699337.00

4. Ethanol futures contracts are traded on the Chicago Board of Trade (CBOT)

Augmented Dickey-Fuller (ADF)	-43.255	-35.225	-46.829	-44.512	-45.955

Table 2: Test for serial dependence in First and Second Moments of Sugar variable

Returns				Squared Returns			
Lags	Autocorrelation	Partial Correlation	LB(n)	Lags	Autocorrelation	Partial Correlation	LB(n)
1	0.002	0.002	0.007	1	0.077	0.077	11.066
2	-0.019	-0.019	0.7073	2	0.042	0.036	14.401
3	0.032	0.032	2.5934	3	0.039	0.034	17.332
4	0.013	0.013	2.9324	4	0.077	0.07	28.428
5	0.028	0.029	4.4207	5	0.038	0.025	31.161
6	-0.044	-0.044	8.0166	6	0.008	-0.003	31.287
12	-0.011	-0.014	12.437	12	0.026	0.013	57.8
24	0.01	0.006	34.326	24	0.05	0.026	123.93
36	0.026	0.02	46.523	36	0.022	-0.004	167.12
46	-0.02	-0.018	58.276	46	-0.011	-0.037	186.33
70	0.046	0.041	81.219	70	-0.004	-0.022	276.08

Notes: LB(n) are the n-lag Ljung-Box statistics for $SUGAR_t$ and $SUGAR_t^2$ respectively. LB(n) follows chi-square distribution with n degree of freedom; the sample period contains 1883 daily returns.

Also, the preliminary results of the linear regression between Sugar and SP, Crude, Ethanol and Var(D/Y) series have shown that the residuals exhibit strong ARCH effect indicating signals of misspecified error variance structure. Particularly, the OLS estimation of the model (equation 1) yields squared residuals that examined with ARCH LM test for 12 lags ($N*R^2 = 29.65$) and the Ljung –Box test ($Q^2(6)=19.27$ and $Q^2(12)=35.5$) indicate that the hypothesis of no ARCH effects in the standardized residuals cannot be rejected.

$$Sugar_t=b_1+b_2SP_t+b_3Crude_t+b_4\ Ethanol_t+b_5Var(Y/D)_{t-1}+u_t \quad (1)$$

In summary, the Sugar return series seems that it is best described by an unconditional leptokurtic distribution and possesses significant conditional heteroskedasticity. This renders the ARCH models a very good choice for modeling the Sugar return series. The autoregressive conditional heteroskedasticity (ARCH) model introduced by Engle (1982), and its extension to the Generalized Autoregressive Conditional Heteroskedasticity (GARCH) model (Bollerslev, 1986), allow the fat tails which are often observed in financial distributions and impose an autoregressive structure on the conditional variance and therefore is capable of capturing not only the volatility persistence of return series over time but also the volatility clustering as well. Volatility clustering is an important feature of financial distributions and appears when there is a tendency that large changes in returns prices will follow large changes, and small changes will follow small changes (Kyle, 1985). Moreover, this model is a weighted average of past squared residuals, but it has declining weights that never go completely to zero.

From the large variety of GARCH models, we proposed the GJR-GARCH model, introduced by Glosten, et al. (1993), in order to allow good and bad news to have a different impact on volatility.

The GJR model is a simple extension of the GARGH model accounting for any asymmetries involved. Statistically, this effect occurs when an unexpected drop in price due to bad news volatility increases more than an unexpected increase in price due to good news of similar magnitude. This model expresses the conditional variance of a given variable as a nonlinear function of its own past values of standardized innovations. The estimation of GJR-GARCH model involves the joint estimation of a mean and a conditional variance equation. The GJR-GARCH (1,1) model is stated as follows:

The mean equation

$$Y_t = X_t'\theta + u_t \tag{2}$$

where X_t is a vector of exogenous variables.

The conditional variance equation

$$\sigma_t^2 = a_0 + a_1\sigma_{t-1}^2 + a_2u_{t-1}^2 + a_3S_{t-1}^-u_{t-1}^2 \tag{3}$$

$u_t \sim GED(0, \sigma_t^2)$, i.e. residuals which we assume to follow the GED (generalized error distribution). We employ the GED because of its ability to accommodate fatter tails and peakedness.

$S_{t-1}^- = 1$ if $u_{t-1}<0$

$S_{t-1}^- = 0$ elsewhere

The leverage effect occurs when $\alpha_3>0$. The condition for a non-negative variance requires that $\alpha_0\geq0$, $\alpha_1\geq0$, $\alpha_2\geq0$, $\alpha_2+\alpha_3>0$.

When $R_t - \hat{R}_t < 0$ then $u_t<0$, which means that the observed return is less than the estimated return (in other words, the mean return). Consequently, when S_t^- is 1, the negative change u_{t-1}^2 at time t-1 correlates with the volatility at time t.

In this model, the good news ($u_{t-1}>0$) related to the bad news ($u_{t-1}<0$) has a different effect on the conditional variance. If $u_{t-1}>0$, it implies that at time t-1 we had good news, which had a positive effect on the return (over the mean return), and this is why the residual is positive. Good news reflects on the coefficient α_2 (α_3 absorbs the effect of the bad news). However, bad news has an effect on $\alpha_2+\alpha_3$, because if $S_{t-1}^- = 1$ then equation (3) becomes

$$\sigma_t^2 = a_0 + a_1\sigma_{t-1}^2 + a_2u_{t-1}^2 + (a_3u_{t-1}^2 * 1) = a_0 + a_1\sigma_{t-1}^2 + (a_2 + a_3)u_{t-1}^2 \tag{4}$$

When $\alpha_3 > 0$, we have the leverage effect, i.e. bad news has a greater effect on volatility. When $\alpha \neq 0$, we simply state that the effect of news is asymmetrical.

The preliminary statistical results and the application of the LR test on the GARCH(p,q) model demonstrated the final specification for the estimation of the mean and volatility for the Sugar series. The specification is:

Mean equation

$$Sugar_t = b_1 + b_2 SP_t + b_3 Crude_t + b_4 Ethanol_t + b_5 Var(Y/D)_{t-1} + u_t \quad (5)$$

Variance equation

$$\sigma_t^2 = a_0 + a_1\sigma_{t-1}^2 + a_2 u_{t-1}^2 + a_3 S_{t-1}^- u_{t-1}^2 \quad (6)$$

$u_t \sim GED(0, \sigma_t^2)$,

Some diagnostic tests were performed to establish goodness of fit and appropriateness of the model. First, it was examined whether the standardized residuals and squared standardized residuals of the estimated model were free from serial correlation. As we can see from Table 3, the LB(n) statistics for standardized residuals are not statistically significant and the LB(n) statistics for standardized squared residuals show no ARCH remaining structure. The ARCH–LM Test concerning four lags in the residuals ($N*R^2 = 4.24$) verifies that we do not need to encompass a higher order ARCH process. Furthermore, the coefficient estimation v=1.21 for tail thickness regulator with 0.045 standard error, confirms the adoption of the GED assumption. Specifically, the assumption of normal distribution is rejected, a fact that verifies the theory for thick tails in the stock returns. A LR test of the restriction v=2 (for v=2 GED distribution is essentially the normal distribution) against the unrestricted models clearly supports this conclusion.

Table 3: Diagnostics on standardized and squared standardized residuals

Residuals				Squared Residuals			
Lags	Autocorrelation	Partial Correlation	LB(n)	Lags	Autocorrelation	Partial Correlation	LB(n)
1	0.006	0.006	0.07	1	0.035	0.035	2.26
2	-0.02	-0.02	0.81	2	-0.028	-0.029	3.71
3	0.03	0.031	2.56	3	-0.009	-0.007	3.86
4	0.01	0.009	2.76	4	0.013	0.013	4.18
5	0.034	0.035	4.96	5	-0.02	-0.021	4.92
6	-0.037	-0.038	7.60	6	-0.046	-0.044	8.84
12	-0.021	-0.023	10.94	12	-0.006	-0.005	10.84
24	0.006	0.001	26.93	24	0.044	0.042	23.40
36	0.023	0.015	36.09	36	0.001	-0.001	26.19
46	-0.003	0.002	44.31	46	-0.038	-0.043	32.76
70	0.042	0.035	64.12	70	-0.011	-0.005	59.18

Notes: LB(n) are the n-lag Ljung-Box statistics for the residual series. LB(n) follows chi-square variable with n degree of freedom; the series of residual contains 1883 elements.

In Table 4 the results for the mean equations are presented. The statistical significance of the b_2, b_3, b_4 coefficients indicates that the increase of SP500, Crude oil and Ethanol respectively exert positive effect on the conditional mean return of the sugar variable. Regarding the effect of the Dollar/Yen exchange rate returns, the statistical significance of b_5 indicates that the increase of its previous day volatility negatively influences the conditional mean returns of the Sugar variable.

In Table 5 the results for the variance equation are presented. The value of the α_1 coefficient (0.9458), which reflects the influence of σ^2_{t-1}, i.e. the older information (residuals u_{t-2}, u_{t-3}, …), is much higher than the value of the α_2 coefficient (0.038), which correlates the price variation of the present day to the price variation of the previous day. Consequently, the volatility shocks (information) are slowly assimilated to the particular market. Finally, the coefficient a_3, which allows the conditional variance to asymmetrically respond to positive and negative shocks, does not appear statistically significant.

Table 4: Mean equations

$$Sugar_t = b_1 + b_2 SP_t + b_3 Crude_t + b_4\ Ethanol_t + b_5 Var(Y/D)_t + u_t$$

b_1	b_2	b_3	b_4	b_5
1.753**	0.0518***	0.105*	0.068*	-0.00087**
(0.826)	(0.0303)	(0.015)	(0.021)	(0.00041)

Notes: Standards errors are shown in parentheses. *indicates statistical significance at the 1% level. **indicates statistical significance at the 5% level.

Table 5: Variance Equations

$$\sigma_t^2 = a_0 + a_1\sigma_{t-1}^2 + a_2 u_{t-1}^2 + a_3 S_{t-1}^- u_{t-1}^2$$

a_0	a_1	a_2	a_3
0.0000057**	0.9458*	0.038*	0.0053
(0.0000025)	(0.0127)	(0.0105)	(0.0151)

Notes: Standards errors are shown in parentheses. *indicates statistical significance at the 1% level. **indicates statistical significance at the 5% level.

4. Conclusion

This study examines the role of financial factors in Sugar market using a GJR-GARCH model. Specifically, we have examined the influence of the SP500, Crude oil, Ethanol and U.S. Dollar/Yen exchange rate variables on Sugar World No 11. The findings show that the stock market, as a proxy variable for economic activity, positively affects the

sugar market. Also, higher energy prices, Crude oil and Ethanol, positively influence the sugar market not only because of their connection with intensive inputs such as fertilizers, pesticides and fuels but also because sugar production itself becomes competitive in the energy sector as feedstock for the production of biofuels. Finally, the lag volatility of the U.S. Dollar/Yen exchange rate returns exerts negative influence on the conditional mean returns of the Sugar variable. This can be explained by the fact that the volatility of the U.S. Dollar/Yen weakens the confidence in commodities markets, creating an unstable environment for investments.

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