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In memory of Jörg…

On behalf of the board of the *International Journal of Economic Sciences and Applied Research (IJESAR),* I would like to express my deep sorrow for the sudden death of Professor Jörg Huffschmid in December 2009. Mr. Huffschmid was one of the first members of IJESAR's editorial board, as he accepted our invitation to support our effort with great pleasure. Bearing in mind that his numerous commitments did not allow him much time to be more actively involved in IJESAR, his participation in our venture was an exceptional honour for us. His absence leaves a gap that is hard to fill. However, we feel greatly obliged to continue guided by his pure scientific discourse, the accuracy of his analyses, his tolerance of different opinion and his belief in an economic policy that would benefit the weak and the wage earner. Convinced that I am expressing the feelings of all my associates, I would like to give my sincere condolences to his family.

Jörg Huffschmid was born in 1940. He studied philosophy and economics in Freiburg, Paris and Berlin and in 1967 he received his PhD in economics from the University of Freie, Berlin. From 1973 on he worked as a professor at the University of Bremen. In 1975 he founded, together with Rudolf Hickel and Herbert Schui, the "Workgroup on Alternative Economic Policy / Arbeitsgruppe Alternative Wirtschaftspolitik", which produced the annual memoranda where alternative proposals were laid down for a more socially fair economic policy in Germany to counteract the neo-liberal proposals made by the five 'wise men' in Sachverstaendigenrat (SVR). In 1995, Jörg Huffschmid was a founding member of and driving force behind the "Workgroup of European Economists for an Alternative Economic Policy in Europe"; within the framework of the group's workshops the annual EuroMemorandum is published. Mr. Huffschmid was an associate of the Institute for Marxist Studies and Research, co-editor of the political science monthly *Sheets on German and International Politics* and editor of the *Journal for Marxist Renewal*. He also coordinated the efforts of the anti-globalization network ATTAC.

One of the major scientific and political contributions of Mr. Huffschmid was his publication in 1969 of *The Policy of Capital – Concentration and Economic Policy in the Federal Republic* (ed. Suhrkamp). Through this book Mr. Huffschmid revealed important social and economic aspects of the free market economy focusing mainly on the role of the capital in perpetuating inequalities and economic crises.

The board of IJESAR is intending to honour, in due time, our colleague and associate Mr. Huffschmid, in the manner that only suits a scientist with global recognition, social sensitivity and radical discourse.

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On the Dynamics of the Greek Twin Deficits: Empirical evidence over the period 1960 – 2007

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Abstract

One of the most important open macroeconomic issues, during the current global economic recession, concerns the sustainability of persistent budget and trade deficits as well as possible interactions between them. These deficits are most crucial due to severe debt servicing costs, faced by today's economies despite their development level. This paper presents time series evidence over the period 1960 up to 2007, using data of the Greek Economy. Our results confirm 'weak' sustainability of both deficits and evidence in favor of the Keynesian rationale regarding the 'twin deficits hypothesis'.

Keywords: Budget and Trade Deficits, Sustainability, Twin Deficits Hypothesis, Cointegration, Greek Economy (1960-2007).

JEL classification: C22, F32, F41, H62.

1. Introduction

One of the hottest macroeconomic issues during the current economic turmoil concerns the sustainability of persistent current account deficits, due to severe debt servicing costs, faced by both advanced and developing economies. These threatening economic characteristics of today's global recession reinforce the question on the ability of a country to service and repay its debt by avoiding default (Wickens and Uctum, 1993).

Public deficits have created increased borrowing requirements for governments worldwide. In particular, developed economies turn, basically, to domestic borrowing, whereas developing ones turn to both domestic and foreign capital. In any case, though, high deficit levels eventually lead to an accumulation of debt, which forces an inexorable necessity for financial discipline and control over the public deficit (e.g. Hakkio and Rush, 1991; Haug, 1991).

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Evidently, long-run persistent current account deficits tend to have certain harmful effects on domestic economy, such as increase in domestic interest rates relative to their foreign counterparts, so that an excessive accumulated external debt burden is imposed on future generations. Much empirical research on the US economy has been conducted verifying the aforementioned claims (e.g. Husted, 1992; Tanner and Liu, 1994; Liu and Tanner, 1995).

Actually, conflicting empirical evidence in the relevant literature does exist on the issue of twin deficits. Bartolini and Lahiri (2006) claim that fiscal deficit reductions in the United States can play only a limited role in correcting the nation's current account imbalance. Their estimates suggest that even if the federal fiscal deficit were fully erased, the nation's current account deficit could improve by only a minimal fraction of its running level. On the contrary, Salvatore (2006) shows that a direct relationship exists between the budget and the current account deficits for all the seven largest and most important industrial countries (USA, Japan, Germany, UK, France, Italy and Canada), with budget deficits leading to current account deficits by one or more years. Normandin (1999), working on the Canadian and the USA economies, also proves that by increasing the budget deficit, through tax cuts, external deficit increases; whereas, these causal responses are positively affected by the degree of the birth rate and the degree of persistence of the budget deficit.

In this study, we investigate the sustainability of twin deficits of the Greek economy, as a first attempt for the period from 1960 and up to 2007. We intentionally leave the current crisis years 2008 – 2009 outside our recent focus, for certain reasons. Namely, we leave the economic storm to calm down, dramatic governmental and economic decisions upon structural reforms to be made, robust and unbiased economic data to emerge, and as long as the economy returns back to its EU Stability and Growth Pact responsibilities, we need to reassess further the challenges that lie ahead.

Accordingly, our objectives here focus on: i) testing for the sustainability of the Greek budget and trade deficits, over the selected time period from 1960 up to 2007, thus adding to the relevant empirical literature and, ii) investigating possible causal linkages between the two deficits in Greece and the directions of the detected causal effects, thus contributing to the ongoing debate regarding the 'twin deficits hypothesis', on both theoretical and empirical aspects.

This paper is divided into four consecutive sections. Namely, Section (2) describes briefly the deficits issue within the Greek Economy. Section (3), presents the theoretical foundation of the sustainability concept for both deficits considered. Section (4) focuses upon the data and empirical results; whereas, last section (5) provides a short summary and conclusions. At the appendix we present our econometric results and relevant statistics.

2. A Brief Reference on the Greek Economy

Beginning from the 1960's, the budget deficit of the Greek economy was growing at low levels, varying from 1.62% of GDP in fiscal year 1960, to 1.52% in 1970, with the highest level in 1968, at 1.92%. At the same decade, the trade deficit varied from 7.6% in 1960, to 7.18% in 1970, with its highest level in 1965, at 11.35%.

The most important event of the decade was the association-for-entry agreement of Greece with the European Economic Community (1962). That agreement demanded gradual reduction of tariffs that created negative impacts on the trade balance. Also, the expansionary fiscal policy influenced income growth and imports' expenditure positively.

The military dictatorship imposed in Greece, over the period 1967-1974, implemented massive public expenditure programs for infrastructure, which contributed to a large increase of G.D.P. (16% for the referred period), resulting to an increase in the budget deficit from 1.71% in 1971, to 3.35% in 1975. The trade deficit remained high and worsened even more, due to the petroleum crisis of 1973, thus having an average of 6.5% during the 1970-1980 period.

The decade 1980-1990, coincides with three important events for Greece, namely: (a) the accession of Greece in the European Economic Community (1981), (b) the second international petroleum crisis (1980) and, (c) the rise of the Greek socialists to power (1981). The failure of the privatization program during the 80's, combined with overall stagnation, has contributed to the high rise of the Greek budget deficit up to 10.34% in 1985. The 1985-1987 stabilization program and the devaluation of the national currency were not sufficient to reverse the aforementioned situation. The budget deficit remained at very high levels, closing at 14.07% in 1989. The trade deficit had been affected also by the petroleum crisis of 1980, reaching 7.83% in 1989, and 9.82% in 1990. Evidently, the huge deficits of the 1980's and the early 1990's, have resulted in exploding debt levels from 24.6 % of GDP in 1976 to 111.3 % in 1996.

In the 1990's, the new conservative government enforced a new stabilization program with minimal results. The socialist government that followed in 1993 implemented the first 'economic convergence to the E.U. standards' program (1993-1998). The goal for Greece was to comply with the economic criteria set by the European Union, at the Maastricht treaty. In addition, European funds helped the Greek economy to achieve a 10% GDP rise average through the entire decade.

The first economic convergence program was followed by a second one (1998-2001), and both programs managed to gradually reduce the budget deficit from 20.79% in fiscal year 1994, to 8.11% in 1997 down to 5.79% in 2000. However, the trade deficit remained at high levels, from 6.23% in 1994, to 13.5% in 2000.

In fact, the basic developments during 1997-2000 that helped decreasing the debt-to-GDP ratio were the following:

(a) Deficits' decline from 10.2 % of GDP in 1995 to less than 1.0 per cent in 2000, while primary surplus increased from 1.0 per cent of GDP in 1995 to around 6.5 per cent in 2000.

(b) Inflation fell from 8.9 per cent in 1995 to 2.5 per cent in 2000, thus reducing nominal interest rates and,

(c) 10-year fixed-interest rate bonds introduced in June 1997 reduced further the interest rates and ended heavy governmental reliance on short-term borrowing.

These three factors then, along with intensive privatization, all favorably affected debt and deficit reduction (Manessiotis and Reischauer, 2001, 122-123).

The recent economic period 2001-2007 is probably the most interesting. The most important fact of this era is the accession of Greece to the European Economic and Monetary Union, and the adoption of the new euro-currency. The fiscal discipline, due to the continuous need for compliance with the Maastricht treaty, resulted in preserving the budget deficit at low levels during 2001-2002. However, the organization of the 2004 Olympics, with their huge public spending, had a negative effect on the budget deficit that reached 9.47% in 2004.

During the recent years and up to the half of the running decade, Greece emerged as one of the fastest growing countries in E.U. Greece succeeded in reducing inflation from double-digit to low single-digit rates during the first half of this decade, eliminated fiscal imbalances and the country joined the euro area by January 2001.

The country's economic performance has changed dramatically by the end of the second half of this decade, partly due to the current economic turmoil and mostly due to its unresolved structural economic deficiencies, such as the chronic imbalances of the social security system. Thus, big failures to stand by the Maastricht Stability and Growth Pact and to cure accumulated structural deficiencies have resulted in explosive debt and deficit problems, along with deepening recession.

The above facts led Greece being under continuous supervision from the European Commission. The trade deficit still remained high at 13.16% in 2001, and 10.49% in 2007, thus indicating a continuous lack of economic competitiveness. Along these lines, a sustainable downward path of debt to GDP ratio can be obtained by substantial expenditure cuts and serious reduction of primary spending, along with sustainable social security system reforms and restructuring (*ibid*).

3. The Concept of Sustainability: Basic Theoretical Issues

3.1 Trade Deficit Sustainability

According to Hakkio and Rush (1991) and Husted (1992), an economy's external sector can be described by the following identity:

$$M_t + (1+i_t)D_{t-1} = X_t + D_t, \qquad (1)$$

where:

M_t represents country's imports of goods and services, without 'sinking funds' (that is, interest plus debt) described by the second term $(1+i_t)D_{t-1}$; X_t describes the country's exports of goods and services, whereas D_t is the country's external borrowing at time t.

Hence, the inter-temporal foreign sector constraint becomes (Hakkio and Rush, 1991; Husted, 1992):

$$D_0 = \sum_{t=1}^{\infty} d_t (X_t - M_t) + \lim_{n \to \infty} d_n D_n \,, \qquad (2)$$

with d_t being the future external surpluses discount coefficient. In (2) above, with the second term becoming zero, the external borrowing equals the present value of $X_t - M_t$.

Assuming an inter-national interest rate stationary at average price I, adding and subtracting from (1) iD_{t-1}, we get:

$$M_t + i_t D_{t-1} = X_t + \sum_{j=0}^{\infty} \lambda^{j-1} (\Delta X_{t+j} - \Delta E_{t+j}) + \lim_{j \to \infty} \lambda^{t+j} D_{t+j}, \qquad (3)$$

where:

$E = M_t + (i_t - I) D_{t-1}$, whereas the left part of (3) corresponds to the total expenses for imports and interest payments. Assuming non-stationary X and E time series at their levels, but stationary at first-differences, (3) above can be transformed as follows:

$$M_t + iD_{t-1} = a + X_t + \lim_{j \to \infty} \lambda^{t+j} D_{t+j} + e_t, \qquad (4)$$

subtracting X_t from both sides of (4) and multiplying by (-1), the left side becomes:

$$(X_t - M_t - i_t D_{t-1}) .$$

Assuming that:

$$\lim_{j \to \infty} \lambda^{t+j} D_{t+j} = 0 ,$$

we get:

$$X_t = a + \beta MM_t + e_t, \qquad (5)$$

where:

$MM_t = M_t + i_t D_{t-1}$ represents import expenses plus interest payments. Thus, we fundamentally question whether imports and exports time series become cointegrated. If long-run cointegration is justified, then we claim that external sector debt (or, in fact, the trade deficit) becomes stable; that is, sustainable (Hakkio and Rush, 1991).

In (5) above, following Hakkio and Rush (1991), β must equal 1 and e_t must be stationary for an economy to achieve sustainability of its external sector debt (i.e. trade deficit sustainability). Nevertheless, sustainability holds even if β gets less than unity, but then the un-prepaid net present value of the external debt faces unbounded increase.

3.2 Budget Deficit Sustainability

The more widely acceptable definition of sustainability is based on the concept of inter-temporal budget constraint, which states that the present value of debt, at the limit, tends to zero.

Let us suppose then that the deficit is financed with government bonds maturing in one year. This means that in every time period, government faces the following national budget constraint:

$$G_t + (1 + r_t)B_{t-1} = R_t + B_t, \tag{6}$$

where:

G equals public spending not including debt servicing costs; that is, public consumption plus transfer payments; r equals the real interest rate per period; B equals the accumulated debt, and R being the public receipts.

Consecutive substitutions in (6) above, give the following relation for the inter-temporal budget constraint:

$$B_t = \sum_{s=0}^{\infty}\prod_{i=1}^{s}(1 + r_{t+i})^{-1}(R_{t+s} - G_{t+s}) + \lim_{s\to\infty}\prod_{i=1}^{s}(1 + r_{t+i})^{-1} B_{t+s}. \tag{7}$$

At this point, two hypotheses accrue: (a) real interest rate is stable, with average value r, and (b) the real supply of bonds has an annual rate of change that, on average, is no higher than the average interest rate r. Based on these two hypotheses we have:

$$\lim_{s\to\infty}(1 + r)^{-s} B_{t+s} = 0. \tag{8}$$

The above formula (8) essentially states that the present value of the debt tends to zero. Additionally, it states that the government does not have the option of continually creating deficits. However, Hamilton and Flavin (1986) claim that (7) and (8) above do not exclude the existence of a constant permanent fiscal deficit. As long as deficits are such that they push debt at a rate less than that of the interest rate, (8) will be satisfied.

Alternatively, according to Hakkio and Rush (1991), sustainability of accumulated debt can be estimated using the following regression:

$$R_t = a_1 + \beta_1 G_t + u_t, \tag{9}$$

where:

$\beta_1 \leq 1$, checking whether R_t and G_t form a co-integration relationship. It can be shown that (Quintos, 1995):

- the deficit is sustainable, in the 'strict sense', if and only if the R_t and G_t series, which are I(1), are co-integrated and $\beta_1 = 1$;
- the deficit is sustainable, in the "weak sense", if the R_t and G_t series are co-integrable and $0 \prec \beta_1 \prec 1$,
- the deficit is not sustainable if $\beta_1 \leq 0$.

Sustainability in the 'strict sense' (i.e. 'strong sustainability') means that the limitation of the budget is valid and, at the same time the un-prepaid debt B_t is I(1). Sustainability in the 'weak sense' (i.e.: 'weak sustainability') means that the limitation is valid but the B_t is magnified at a rate that is lower than the growth rate of the economy, which approaches the average real interest rate. Even if this latter situation is consistent with sustainability, it may have consequences which affect the government's ability to negotiate its debt and, for this reason it is the least desirable scenario. A deficit which is not sustainable is one where B_t is stated as developing at a rate equal to or greater than the rate of growth of the economy, such that it contravenes the inter-temporal budget constraint.

4. Data and Empirical Results

Our empirical analysis engages annual data of the Greek economy, taken from the IFS (IMF) database and the period covered runs from 1960 to 2007. The key variables used for the investigation of the budget deficit sustainability first are the log of the nominal government spending (LEX) and the log of the nominal government revenues (LRE). For the case of the trade deficit sustainability, the analysis involves the log of the Greek exports (LXP) and, the log of the Greek imports (LIM) accordingly. Finally, for the investigation of the twin deficits hypothesis, the budget deficit (LBB) and the trade deficit (LTB) are used in logarithmic form.

4.1 Integration Analysis

We apply the traditional cointegration methodology proposed by Johansen (1988 and 1989), which requires stationary variables of integration order of one, I(1). Accordingly, in the first step we apply Dickey and Fuller's (1979), unit root tests. The results of the unit root test on the levels and the first differences of the variables are presented in tables 2 and 3. The results reveal that the selected variables are integrated of order I(1), therefore we proceed with the investigation of a possible long-run equilibrium between the examined variables, by means of the maximum likelihood methodology proposed by Johansen (1988) and Johansen & Juselious (1990, 1992).

4.2 Trade deficit analysis

Initially, we proceed by testing for cointegration between exports and imports (LIM, LXP). In order to apply the Johansen's cointegration methodology, we must first determine the order of the VAR to be estimated, through the use of the Schwarz Bayesian criterion. The results indicate that a VAR(3) is the most appropriate.

Table 4 presents the results of the cointegration test, which are based on criteria of the trace and maximal eigenvalue of the Stochastic Matrix. The results confirm the hypothesis of cointegration between LIM and LXP, at the 5% significance level. The cointegrating vector is presented in Table 5.

Based on the cointegrating vector, the long-run relationship between LIM and LXP can be written as follows:

$$LXP = 0.91970\ LIM \qquad (10)$$

In the next step, we continue with the estimation of the error correction models for the involved variables (Tables 6 and 8).

From Table 6, with exports as the dependent variable, we observe that the coefficient of the lagged EC term is statistically significant and has the correct negative sign, suggesting that any deviation from the long-term path is corrected each year by 43 %. Thus, we confirm the existence of a long-run causal effect running from imports towards exports. When imports is the dependent variable, from the respective error correction model reported in Table 8, we observe that the coefficient of the lagged EC term is also statistically significant at the 1% level, and has the correct negative sign, suggesting that any deviation from the long-term path is corrected by 25 % each year. Therefore, a long-run causal effect from exports to imports is verified as well. Conclusively, our results suggest the existence of a bidirectional long-run causal relationship between imports and exports.

Regarding the short-run period, after applying Granger causality tests, by means of the Wald x2 statistic (Tables 7 and 9), we do not find evidence of any statistically significant causal effect, either from imports to exports, or vice versa.

Finally, we proceed with testing trade deficit for sustainability, based on Quintos (1995), analysis. Table 10 presents the likelihood ratio statistic test applied on the β coefficient of the long-run equilibrium relationship. The null hypothesis is rejected and thus we conclude that the Greek trade deficit exhibits weak sustainability over the examined sample period.

4.3 Budget deficit analysis

Similar to the above analysis, we next proceed by investigating the relationship between Greek government revenues and spending, as well as the concept of Greek fiscal policy sustainability.

Once again, with the use of the Schwarz Bayesian criterion, a VAR(3) model is selected. The results from the cointegration test are presented in Table 11 and confirm the hypothesis of cointegration between LRE and LEX, at the 5% significance level.

The cointegrating vector is presented in Table 12. Accordingly, the long-run relationship between LRE and LEX is written as below:

$$LRE = 0.62506 + 0.90906\ LEX \quad (11)$$

Tables 13 and 15 describe the estimation of the respective error correction models for the two considered variables.

Table 13 indicates that the coefficient of the lagged EC term is statistically significant and has the correct negative sign, suggesting that any deviation from the long-term path is corrected each year by 20 %. We accept the existence of a long-run causal effect from government spending to revenues. In Table 15, the coefficient of the lagged EC term is found statistically significant at the 2.5% level having the correct negative sign, thus suggesting that any deviation from the long-term path is corrected each year by 18 %. Therefore, the existence of a long-run causal effect, directed from government revenues to spending, is also confirmed. Conclusively, we have confirmed a bi-directional long-run causal relationship between Greek government revenues and spending.

Regarding the short-run period, after applying Granger causality tests (Tables 14 and 16), we find statistically significant short-run causal effects running from revenues to spending at the 2% significance level, but not from spending to revenues.

Finally, Table 17 presents the test for sustainability, based on Quintos (1995) analysis, for the β coefficient in the cointegration equation of the budget deficit. The likelihood ratio, at the 1% level of significance, indicates that the null hypothesis is rejected and so we conclude that the Greek budget deficit could be also considered as weakly sustainable over the sample period.

4.4 The twin deficits hypothesis

In this final section, we investigate the twin deficits hypothesis for Greece, by testing for cointegration between the trade and budget deficit. Having identified the two variables to be integrated of order I(1), we test for cointegration, using a VAR(2), chosen by means of the Schwarz Bayesian Criterion. Table 18 presents the results of the cointegration tests that indicate the possible existence of a long-run equilibrium relationship between the variables LBB and LTB.

From the cointegrating vector, presented in Table 19, the long-run relationship among the Greek twin deficits is as follows:

$$LTB = 0.46749\ LBB \quad (12)$$

The results obtained from the error correction model for DLTB (Table 20) show that the lagged EC term in this equation is statistically significant and has the correct negative sign suggesting that, any deviation from the long-run equilibrium path is corrected each year by 78 %. Therefore, a long-run causal effect running from budget deficit to trade deficit is confirmed. Regarding the short-run dynamics, there is also evidence of a causal effect running from budget deficit to trade deficit, as the coefficient of the lagged budget deficit is found statistically significant at the 2%.

On the other hand, no evidence of a long-run or short-run causality is detected running from trade deficit towards budget deficit. From the respective error correction model, the lagged EC term is not negative and statistically insignificant (Table 21), suggesting that a long-run causal effect running from trade deficit to budget deficit does not exist. Furthermore, as the coefficient of the trade deficit in the error correction model is not statistically significant, no evidence of a short-run causal effect is concluded as running from trade deficit to budget deficit.

In general, the twin deficits hypothesis is confirmed for the Greek case, with causality running from the budget deficit to the trade deficit, within both the long and short-run time horizons. Thus, our findings are consistent with the rationale of the Keynesian proposition and support the view that policy measures which are able to reduce the budget deficit may also contribute to the reduction of the trade deficit.

5. Summary and Conclusions

Summarizing our work, we restate that using annual data over the selected 1960-2007 period for the Greek Economy, our analysis attempts to investigate both the budget and trade deficit for sustainability. In fact, we attempt to provide evidence regarding the well known 'twin deficits hypothesis', using time series techniques. We intentionally pursue our empirical research leaving outside the serious recession years of 2008-2009 for certain reasons, namely; we leave: (a) the economic storm to calm down and clear evidence to appear, (b) robust and unbiased new economic data to emerge, (c) dramatic governmental and economic decisions upon structural reforms to be made, and, (d) as long as the economy returns back to its E.U. Stability and Growth Pact responsibilities, we need to reassess the new and risky challenges that lie ahead with respect to the twin deficits sustainability in the future.

Thus, our findings provide substantial statistical evidence that over the examined time span and before the current explosion of the global economic recession, the Greek Economy shows clearly that both budget and trade deficit sustainability holds, *though in the 'weak' form following Quintos terminology.*

The 'twin-deficits-hypothesis' is confirmed for the Greek case, *for the specific time span considered*, thus providing evidence consistent with the rationale of the Keynesian proposition, while suggesting that policy measures that are able to reduce the budget deficit should be seriously considered by economic policy authorities in order to reduce the trade deficit.

Furthermore, a serious economic challenge for the Greek economy seems to be the aging related heavy public expenditure that threatens the long-run sustainability of the social security financing. Moreover, increasing labor productivity, maintaining wages at competitive levels and, promoting disciplined fiscal policies could restrain current account deficits. Finally, a sustainable downward path of debt-to-GDP ratio can be obtained by substantial state expenditure cuts and serious reduction of primary spending, along with sustainable social security and state tax systems' reforms and restructuring.

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Appendix

Table 1: Empirical Results for the Greek economy of the period 1960-2007

Relationship	**Cointegration?**	**Long-run Relationship**	**Short-run Relationship**	**Sustainability?**
Imports-Exports	Yes	Yes, bi-directional	No, in both directions	Yes, weak
Government Revenues-Expenses	Yes	Yes, bi-directional	Yes, from revenues to spending No, from spending to revenues	Yes, weak
Budget Deficit-Trade Deficit	Yes	Yes, from the budget deficit to the trade deficit No, from the trade deficit towards the budget deficit.	Yes, from the budget deficit to the trade deficit No, from the trade deficit towards the budget deficit	n.a.

Table 2: Unit root tests on the levels of the variables

Variables	Include an intercept but not a trend, critical value 5% = -2,9287	Include an intercept and a linear trend, critical value 5% = -3,5136
	ADF Statistic	ADF Statistic
LIM	-1,2631 (1)	-0,68012 (1)
LXP	-1,4684 (1)	-0,62639 (1)
LTB	-0,50755(0)	-2,63090 (0)
LRE	-1,6998 (1)	0,16062 (1)
LEX	-1,7933 (1)	0,31994 (1)
LBB	-1,5756 (*)	-0,47233 (0)

Table 3: Unit root tests on the first differences of the variables

Variables	Include an intercept but not a trend, critical value 5% = -2,9287	Include an intercept and a linear trend, critical value 5% = -3,5136
	ADF Statistic	ADF Statistic
DLIM	-4.4685 (0)	-4.6269 (0)
DLXP	-4.5305 (0)	-5.2867 (1)
DLTB	-7.6839 (0)	-7.5868 (0)
DLRE	-3.8586 (0)	-4.2047 (0)
DLEX	-4.1192 (0)	-4.5237 (0)
DLBB	-6.4568 (0)	-6.6790 (0)

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Table 4: Cointegration with no intercepts or trends in the VAR

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            Cointegration with no intercepts or trends in the VAR
   Cointegration LR Test Based on Maximal Eigenvalue of the Stochastic Matrix
*****************************************************************************
 45 observations from 1963 to 2007. Order of VAR = 3, chosen r =1.
 List of variables included in the cointegrating vector:
 LXP             LIM
 List of I(0) variables included in the VAR:
 OIL
 List of eigenvalues in descending order:
.37357    .010342
*****************************************************************************
 Null    Alternative    Statistic     95% Critical Value     90%Critical Value
 r = 0      r = 1        21.0472           11.0300                 9.2800
 r<= 1      r = 2         .46779            4.1600                 3.0400
*****************************************************************************
 Use the above table to determine r (the number of cointegratingvectors).



            Cointegration with no intercepts or trends in the VAR
         Cointegration LR Test Based on Trace of the Stochastic Matrix
*****************************************************************************
 45 observations from 1963 to 2007. Order of VAR = 3, chosen r =1.
 List of variables included in the cointegrating vector:
 LXP             LIM
 List of I(0) variables included in the VAR:
 OIL
 List of eigenvalues in descending order:
.37357    .010342
*****************************************************************************
 Null    Alternative    Statistic     95% Critical Value     90%Critical Value
 r = 0      r>= 1        21.5150           12.3600                10.2500
 r<= 1      r = 2         .46779            4.1600                 3.0400
*****************************************************************************
 Use the above table to determine r (the number of cointegratingvectors).
```

Table 5: Estimated Cointegrated Vectors in Johansen Estimation

```
Estimated Cointegrated Vectors in Johansen Estimation (Normalized in Brackets)
            Cointegration with no intercepts or trends in the VAR
*****************************************************************************
 45 observations from 1963 to 2007. Order of VAR = 3, chosen r =1.
 List of variables included in the cointegrating vector:
 LXP             LIM
 List of I(0) variables included in the VAR:
 OIL
*****************************************************************************
                  Vector  1
 LXP                  1.1804
                  (  -1.0000)

 LIM                 -1.0856
                  (   .91970)

*****************************************************************************
```

Table 6: ECM for variable LXP estimated by OLS based on cointegrating VAR(3)

```
      ECM for variable LXP estimated by OLS based on cointegrating VAR(3)
*******************************************************************************
 Dependent variable is dLXP
 45 observations used for estimation from 1963 to 2007
*******************************************************************************
 Regressor              Coefficient       Standard Error         T-Ratio[Prob]
 dLXP1                      .27234             .17698             1.5388[.132]
 dLIM1                      .11136             .21826              .51020[.613]
 dLXP2                    -.085242             .16814            -.50697[.615]
 dLIM2                     -.25108             .20887            -1.2021[.237]
 ecm1(-1)                  -.43271            .090505            -4.7810[.000]
 OIL                        .35488            .067587             5.2508[.000]
*******************************************************************************
 List of additional temporary variables created:
 dLXP = LXP-LXP(-1)
 dLXP1 = LXP(-1)-LXP(-2)
 dLIM1 = LIM(-1)-LIM(-2)
 dLXP2 = LXP(-2)-LXP(-3)
 dLIM2 = LIM(-2)-LIM(-3)
 ecm1 =    1.1804*LXP   -1.0856*LIM
*******************************************************************************
 R-Squared                      .44739   R-Bar-Squared                    .37654
 S.E. of Regression            .090505   F-stat.    F(  5,  39)    6.3149[.000]
 Mean of Dependent Variable     .16202   S.D. of Dependent Variable      .11462
 Residual Sum of Squares        .31946   Equation Log-likelihood        47.4732
 Akaike Info. Criterion        41.4732   Schwarz Bayesian Criterion     36.0532
 DW-statistic                   1.7716   System Log-likelihood         106.6639
*******************************************************************************

                              Diagnostic Tests
*******************************************************************************
*    Test Statistics  *        LM Version        *         F Version          *
*******************************************************************************
*                     *                          *                            *
* A:Serial Correlation*CHSQ(   1)=   1.7452[.186]*F(   1,  38)=   1.5332[.223]*
*                     *                          *                            *
* B:Functional Form   *CHSQ(   1)=   .37537[.540]*F(   1,  38)=   .31964[.575]*
*                     *                          *                            *
* C:Normality         *CHSQ(   2)=   1.9199[.383]*       Not applicable       *
*                     *                          *                            *
* D:Heteroscedasticity*CHSQ(   1)=   .42645[.514]*F(   1,  43)=   .41139[.525]*
*******************************************************************************
   A:Lagrange multiplier test of residual serial correlation
   B:Ramsey's RESET test using the square of the fitted values
   C:Based on a test of skewness and kurtosis of residuals
   D:Based on the regression of squared residuals on squared fitted values
```

Table 7: Wald test of restriction(s) imposed on parameters

```
  Wald test of restriction(s) imposed on parameters
*******************************************************************************
 Based on CVAR regression of dLXP on:
 dLXP1          dLIM1          dLXP2          dLIM2          ecm1(-1)
 OIL
 45 observations used for estimation from 1963 to 2007
*******************************************************************************
 Coefficients A1 to A6 are assigned to the above regressors respectively.
 List of restriction(s) for the Wald test:
                      a2=0; a4=0;
*******************************************************************************
 Wald Statistic                CHSQ( 2)=   1.7542[.416]
```

Table 8: ECM for variable LIM estimated by OLS based on cointegrating VAR(3)

```
      ECM for variable LIM estimated by OLS based on cointegrating VAR(3)
********************************************************************************
 Dependent variable is dLIM
 45 observations used for estimation from 1963 to 2007
********************************************************************************
 Regressor             Coefficient       Standard Error         T-Ratio[Prob]
 dLXP1                     .15934             .18330             .86927[.390]
 dLIM1                     .12596             .22605             .55723[.581]
 dLXP2                     .22992             .17414            1.3203[.194]
 dLIM2                    -.29960             .21633           -1.3850[.174]
 ecm1(-1)                 -.25526            .093735           -2.7232[.010]
 OIL                       .24257            .069999            3.4653[.001]
********************************************************************************
 List of additional temporary variables created:
 dLIM = LIM-LIM(-1)
 dLXP1 = LXP(-1)-LXP(-2)
 dLIM1 = LIM(-1)-LIM(-2)
 dLXP2 = LXP(-2)-LXP(-3)
 dLIM2 = LIM(-2)-LIM(-3)
 ecm1 =    1.1804*LXP   -1.0856*LIM
********************************************************************************
 R-Squared                      .16617   R-Bar-Squared                   .059268
 S.E. of Regression            .093735   F-stat.    F(  5,  39)    1.5544[.196]
 Mean of Dependent Variable     .15798   S.D. of Dependent Variable      .096642
 Residual Sum of Squares        .34266   Equation Log-likelihood         45.8954
 Akaike Info. Criterion        39.8954   Schwarz Bayesian Criterion      34.4754
 DW-statistic                   1.8393   System Log-likelihood          106.6639
********************************************************************************

                              Diagnostic Tests
********************************************************************************
*    Test Statistics  *        LM Version        *          F Version           *
********************************************************************************
*                     *                          *                              *
* A:Serial Correlation*CHSQ(   1)=   1.6751[.196]*F(   1,  38)=   1.4692[.233]*
*                     *                          *                              *
* B:Functional Form   *CHSQ(   1)=   2.6972[.101]*F(   1,  38)=   2.4229[.128]*
*                     *                          *                              *
* C:Normality         *CHSQ(   2)=   5.6521[.059]*       Not applicable         *
*                     *                          *                              *
* D:Heteroscedasticity*CHSQ(   1)=   3.7031[.054]*F(   1,  43)=   3.8559[.056]*
********************************************************************************
   A:Lagrange multiplier test of residual serial correlation
   B:Ramsey's RESET test using the square of the fitted values
   C:Based on a test of skewness and kurtosis of residuals
   D:Based on the regression of squared residuals on squared fitted values
```

Table 9: Wald test of restriction(s) imposed on parameters

```
Wald test of restriction(s) imposed on parameters
********************************************************************************
 Based on CVAR regression of dLIM on:
 dLXP1          dLIM1          dLXP2          dLIM2          ecm1(-1)
 OIL
 45 observations used for estimation from 1963 to 2007
********************************************************************************
 Coefficients A1 to A6 are assigned to the above regressors respectively.
 List of restriction(s) for the Wald test:
                        a1=0; a3=0;
********************************************************************************
 Wald Statistic               CHSQ( 2)=   2.5845[.275]
********************************************************************************
```

Table 10: Restricted Cointegrated Vectors in Johansen Estimation

```
Restricted Cointegrated Vectors in Johansen Estimation(Normalized in Brackets)
             Cointegration with no intercepts or trends in the VAR
*******************************************************************************
 45 observations from 1963 to 2007. Order of VAR = 3, chosen r =1.
 List of variables included in the cointegrating vector:
 LXP             LIM
 List of I(0) variables included in the VAR:
 OIL
*******************************************************************************
 List of imposed restriction(s) on cointegrating vectors:
 -1 1
*******************************************************************************
                  Vector  1
 LXP                 -1.0000
                    (  -1.0000)

 LIM                  1.0000
                    (   1.0000)

*******************************************************************************
 LR Test of Restrictions          CHSQ( 1)=  14.4165[.000]
*******************************************************************************
```

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Table 11: Cointegration with restricted intercepts and no trends in the VAR

```
Cointegration with restricted intercepts and no trends in the VAR
   Cointegration LR Test Based on Maximal Eigenvalue of the Stochastic Matrix
*****************************************************************************
 45 observations from 1963 to 2007. Order of VAR = 3.
 List of variables included in the cointegrating vector:
 LRE             LEX             Intercept
 List of I(0) variables included in the VAR:
 OIL
 List of eigenvalues in descending order:
.33037     .13167      .0000
*****************************************************************************
 Null    Alternative    Statistic     95% Critical Value     90%Critical Value
 r = 0      r = 1         18.0461           15.8700                13.8100
 r<= 1      r = 2          6.3532            9.1600                 7.5300
*****************************************************************************
 Use the above table to determine r (the number of cointegratingvectors).


       Cointegration with restricted intercepts and no trends in the VAR
          Cointegration LR Test Based on Trace of the Stochastic Matrix
*****************************************************************************
 45 observations from 1963 to 2007. Order of VAR = 3.
 List of variables included in the cointegrating vector:
 LRE             LEX             Intercept
 List of I(0) variables included in the VAR:
 OIL
 List of eigenvalues in descending order:
.33037     .13167      .0000
*****************************************************************************
 Null    Alternative    Statistic     95% Critical Value     90%Critical Value
 r = 0      r>= 1         24.3993           20.1800                17.8800
 r<= 1      r = 2          6.3532            9.1600                 7.5300
*****************************************************************************
 Use the above table to determine r (the number of cointegratingvectors).
```

Table 12: Estimated Cointegrated Vectors in Johansen Estimation

```
Estimated Cointegrated Vectors in Johansen Estimation (Normalized in Brackets)
       Cointegration with restricted intercepts and no trends in the VAR
*****************************************************************************
 45 observations from 1963 to 2007. Order of VAR = 3, chosen r =1.
 List of variables included in the cointegrating vector:
 LRE             LEX             Intercept
 List of I(0) variables included in the VAR:
 OIL
*****************************************************************************
                  Vector  1
 LRE                  1.8533
                   (  -1.0000)

 LEX                 -1.6847
                   (   .90906)

 Intercept           -1.1584
                   (   .62506)

*****************************************************************************
```

Table 13: ECM for variable LRE estimated by OLS based on cointegrating VAR(3)

```
      ECM for variable LRE estimated by OLS based on cointegrating VAR(3)
*******************************************************************************
 Dependent variable is dLRE
 45 observations used for estimation from 1963 to 2007
*******************************************************************************
 Regressor              Coefficient       Standard Error         T-Ratio[Prob]
 dLRE1                    .0059447            .14195             .041880[.967]
 dLEX1                     .062860            .14468              .43449[.666]
 dLRE2                      .16410            .11703              1.4023[.169]
 dLEX2                     -.15652            .12893             -1.2140[.232]
 ecm1(-1)                  -.20738           .049606             -4.1805[.000]
 OIL                        .11578           .028648              4.0416[.000]
*******************************************************************************
 List of additional temporary variables created:
 dLRE = LRE-LRE(-1)
 dLRE1 = LRE(-1)-LRE(-2)
 dLEX1 = LEX(-1)-LEX(-2)
 dLRE2 = LRE(-2)-LRE(-3)
 dLEX2 = LEX(-2)-LEX(-3)
 ecm1 =    1.8533*LRE   -1.6847*LEX   -1.1584
*******************************************************************************
 R-Squared                      .64552   R-Bar-Squared                  .60008
 S.E. of Regression            .049606   F-stat.    F(  5,  39)   14.2041[.000]
 Mean of Dependent Variable     .15305   S.D. of Dependent Variable     .078442
 Residual Sum of Squares       .095971   Equation Log-likelihood        74.5311
 Akaike Info. Criterion        68.5311   Schwarz Bayesian Criterion     63.1111
 DW-statistic                   1.8336   System Log-likelihood         129.9504
*******************************************************************************


                              Diagnostic Tests
*******************************************************************************
*    Test Statistics  *        LM Version        *          F Version          *
*******************************************************************************
*                     *                          *                             *
* A:Serial Correlation*CHSQ(   1)= .3099E-4[.996]*F(   1,  38)= .2617E-4[.996]*
*                     *                          *                             *
* B:Functional Form   *CHSQ(   1)=   1.4386[.230]*F(   1,  38)=   1.2549[.270]*
*                     *                          *                             *
* C:Normality         *CHSQ(   2)=   1.1419[.565]*       Not applicable        *
*                     *                          *                             *
* D:Heteroscedasticity*CHSQ(   1)=   2.5637[.109]*F(   1,  43)=   2.5978[.114]*
```

Table 14: Wald test of restriction(s) imposed on parameters

```
              Wald test of restriction(s) imposed on parameters
*******************************************************************************
 Based on CVAR regression of dLRE on:
 dLRE1          dLEX1          dLRE2          dLEX2          ecm1(-1)
 OIL
 45 observations used for estimation from 1963 to 2007
*******************************************************************************
 Coefficients A1 to A6 are assigned to the above regressors respectively.
 List of restriction(s) for the Wald test:
 a2=0; a4=0;
*******************************************************************************
 Wald Statistic                CHSQ( 2)=   2.2357[.327]
*******************************************************************************
```

Table 15: ECM for variable LEX estimated by OLS based on cointegrating VAR(3)

```
ECM for variable LEX estimated by OLS based on cointegrating VAR(3)
*******************************************************************************
 Dependent variable is dLEX
 45 observations used for estimation from 1963 to 2007
*******************************************************************************
 Regressor              Coefficient       Standard Error         T-Ratio[Prob]
 dLRE1                    -.017140            .22418           -.076456[.939]
 dLEX1                    -.073115            .22849            -.31999[.751]
 dLRE2                     .50986             .18482             2.7586[.009]
 dLEX2                    -.21677             .20363            -1.0645[.294]
 ecm1(-1)                 -.18265            .078345            -2.3314[.025]
 OIL                       .10097            .045245             2.2317[.031]
*******************************************************************************
 List of additional temporary variables created:
 dLEX = LEX-LEX(-1)
 dLRE1 = LRE(-1)-LRE(-2)
 dLEX1 = LEX(-1)-LEX(-2)
 dLRE2 = LRE(-2)-LRE(-3)
 dLEX2 = LEX(-2)-LEX(-3)
 ecm1 =    1.8533*LRE   -1.6847*LEX   -1.1584
*******************************************************************************
 R-Squared                      .40219   R-Bar-Squared                   .32555
 S.E. of Regression            .078345   F-stat.    F(  5,  39)    5.2477[.001]
 Mean of Dependent Variable     .15475   S.D. of Dependent Variable     .095397
 Residual Sum of Squares        .23938   Equation Log-likelihood         53.9661
 Akaike Info. Criterion        47.9661   Schwarz Bayesian Criterion      42.5461
 DW-statistic                   2.1411   System Log-likelihood          129.9504
*******************************************************************************


                              Diagnostic Tests
*******************************************************************************
*    Test Statistics  *        LM Version        *         F Version          *
*******************************************************************************
*                     *                          *                            *
* A:Serial Correlation*CHSQ(   1)=   2.3550[.125]*F(   1,  38)=   2.0985[.156]*
*                     *                          *                            *
* B:Functional Form   *CHSQ(   1)=   .13656[.712]*F(   1,  38)=   .11567[.736]*
*                     *                          *                            *
* C:Normality         *CHSQ(   2)=   .94326[.624]*       Not applicable       *
*                     *                          *                            *
* D:Heteroscedasticity*CHSQ(   1)=   1.2431[.265]*F(   1,  43)=   1.2216[.275]*
```

Table 16: Wald test of restriction(s) imposed on parameters

```
   Wald test of restriction(s) imposed on parameters
*******************************************************************************
 Based on CVAR regression of dLEX on:
 dLRE1          dLEX1          dLRE2          dLEX2          ecm1(-1)
 OIL
 45 observations used for estimation from 1963 to 2007
*******************************************************************************
 Coefficients A1 to A6 are assigned to the above regressors respectively.
 List of restriction(s) for the Wald test:
 a1=0; a3=0;
*******************************************************************************
 Wald Statistic                CHSQ( 2)=   7.6871[.021]
*******************************************************************************
```

Table 17: Restricted Cointegrated Vectors in Johansen Estimation

```
Restricted Cointegrated Vectors in Johansen Estimation(Normalized in Brackets)
       Cointegration with restricted intercepts and no trends in the VAR
*******************************************************************************
 45 observations from 1963 to 2007. Order of VAR = 3, chosen r =1.
 List of variables included in the cointegrating vector:
 LRE             LEX             Intercept
 List of I(0) variables included in the VAR:
 OIL
*******************************************************************************
 List of imposed restriction(s) on cointegrating vectors:
   -1 1 0.62506
*******************************************************************************
                  Vector  1
 LRE                 -1.0000
                  (  -1.0000)

 LEX                  1.0000
                  (   1.0000)

 Intercept            .62506
                  (   .62506)

*******************************************************************************
 LR Test of Restrictions          CHSQ( 2)=  15.0063[.001]
*******************************************************************************
```

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Table 18: Cointegration with unrestricted intercepts and no trends in the VAR

```
Cointegration with unrestricted intercepts and no trends in the VAR
   Cointegration LR Test Based on Maximal Eigenvalue of the Stochastic Matrix
*****************************************************************************
 46 observations from 1962 to 2007. Order of VAR = 2, chosen r =1.
 List of variables included in the cointegrating vector:
 LTB             LBB
 List of I(0) variables included in the VAR:
 DUM2            DUM5
 List of eigenvalues in descending order:
.30809    .022973
*****************************************************************************
 Null    Alternative    Statistic     95% Critical Value     90%Critical Value
 r = 0      r = 1        16.9418           14.8800                12.9800
 r<= 1      r = 2         1.0691            8.0700                 6.5000
*****************************************************************************
 Use the above table to determine r (the number of cointegratingvectors).



      Cointegration with unrestricted intercepts and no trends in the VAR
          Cointegration LR Test Based on Trace of the Stochastic Matrix
*****************************************************************************
 46 observations from 1962 to 2007. Order of VAR = 2, chosen r =1.
 List of variables included in the cointegrating vector:
 LTB             LBB
 List of I(0) variables included in the VAR:
 DUM2            DUM5
 List of eigenvalues in descending order:
.30809    .022973
*****************************************************************************
 Null    Alternative    Statistic     95% Critical Value     90%Critical Value
 r = 0      r>= 1        18.0109           17.8600                15.7500
 r<= 1      r = 2         1.0691            8.0700                 6.5000
*****************************************************************************
 Use the above table to determine r (the number of cointegratingvectors).
```

Table 19: Estimated Cointegrated Vectors in Johansen Estimation

```
Estimated Cointegrated Vectors in Johansen Estimation (Normalized in Brackets)
      Cointegration with unrestricted intercepts and no trends in the VAR
*****************************************************************************
 46 observations from 1962 to 2007. Order of VAR = 2, chosen r =1.
 List of variables included in the cointegrating vector:
 LTB             LBB
 List of I(0) variables included in the VAR:
 DUM2            DUM5
*****************************************************************************
                  Vector  1
 LTB                  .64553
                  (  -1.0000)

 LBB                 -.30178
                  (   .46749)

*****************************************************************************
```

Table 20: ECM for variable LTB estimated by OLS based on cointegrating VAR(2)

```
      ECM for variable LTB estimated by OLS based on cointegrating VAR(2)
********************************************************************************
 Dependent variable is dLTB
 46 observations used for estimation from 1962 to 2007
********************************************************************************
 Regressor              Coefficient       Standard Error         T-Ratio[Prob]
 Intercept                1.5024             .38073              3.9460[.000]
 dLTB1                    .12292             .12990              .94624[.350]
 dLBB1                    .29606             .12151              2.4365[.019]
 ecm1(-1)                -.78024             .20538             -3.7990[.000]
 DUM2                    -.42278             .21697             -1.9485[.058]
 DUM5                    .053802            .013769              3.9076[.000]
********************************************************************************
 List of additional temporary variables created:
 dLTB = LTB-LTB(-1)
 dLTB1 = LTB(-1)-LTB(-2)
 dLBB1 = LBB(-1)-LBB(-2)
 ecm1 =    .64553*LTB   -.30178*LBB
********************************************************************************
 R-Squared                      .46471   R-Bar-Squared                    .39780
 S.E. of Regression             .20538   F-stat.    F(  5,  40)    6.9452[.000]
 Mean of Dependent Variable     .14952   S.D. of Dependent Variable      .26466
 Residual Sum of Squares       1.6872    Equation Log-likelihood        10.7570
 Akaike Info. Criterion        4.7570    Schwarz Bayesian Criterion     -.72891
 DW-statistic                  2.0722    System Log-likelihood           9.3303
********************************************************************************


                              Diagnostic Tests
********************************************************************************
*    Test Statistics  *        LM Version        *         F Version           *
********************************************************************************
*                     *                          *                             *
* A:Serial Correlation*CHSQ(   1)=   .83253[.362]*F(   1,  39)=   .71885[.402]*
*                     *                          *                             *
* B:Functional Form   *CHSQ(   1)=   3.7773[.052]*F(   1,  39)=   3.4890[.069]*
*                     *                          *                             *
* C:Normality         *CHSQ(   2)=   3.0406[.219]*       Not applicable        *
*                     *                          *                             *
* D:Heteroscedasticity*CHSQ(   1)=   2.9118[.088]*F(   1,  44)=   2.9735[.092]*
********************************************************************************
   A:Lagrange multiplier test of residual serial correlation
   B:Ramsey's RESET test using the square of the fitted values
   C:Based on a test of skewness and kurtosis of residuals
   D:Based on the regression of squared residuals on squared fitted values
```

Table 21: ECM for variable LBB estimated by OLS based on cointegrating VAR(2)

```
      ECM for variable LBB estimated by OLS based on cointegrating VAR(2)
*******************************************************************************
 Dependent variable is dLBB
 46 observations used for estimation from 1962 to 2007
*******************************************************************************
 Regressor              Coefficient       Standard Error         T-Ratio[Prob]
 Intercept                 -.49704             .49787            -.99833[.324]
 dLTB1                     .025882             .16987             .15236[.880]
 dLBB1                    -.083118             .15890            -.52309[.604]
 ecm1(-1)                  .40806              .26857             1.5194[.137]
 DUM2                      .67439              .28373             2.3769[.022]
 DUM5                     -.037120            .018005            -2.0617[.046]
*******************************************************************************
 List of additional temporary variables created:
 dLBB = LBB-LBB(-1)
 dLTB1 = LTB(-1)-LTB(-2)
 dLBB1 = LBB(-1)-LBB(-2)
 ecm1 =    .64553*LTB   -.30178*LBB
*******************************************************************************
 R-Squared                      .26107   R-Bar-Squared                    .16871
 S.E. of Regression             .26857   F-stat.    F(  5,  40)    2.8265[.028]
 Mean of Dependent Variable     .16603   S.D. of Dependent Variable      .29456
 Residual Sum of Squares       2.8852    Equation Log-likelihood        -1.5828
 Akaike Info. Criterion       -7.5828    Schwarz Bayesian Criterion    -13.0687
 DW-statistic                  1.8853    System Log-likelihood           9.3303
*******************************************************************************


                              Diagnostic Tests
*******************************************************************************
*    Test Statistics  *        LM Version        *         F Version          *
*******************************************************************************
*                     *                          *                            *
* A:Serial Correlation*CHSQ(   1)=   .83622[.360]*F(   1,  39)=   .72209[.401]*
*                     *                          *                            *
* B:Functional Form   *CHSQ(   1)=   .64648[.421]*F(   1,  39)=   .55591[.460]*
*                     *                          *                            *
* C:Normality         *CHSQ(   2)=  17.0153[.000]*       Not applicable       *
*                     *                          *                            *
* D:Heteroscedasticity*CHSQ(   1)= .0032720[.954]*F(   1,  44)= .0031299[.956]*
*******************************************************************************
   A:Lagrange multiplier test of residual serial correlation
   B:Ramsey's RESET test using the square of the fitted values
   C:Based on a test of skewness and kurtosis of residuals
   D:Based on the regression of squared residuals on squared fitted values
```

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Multiculturalism versus Assimilation: Attitudes towards Immigrants in Western Countries

Borooah K. Vani[1], Mangan John[2]

Abstract

A long standing area of debate in Western countries is that of the appropriate philosophy for facilitating large scale immigration; should immigrants preserve their traditions and culture while living in the host country (integration/multiculturalism) or should they assimilate themselves into the ways and manners of their hosts? The ways that nations go about resolving this issue goes to the heart of internal policy formulation on immigration but is also influential to the image that the country projects overseas. Countries are often labeled according to the official views of their Governments. For example, France might be classed as essentially assimilationist and Britain as multi-cultural, whereas the Netherlands and Germany might be seen as somewhere between the two, but how did these policy differences come about and do they accurately reflect the views of the majority of residents of the various countries? This paper addresses part of this issue by seeking to identify and analyse the characteristics of those people in Western countries who think that immigrants should assimilate culturally and how they differ from those who think that immigrants should preserve a separate cultural existence? By doing so, it seeks to explain why these inter-country differences in views exist and whether they are caused primarily by attribute effects (the composition of the population) or by coefficient effects (the strength of the views they hold). This study exploits a unique set of data provided by The Human Beliefs and Values Survey to identify and to estimate the strength of those factors which lead people to favour cultural integration over multiculturalism for immigrants. In doing so, it provides Governments with a snapshot of contemporary views on this increasingly important issue and how these views may shift as demographic characteristics alter.

Keywords: Immigrants, Multiculturalism, Assimilation, Western Countries, Logit, Decomposition.

JEL classification: J61, F22

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1. Introduction

Tolerance of inter-personal behavioural differences is the *leitmotif* of Western society: many Western countries are major aid donors, most are high net recipients of immigrants, and all are signatories to a number of United Nations charters which repudiate discrimination and persecution and guarantee human rights. Yet, despite this reputation for liberalism, there can be little doubt that, in the past decade or so within Western countries, there is an increasing awareness of, and a hardening of attitudes towards people who are 'different' and, in particular, towards immigrants. The rise to electoral prominence in several of these countries of right-wing parties, with explicitly anti-foreigner agendas, is testimony to this. Arguments about the wearing of the Muslim veil in Britain, and the headscarf in France are part of a wider debate taking place across Europe – embracing *inter alia* the Netherlands, Belgium, Austria, Germany, Denmark, Italy, and Switzerland - about the erosion of national identity through the steady drip of special demands predicated on tolerance for cultural diversity[1].

A central pillar of the debate in Western countries about immigrants concerns the relative merits of multiculturalism versus assimilation: should immigrants preserve their traditions and culture while living in the host country or should they absorb themselves into the ways and manners of their hosts[2]? Of course, in practice, the distinction between the two need not be as stark. Within the two polar cases of multiculturalism and assimilation there are various degrees of integration and coexistence[3]. Integration provides for the coexistence of minority cultures with the majority culture. Assimilation requires the absorption of minority cultures into the majority culture. In simplistic terms the aim of assimilation is a monocultural, perhaps even a monofaith, society; the aim of integration is a multicultural, pluralist society[4]. Historically, there was a belief that that all immigrants would become assimilated in some way; either strict assimilation in which immigrants adopted the majority culture or in a US-style melting pot situation whereby minority and majority cultures merged to form a new entity, still predominantly majority culture but with a significant cultural input from the more recent arrivals. The proviso here was that all were expected to share a strong national identity as Americans[5]. This later situation may be described as partial assimilation with the preconditions being the new arrivals adopted the language, observed the law and contributed economically to the host country, while at the same time being free to observe customs and traditions, where these were deemed compatible with the established mainstream values of the host country. In practice, this is the type of system that

[1] See, Jacques (2006) for a discussion of growing intolerance in Western countries towards some segments of their own society and the rest of the world and Prins and Salisbury (2008) who claim multiculturalism in Britain is weakening national resolve and harming national defense efforts.

[2] The British Secretary of State for Communities, Ruth Kelly, spoke in November 2006, about the need for 'honest debate about integration and cohesion in the UK' and was closely followed by the British Prime Minister, Tony Blair, who declared that liberal values had to be defended from a 'new and virulent ideology associated with a minority of our Muslim minority'.

[3] See, Entzinger, H. And Biezeveld, R. (2003) for a comparative discussion of integration by immigrants into some European Countries.

[4] See a discussion on this issue in *The Guardian* (2006).

[5] For a discussion of this view see Hall (1999).

emerged in a number of European countries. The basic problem with this system is that assimilation of any dimension is the result of the interaction of two factors that may not coincide or be mutually inclusive, structural assimilation and cultural assimilation.[6] Structural assimilation measures the extent of participation of groups and individuals in a larger society, basically at the institutional level. Cultural assimilation is concerned with the process of value orientation and identification of immigrants. Clearly, one can participate in a structural sense without altering core values and orientations. For example, Moslems can, and do, actively participate in French society but do not necessarily accept the basic values of (Gallic) French life.

As a result, to some the core problem with assimilation (both benign and severe) is the belief that involvement in institutional life will engender identification with majority views and values. This realization has led to some countries abandoning attempts at assimilation and moving toward the introduction of policies that allow separate development, within the overarching framework of a common institutional, legal and economic framework.

The UK, at least at the level of Government policy, when down this path in the 1960's with the then Home Secretary Roy Jenkins, proclaiming that integration is 'not a flattening process of assimilation but equal opportunity accompanied by cultural diversity in an atmosphere of mutual tolerance'[7].

However, neither the quasi-assimilation countries nor the quasi- multi-cultural countries, or those in between, factored in the impact on their policies of the mass migration from persons of different language, ethnicity and religion that has occurred in Europe over the past two decades. Specifically, those countries that favoured assimilation faced the daunting problem of inducing large number of persons, in years to come possibly a numerical majority, to adopt the current mainstream values and cultures, particularly where these values were diametrically opposed to their own set of social and religious beliefs. Similarly, the multi-culturalists were faced with a problem that a policy which legally enshrines respect for individual also may provide a mechanism for pursuing separate development and the balkanization of the population. The impetus given to these types of consideration post 9/11 has led to a re-awakening of a debate on immigration that many had thought had been completed decades earlier.

In 2003 the EU commission was so concerned about the lack of common approaches to the immigration issue in Europe that they commissioned a study into the degree of integration currently practiced in the EU by the member states[8].

Similarly, scholars in many European countries investigated the numerous currents of debate into an appropriate immigration policy for Europe.

This paper does not directly answer this question but it addresses a related query: who are the people in Western countries who think that immigrants should integrate culturally, and how do they differ from those who think that immigrants should preserve a separate cultural existence? Although there is a vast literature on immigrants living in

[6] This distinction was first made by Gordon (1964) and Hoffman-Nowotny (1970).
[7] See, The Guardian (2006).
[8] See, Entzinger and Biezeveld (2003).

the West, and on immigration to Western countries, this question, to the best of our knowledge, has not been addressed in any systematic manner[9]. This study exploits a unique set of data provided by The Human Beliefs and Values Survey (HBVS) for the period 1999-2002, described in Ingelhart *et. al*., 2004. The HBVS asked over 30,000 respondents in 18 Western countries whether they thought it better that immigrants should 'maintain their distinct customs and traditions' or that they 'take over the customs of the country'. In addition, the HBVS contained a wealth of information on the attributes and circumstances of the respondents – *inter alia* their political orientation, attitude to immigrants, sex, age, income, social class, labour market and marital status, education level. We used these data, in conjunction with the data on responses, to identify - and to estimate the strength of - those factors which led people to favour integration, over multiculturalism as a basis for immigration policy.

2. Multiculturalism and Differing National Responses

Rex and Singh (2003) outline two polar opposite views of multiculturalism. The 'soft view' is illustrated in the approving phrase often used by politicians. 'We now live in a multicultural society'. By this statement multiculturalism is seen as a natural extension of liberal democracy and the democratic values of tolerance and respect for diversity. Conversely, the 'hard view' sees multiculturalism, with its emphasis on the group over the individual, as a threat to liberal democratic values (Barry, 1999) and by extension the view that 'economic migrants or political migrants and refugees may be seen as endangering the unity of society' (Rex and Singh, 2003 p.4). A 'middle view' sees multiculturalism, or at least the acknowledgement and toleration of a variety of cultural expressions as one, possibly the only, feasible means for the Western nations to cope with the issues raised by globalization, mass immigration and the growth of large and increasing vocal ethnic minorities within their borders. All of these views may be seen, to varying degrees within different European countries. Britain is often seen as having the most developed form of multiculturalism in that, under official policy at least, the British advocate a society that extends equitable status to distinct cultural and religious groups with no one's culture predominating. UK law allows for the extension of legal recognition to specific minority groups such as Black, White and Muslim and even special legal protections for the members of these groups[10]. Conversely, France is often perceived as main proponent of assimilation of the European nations[11]. The French system in its harshest form presumes a loss of many characteristics of the absorbed group. Legally, all citizens are simply recognized as citizens, as opposed to 'French Arabs' for example. In between these two extremes come the policies of Germany, Sweden and the Netherlands. Under the German system (Gastarbeider) immigrants, independent of their length of stay, are treated as guest workers and denied citizenship**.** The Dutch response to cultural diversity has been referred to as pillarisation under

[9] See *inter alia*: Card (2005) on the successful assimilation of post-1965 immigrants to the USA; Borooah and Mangan (2007) on the assimilation of immigrants in Australia; Polachek *et. al.* (2006) on the economics of immigration and social diversity and Hanson (2005) on the divisive effects of immigration in the USA.

[10] See report of the Commission on the Future of Multi-Ethnic Britain (2000).

[11] Withol de Wenden (2003) speaks of the Jacobin Tradition in France, dating back to the French revolution, which has opposed the right to be different, pluralism and group rights.

which separate education, separate trade unions, and separate media has grown up, firstly for Catholics and Protestants but later extended to immigrants. Rath (1991) claims that this has led to 'minorisation' and singling out migrants for unequal treatment. In Sweden, the provision for ethnic minorities was conceived of as part of the provisions of the Welfare State (Rex and Singh, 2003).

There are however signs that 'official policies' are changing and converging on models which are both politically expedient and able to cope with the reality that most countries are multi-ethnic. These changes are either in response to international events or shifts in public sentiment. In Britain, the stridently multicultural Commission on the Future of Multi-Ethnic Britain (2000), was very quickly tempered by the calls for 'Building Cohesive Communities' (2001) and a quest for 'Britishness' (Singh, 2003).

Wihtol de Wenden (2003) argues that 'In France, like most democracies, the rise of claims for difference means that the republican model of integration has no other choice but to integrate with multiculturalism' (p.77). Even in those nations that helped define Multiculturalism, Canada and Australia, there is a recognition that multiculturalism has been imposed from the top and that official policy has often run ahead of popular opinion. For example, Castles (1997) argues, from an Australian point of view, that multiculturalism has developed in a top down and ad hoc way as a strategy for integrating immigrant communities into a basically unchanged society.

Politicians and policy makers therefore face a dilemma. In Europe in particular, the existence of very well established ethnic minorities, some of which are tipped to become majorities in the not too distant future, and an increasing reliance on immigration as a source of labour within an aging domestic population make the imposition of a purely assimilation solution highly impractical. On the other hand there are clear signs that full multiculturalism, needs to be reigned back or face a widespread political and social backlash.

As well, there are differences between the official national policy on immigration and the views of the effected populations. Not all French favour assimilation and not all British are multicultural, but can we establish whether the French people in their views are essentially assimilationist and the British essentially multicultural, and if so are inter-country differences in views caused primarily by attribute effects (for example, does Italy have more persons with right wing views than Spain?) or coefficient effects (are Spanish right-wingers more strident in their integrationist views than Italian right-wingers?).

Ideally Governments should attempt to design public policies that not only serve national interests but are also compatible with the views of the domestic populations. The analysis of data from the Human Values and Beliefs Survey is one way of assessing if this type of compatibility is currently taking place in Europe. An analysis of the survey makes for interesting comparisons with 'official attitudes' as expressed in the EU (2003) report on 'Benchmarking Integration in Europe'.

3. Data and Estimation

Table 1 shows the proportions of respondents in 18 Western countries, who favoured either assimilation or multiculturalism. Respondents from Austria (82 percent), Belgium (72 percent), Denmark (77 percent), Germany (78 percent), Iceland (73 percent), and the Netherlands (70 percent) were most in favour of immigrants being absorbed into the host culture. On the other hand, the majority of respondents in the Mediterranean countries – Greece (77 percent), Italy (60 percent), Malta (55 percent) and Spain (52%) favoured multiculturalism. In order to estimate the effects of the different respondent attributes, on the likelihood of respondents regarding it as preferable that immigrants integrate, we estimated a logit equation whose dependent variable took the value 1 if a respondent thought it better that an immigrant should adopt the customs of the host country and the value 0 if he/she thought it preferable that immigrants should maintain their own distinct culture and traditions. The estimation results from this model are shown in Table 2 with a positive (negative) coefficient implying that the probability of the outcome ('regarding integration as preferable') would increase (decrease) with an increase in the value of the associated variable. Shown alongside each coefficient is the implied change in the probability of the outcome, consequent upon a change in value of the variable, the values of the other variables held constant at their mean values. These are the *marginal probabilities* associated with the different variables; for discrete variables – as are all the explanatory variables used - the marginal probabilities refer to changes consequent upon a move from the residual category for that variable to the category in question.

From the results of Table 2 it is possible to paint a portrait of those who thought that integration was preferable to multiculturalism. Respondents who expressed ambivalence to assisting immigrants, for example those who said they *might* or *migh*t not help immigrants, were much more likely to demand integration - by respectively, 16 and 25 percentage points - than those who expressed a clear willingness to help immigrants. Similarly, those who were opposed to having an immigrant for a neighbour, or those who regarded maintaining order in society as the most important social goal, were more likely to support integration than, respectively, those who were prepared to have immigrant neighbors or those who thought that, compared to preserving order, other social aims were more important (by 10 and 7 percentage points respectively). In terms of social class, classes C1 and C2 were more likely to support integration – by respectively – 3 and 4 percentage points – than either the highest (A-B) or lowest social classes (D-E).

Conversely, people who regarded themselves as politically left-wing or as middle-of-the-road were less likely - by respectively, 10 and 2 percentage points - to support integration than those who thought of themselves as right-wing; young persons (15-29 years) and middle-aged persons (30-49 years) were less likely - by respectively, 9 and 6 percentage points - to support integration than those who were 50 years or older; people with children were more likely to support integration, by 5 percentage points, compared to childless persons; those with a high level of education were less likely to support integration, compared to the moderately well educated or the poorly educated, by 7 percentage points. In terms of labour market status, compared

to retired and employed persons, the unemployed (by 7 percentage points), students (by 7 percentage points), and housewives (by 3 percentage points) were less likely to support integration.

Using the above results one can build profiles of those who are most likely to, respectively, support cultural integration and multiculturalism. The probability of persons supporting cultural assimilation was 85 percent if they: (i) did not believe in helping immigrants; (ii) would not want an immigrant for a neighbour; (iii) believed in the primacy of order in society as a social goal; (v) regarded themselves as politically right-wing (vi) were aged 50 yrs or more and retired. At the other extreme, the probability of persons supporting cultural assimilation was only 25 percent if they: (i) did believe in helping immigrants; (ii) would not object to an immigrant for a neighbour; (iii) did not believe in the primacy of order in society as a social goal; (v) regarded themselves as politically left-wing; and (vi) were students aged 15-29 years. Finally, acceptance of multiculturalism rose with higher levels of formal education. Based on these results it is possible to see a process where differences in the composition of the respective populations may provide an explanation for apparent national differences in attitudes to multiculturalism. But do differences based purely on nationality also emerge?

4. Country Effects versus Personal Characteristics

Table 2 shows that, even after controlling for personal characteristics, there were significant country effects: *ceteris paribus* respondents in some countries (Austria, France and Germany) were more likely to regard assimilation as preferable to multiculturalism than respondents in other countries (Italy, Portugal, Spain). However, Table 2 traces country effects purely through intercept shifts and holds the slope coefficients (which reflect attitude intensity) as being invariant across countries. If the equation had been estimated separately for the different countries then we would be able to decompose the overall level of difference into two distinct components; First, countries might differ in terms of their attributes: for example, one country might have more right-wing respondents than another. Second, countries might differ in terms of their coefficients: right-wing respondents in one country might be more pro-assimilation compared to right-wing respondents in another country.

In order to disentangle the relative strengths of 'attribute differences' and 'coefficient differences' in explaining the overall difference, we divided the countries into two groups: 'Northern Europe', with a large proportion of respondents favouring cultural assimilation (Austria, Belgium, Denmark, Finland, France, Germany, Iceland, Luxembourg, the Netherlands, Sweden) and 'Southern Europe', with a smaller proportion, sometimes a minority, of respondents favouring assimilation (Italy, Greece, Malta, Portugal, Spain, Great Britain, Ireland, and Northern Ireland). The 'assimilation equation', shown in Table 2, was then estimated separately for the 'North' and the 'South' groups of countries and these estimates are shown in Table 3; lastly, these estimates were used to decompose the difference between the North and the South, in the average proportion of their respondents who favoured assimilation, into a part caused by attribute differences and a residual part engendered by coefficient differences.

The column headed 'sample average' in Table 4 shows that 70.8 percent of respondents from the North and 43.1 percent of respondents from the South regarded cultural assimilation as preferable to multiculturalism: a difference of 27.7 percentage points. So, compared to respondents from the South, Northern respondents had an 'assimilation surplus'.

Partly, this may have had to do with the fact that the coefficient responses, to a given vector of values of the 'assimilation determining' variables, were different between the countries of the 'North' and the 'South': Table 3 shows that the ordered logit estimates were, for several variables, significantly different between the two groups of countries. Partly, however, this may be due to the fact that the attribute vectors were different between the Northern and Southern countries. This section assesses the proportions of the overall difference in satisfaction levels between Western and non-Western countries which were caused by, respectively, 'coefficient' and 'attribute' differences[12].

To facilitate this analysis it is useful to assign northern coefficients to the attributes of southern respondents and compare with the original southern results and, reverse the exercise by assigning southern coefficients to northern respondents.

The next column of Table 4 shows that *if the attributes of Southern respondents had been evaluated at 'Northern' coefficients*, 68.2 percent of respondents from countries of the South would prefer cultural assimilation over multiculturalism: only 2.6 percentage points *below* the average proportion of 70.8 percent for the Northern respondents. Consequently, of the overall difference of 27.7 percentage points between Northern and Southern countries, in their respective proportions preferring cultural assimilation to multiculturalism, 2.6 percentage points, or 9 percent, could be explained by attribute differences between the two groups, the remainder (91 percent) being due to coefficient differences.

On an alternative decomposition, *if the attributes of Northern respondents had been evaluated at 'Southern' coefficients*, 46.3 percent of respondents from countries of the North would prefer cultural assimilation over multiculturalism: only 3.2 percentage points *above* the average proportion of 43.1 percent for the South. Consequently, on this alternative decomposition, of the overall difference of 27.7 percentage points between Northern and Southern countries, in their respective proportions preferring cultural assimilation to multiculturalism, only 3.2 percentage points, or 11 percent, could be explained by attribute differences between the two groups, the remainder (89 percent) being due to coefficient differences. On average, therefore, only 10 percent of the overall difference of 27.7 percentage points between Northern and Southern countries, in their respective proportions preferring cultural assimilation to multiculturalism was due to differences between them in their attributes, 90 percent being explained by differences between them in their responses to a given set of attributes. Overall, the large bulk of differences in views were not caused by compositional differences amongst the populations, but by different levels intensity in the views held on immigration across groups in the broad Northern Europe/Southern Europe breakup.

[12] The methodology used is that of Oaxaca (1973) adapted to probabilistic models (Nielsen, 1998; Borooah and Iyer, 2005).

5. Conclusions

This paper set out to examine views on immigration policy in Europe, principally the extremes of multiculturalism versus assimilation. It asked the question: are the observed national differences in attitudes towards multiculturalism and assimilation due primarily to differences in attributes of the respective populations or differences in the coefficients of the various groups within each country? For example, do views in Germany differ from the UK because there are a higher proportion of right-wingers in Germany or because German right wingers think differently (more stridently) about immigration than British right wingers?

To answer this question, this paper undertook an inquiry into the nature of people in Western countries who thought that immigrants should assimilate into the culture of the host country and, by implication, into the nature of those who thought it best if immigrants preserved their own cultures and traditions. Having identified the personal characteristics that might make it likely that people would support one or the other camp, the paper also pointed to the existence of strong country effects: which side one supported in the assimilation versus multiculturalism debate depended not just on who you were but also on where you lived. Using a decomposition analysis, the paper showed that these inter-country differences (or, more accurately, differences between a group of countries who were strong supporters of multiculturalism and another group of countries who were less enthusiastic about multiculturalism) were largely due to differences between countries in how they *responded* to a given set attributes rather than to differences between them in their attributes. In other words, the main differences were not between middle class and working class or males and females but between nationalities, particularly when these nationalities were grouped together into Northern and Southern Europe. These results, while interesting in themselves also have significant policy implications. If attitudes to immigration policy were generically determined by attribute effects we would be able to detect and accurately forecast trends in Europe towards or against multiculturalism by using trends in predictor variables such as aging, acceptance of right wing views and the relative deepening of education. However, the results of this paper show that predictions in this area are not so simple. Differences in attitudes to immigration between the broad groups of North Europe and South Europe have been shown to be overwhelmingly determined by inter-country differences in attitudes across compositional groups. This conclusion does not sit well with the recommendations of the EU Commission into immigration (2003) who argued 'there is a growing recognition of the need to act collectively at the EU level by adopting additional common elements and adapting old ones to new challenges'. The inevitable conclusion from our results is that the development of a unified-European policy on this important immigration question may not be easy to define or direct.

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Appendix

Table 1: Integration versus Multiculturalism in Western Countries, 1999-2000

Country: sample size	**Integration**	**Multiculturalism**
Austria: 1,404	82	18
Belgium: 1,708	72	28
Denmark: 837	77	23
Finland: 924	67	33
France: 1,439	74	26
Germany:1,869	78	22
Greece: 1,031	23	77
Iceland: 896	73	27
Ireland: 873	43	57
Italy: 1,763	40	60
Luxembourg: 1,013	40	60
Malta: 929	45	55
Netherlands: 913	70	30
Portugal: 841	53	47
Spain: 950	48	52
Sweden: 805	64	36
Great Britain: 836	55	45
Northern Ireland: 827	*47*	*53*
All Western Countries: 19,858	**60**	**40**

Source: The Human Beliefs and Values Survey: Ingelhart *et. al*., 2004.

Table 2: Logit Esitmates of the Integration Model*

Determining Variables	**Coefficient estimates**	**Marginal Probabilities**
Would *perhaps* help immigrants	0.676***	.157***
	(15.37)	
Would *not* help immigrants	1.187***	.252***
	(22.20)	
Sympathises, to some extent, with immigrants	0.349***	.079***
	(5.22)	
Does not sympathise with immigrants	0.293***	.067***
	(2.96)	
Religion: very important, rather important	-0.174***	-.041***
	(4.70)	
Would not want immigrant as neighbour	0.453***	.102***
	(8.02)	
Female	0.001	.000
	(0.02)	
Associates with other people regularly	0.044	.010
	(0.91)	
Believes that maintaining order in the nation is the most important government objective	0.307***	.072***
	(8.75)	
Left-wing politically	-0.425***	-.103***
	(9.61)	
Middle-of-the-road politically	-0.084**	-.020**
	(2.20)	
Young (15-29)	-0.365***	-.088***
	(5.99)	
Middle-aged (30-49)	-0.247***	-.059***
	(5.45)	
High education	-0.304***	-.073***
	(5.94)	
Middle education	0.005	.001
	(0.12)	
Social class: A-B (upper class, upper middle class)	0.107	.025
	(1.51)	
Social class: C1 (middle, non-manual)	0.118**	.028**
	(1.97)	
Social class: C2 (middle, manual)	0.173***	.040***
	(2.94)	
Has children	0.207***	.049***
	(4.69)	
Employed	-0.064	-.015
	(1.22)	
Unemployed	-0.300***	-.073***
	(3.60)	

Student	-0.304***	-.074***
	(3.45)	
Housewife	-0.140**	-.033**
	(2.14)	
Austria	1.615***	.291***
	(14.08)	
Belgium	1.185***	.235***
	(11.79)	
Denmark	1.407***	.259***
	(11.90)	
Finland	0.953***	.194***
	(8.90)	
France	1.197***	.235***
	(11.26)	
Germany	1.358***	.260***
	(12.50)	
Greece	-0.734***	-.181***
	(6.64)	
Iceland	1.359***	.254***
	(12.39)	
Ireland	0.137	.032
	(1.30)	
Italy	-0.099	-.024
	(0.98)	
Luxembourg	-0.204*	-.049*
	(1.81)	
Malta	-0.003	-.001
	(0.03)	
The Netherlands	1.345***	.252***
	(12.45)	
Portugal	0.428***	.096***
	(4.09)	
Spain	0.189*	.044*
	(1.72)	
Sweden	1.203***	.232***
	(10.36)	
Great Britain	0.252**	.058**
	(2.20)	
Constant	-0.695***	
	(6.56)	
Observations	19071	

Notes to Table 2:
* Dependent variable = 1, if respondent thinks integration is preferable to multiculturalism = 0, if respondent thinks multiculturalism is preferable to integration
1. Absolute value of z statistics in parentheses.
2. * significant at 10%; ** significant at 5%; *** significant at 1%.
3. Residual categories are: (i) Would help immigrants (ii) Sympathises with immigrants; (iii) religion not very important or not at all important (iv) Male; (v) Old (50+ years); (vi) Right wing politically; (vii) Low level of education; (viii) Retired; (ix) social class D-E (manual, unskilled); (x) Northern Ireland.

Table 3: Logit Esitmates of the Integration Model[*]: Northern and Southern Countries[**]

Determining Variables	**Coefficient estimates: Northern Countries**	**Coefficient estimates: Southern Countries**
Would *perhaps* help immigrants	0.811***	0.496***
	(14.61)	(7.70)
Would *not* help immigrants	1.321***	0.955***
	(19.16)	(12.37)
Sympathises, to some extent, with immigrants	0.447***	-0.018
	(5.50)	(0.17)
Does not sympathise with immigrants	0.475***	-0.011
	(3.56)	(0.07)
Religion: very important, rather important	-0.195***	-0.192***
	(4.20)	(3.55)
Would not want immigrant as neighbour	0.466***	0.330***
	(5.28)	(4.62)
Female	0.077*	-0.080
	(1.66)	(1.49)
Associates with other people regularly	-0.558***	0.067
	(10.49)	(1.00)
Believes that maintaining order in the nation is the most important government objective	0.377***	0.135***
	(8.29)	(2.62)
Left-wing politically	-0.413***	-0.356***
	(7.19)	(5.30)
Middle-of-the-road politically	-0.062	-0.070
	(1.19)	(1.30)
Young (15-29)	-0.296***	-0.471***
	(3.67)	(5.20)
Middle-aged (30-49)	-0.246***	-0.263***
	(4.07)	(3.96)
High education	-0.230***	-0.590***
	(3.68)	(7.48)
Middle education	0.025	-0.107*
	(0.46)	(1.81)
Social class: A-B (upper class, upper middle class)	0.203***	0.193**
	(2.81)	(2.03)

Social class: C1 (middle, non-manual)	0.267***	0.175***
	(4.56)	(2.62)
Social class: C2 (middle, manual)	0.202***	0.156**
	(3.34)	(2.30)
Has children	0.292***	0.143**
	(4.99)	(2.20)
Employed	-0.150**	-0.069
	(2.22)	(0.89)
Unemployed	-0.252**	-0.277**
	(2.26)	(2.25)
Student	-0.363***	-0.388***
	(3.23)	(2.79)
Housewife	-0.266***	-0.120
	(2.78)	(1.36)
Constant	0.315***	-0.248**
	(3.09)	(2.16)
Observations	11301	7770

Notes to Table 3:
* Dependent variable = 1, if respondent thinks integration is preferable to multiculturalism = 0, if respondent thinks multiculturalism is preferable to integration.
** Northern countries: Austria, Belgium, Denmark, Finland, France, Germany, Iceland, Luxembourg, the Netherlands, Sweden.
Southern Countries: Italy, Greece, Malta, Portugal, Spain, Great Britain, Ireland, and Northern Ireland.
1. Absolute value of z statistics in parentheses.
2. * significant at 10%; ** significant at 5%; *** significant at 1%.
3. Residual categories are: (i) Would help immigrants (ii) Sympathises with immigrants; (iii) religion not very important or not at all important (iv) Male; (v) Old (50+ years); (vi) Right wing politically; (vii) Low level of education; (viii) Retired; (ix) social class D-E (manual, unskilled).

Table 4: The Decomposition of Differences Between North and South European Countries in the Proportions of Their Respondents Wanting Cultural Integration

Sample Average $\overline{P}^N - \overline{P}^S$	***Non-Western attributes evaluated using Western coefficient estimates*** $P(\mathbf{X}^{\mathbf{N}}, \hat{\boldsymbol{\beta}}^{\mathbf{N}})$ $-P(\mathbf{X}^{\mathbf{S}}, \hat{\boldsymbol{\beta}}^{\mathbf{N}})$	$P(\mathbf{X}^{\mathbf{S}}, \hat{\boldsymbol{\beta}}^{\mathbf{N}})$ $-P(\mathbf{X}^{\mathbf{S}}, \hat{\boldsymbol{\beta}}^{\mathbf{S}})$
0.708 - 0.431 = 0.277	**0.708 - 0.682 = 0.026**	**0.682- 0.431 = 0.251**
Sample Average +++++ $\overline{P}^N - \overline{P}^S$	***Western attributes evaluated using non-Western coefficient estimates*** $P(\mathbf{X}^{\mathbf{N}}, \hat{\boldsymbol{\beta}}^{\mathbf{S}})$ $-P(\mathbf{X}^{\mathbf{S}}, \hat{\boldsymbol{\beta}}^{\mathbf{S}})$	$P(\mathbf{X}^{N}, \hat{\boldsymbol{\beta}}^{N})$ $-P(\mathbf{X}^{N}, \hat{\boldsymbol{\beta}}^{SW})$
0.708 - 0.431 = -0.277	**0.463-0.431=0.032**	**0.708-0.463=0.245**

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The effect of socio-economic determinants on crime rates: An empirical research in the case of Greece with cointegration analysis

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Abstract

The present paper analyzes the relationship between the criminal offences, the function of the justice system and some of their socio-economic determinants in the case of Greece by estimating their dynamic interactions. The analysis covers the period 1971-2006 and the cointegration methodologies of Johansen (1988) and Johansen-Juselius (1990, 1992) are applied to the VAR model. From the cointegration results, a cointegrating vector is shown among total offences, convicted persons and socio-economic variables. Moreover, Error Correction Models are estimated for the short-run dynamics of the explanatory variables and their convergence to a long-run equilibrium state.

Keywords: Crimes, Socioeconomic determinants, Greece, Cointegration, Error Correction Model.

JEL classification: I2, K42

1. Introduction

Criminality is presented as a historical social phenomenon, which does not rule out from a person's life, but it keeps pace with the social and technological evolution. It has the tension to readjust all the time and as a result, a large variety of criminal activities is shown worldwide during different time periods. Lately, types of organized, violent and profiteering crime appear to be the most prevalent, but without ruling out the different kinds of single crimes. Moreover, the criminal's character becomes even more unscrupulous and provocative, thus more dangerous towards the rest of the people.

The proper actions for a significant reduction and an effective prevention of crime rates has become a prior issue for every country, since criminal actions are presented through different forms, everywhere and in every time. There are no certain causes for committing crimes, but every time criminal actions come from different kinds of motives. In fact, there are many incentives that drive a person to criminal activities, due to the special socioeconomic and political conditions that characterize every country.

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Many approaches have been made in order to analyze the economics of crime and the relationship between the motives and the illegitimate activities, which appear to be different for each country. In fact, more attention has been paid to specific types of crime, such as homicides, violent assaults, thefts, burglaries and robberies. Due to the complexity of a criminal action, the results are not unanimous, so no *a priori* theoretical approach can be extracted.

Over the past 30 years crime rates in Greece are continuously growing, especially in robberies, violent assaults and the so-called economic crimes, in which digital, electronic and tax frauds are included. On the other hand, in no way can all the criminal activities remain without any punishment, either by imposing a fine, or by imprisoning in special institutions. But surprisingly it seems that, as time passes, the number of convicted persons becomes lower. Perhaps the ineffectiveness and the elastic calls of the Greek justice system and the insufficiency of the police force to proceed to arrests and solve the crime cases as well could be the main reasons.

According to official data tables, during the last decades there is a constant rise of criminal acts in developed countries and countries of the Western World, Greece included. Even though Greece is theoretically considered as one of the safest countries in the European Union, due to relatively lower crime rates than other major countries, criminality is something that cannot be ignored. Indeed, criminal behaviour has recently become a subject of discussion among specialists and politicians, paying more attention to issues such as the prisoner's way of living, the application of rehabilitation programs (employment, education, learning) and corrections to the legislative system (Lambropoulou, 2005).

Economics of crime are mostly related with factors such as poverty, income inequality, social exclusion, cultural characteristics, age, sex, education level and family background (Buonanno, 2003). In the case of Greece, delinquent actions are more likely to burst because of its crucial geopolitical position, some economic problems, the growth of legal and illegal immigration, the loose moral values through family and school environment, the improper organization of the Greek justice system. Moreover, the impact of television addiction and alcohol consumption is important for the rise of crime rates.

The present paper presents the long-term relationship between criminal offences and some of the socio-economic factors in the case of Greece. The structure of the paper is the following: Section 1 refers to criminality as a social phenomenon that keeps pace with the social and technological evolution. Section 2 presents the theoretical and empirical approaches. Section 3 describes the specification of the multivariate VAR model and the data that will be used in it. Section 4 presents the results of the unit root test and the integration order of the variables. Section 5 shows the results from the cointegration analysis among the explanatory variables. Section 6 presents the results of the Error Correction Model, and finally in section 7 final conclusions are drawn.

2. Theoretical and empirical approaches

Many studies that refer to criminality for decades were based previously on theoretical and sociological approaches, but only recently economic analysis has been applied. Although Fleisher (1963, 1966) was the first who worked on criminality from its economic view, Becker's study (1968) became the major breakpoint by designing a model, analyzing a criminal's decision. In particular, the criminal behaves in a rational way and decides how to allocate time between legitimate and illegitimate activities, based on an income benefit-cost comparison, plus the likelihood of apprehension and conviction. The above studies paved the way for the field of empirical research, which aims in verifying the socioeconomic variables that determine criminal decisions and behaviours.

The crime-unemployment relationship has been ambiguous in most studies, leading to different approaches. The first one indicates a positive relationship (Reilly and Witt, 1992; Papps and Winkelmann, 2000; Raphael and Ebmer, 2001; Edmark, 2005), known as 'motivation effect', where a rise in unemployment rates leads to economic problems and increases the motivation to engage in criminal acts. The second one comes from the work of Cantor and Land (1985), who found a negative correlation known as 'opportunity effect' (Britt, 1994; Melick, 2004) and indicates that, during economic depression a rise in unemployment rates leads to decrease in median family income and discourages a person from the decision to commit a crime.

No consensus is also found in the case of income earnings and income inequality. Several studies show that changes in income can affect crime in three ways: first, an income decrease makes the need for returns from illegal activities, known as 'motivation effect' (Grogger, 1998; Machin and Meguir, 2000; Gould et al. 2002). Second, an income increase sets the opportunities for criminal offences, due to the large amount of stolen goods, known as 'opportunity effect' (Levitt, 1999). Finally, the third way is known as 'routine-activity effect' (Beki et al. 1999), indicating that an income increase leads to outdoor activities, thus increasing the likelihood of potential crime victims. In addition, when the crime-income inequality relationship is studied, motivation effects for criminal actions are more likely to happen when inequality measure is rising (Blau and Blau, 1982; Hsieh and Pugh, 1993; Fajnzylber et al. 2002), but in some cases the present relationship does not appear to be so significant (Stack, 1984; Neumayer, 2003).

A number of empirical studies has set the question how the authorities and the prevention policies can better combat crime. Different variables have been tested, such as the growth of police force (De Oliveira, 2003), the money spent for the appropriate equipment (Imrohoroglu et al. 2000), people who have been arrested (Corman et al. 1987, Corman and Mocan, 2000), convicted (Pudney et al. 2000; Funk and Kugler, 2003) or sentenced to imprisonment (Levitt, 1996). The results are still ambiguous, but it seems that the possibility of sentence and conviction are more effective ways for crime prevention than the others. That is because, in most cases, criminal actions are not always connected with arrests, and arrests do not always lead to convictions and imprisonments.

Not much effort has been made to analyze the crime rates with the cointegration and causality method. One of the first attempts was by Masih and Masih (1996), who bound cointegration with Granger causality for several types of crime in Australia, but few studies followed the methodology. For the rest of the researches, several were the ones that came up with mixed results, trying to relate different crime types with socio-economic factors (Scorcu and Cellini, 1998; Witt and Witte, 2000; Lee, 2002; Narayan and Smyth, 2004; Lee and Holoviak, 2006; Kuştepeli and Őnel, 2006), while the rest failed to find a cointegrating vector (Hale and Sabbagh, 1991; O'Brien, 1998; Luiz, 2001; Saridakis, 2004).

Returning to the crime-unemployment relationship and the 'opportunity effect' approach, Cantor and Land's (1985) dimension negatively correlates the two variables. Specifically, they indicate that during times of economic depression, a rise in unemployment rates lowers the consumption expenditures, mostly in households, so the potential earnings from illegitimate activities become lower and discourage a person from committing a crime. Moreover, the long-term unemployment drives the unemployed persons to allocate more time in their places, thus preventing from crimes such as offences against properties and from violent assaults as well, since the latter ones mostly occur in public places. In general, Cantor and Land (1985) stress that in a present time period, unemployment operates as a means of prevention from crime activities, while in lagged period the poverty problem leads to illegitimate actions. Consequently, the present approach indicates that changes in opportunity effects for delinquent actions appear in the same time levels as changes in unemployment rates, whereas motivation effects appear in lagged times from unemployment changes, which means that unemployment first differences are added. The contribution of Cantor & Land's (1985) work was very important, despite the fact that other researchers criticized the 'first-difference' approach of unemployment rates (Greenberg, 2001), while others have the dilemma concerning whether the cointegration technique or the 'first-differences' regression model can better describe the crime-unemployment relationship for time series analysis (Britt, 2001).

To summarize, the crime-unemployment relationship is not characterized by unanimity, but their results remain ambiguous. Examples come from the correlation studies of Box (1987) and Chiricos (1987), in which the crime rates consist the dependent variables. The former noted that 33 of the 50 studies examined supported a positive correlation, while the rest were characterized by an insignificant and negative correlation mix. Respectively, the time series studies search of the latter showed that 46 studies supported positive correlations and 22 negative correlations, pointing out that less than half of them were statistically significant. Beside the cases where the crime-unemployment relationship is proved to be insignificant (Timbrell, 1990**,** Young, 1993), there are researchers that argue even for the existence of such a causal relationship between the two variables. For example, Field (1990) and Pyle and Deadman (1994) stressed that unemployment might be a less important factor than the rest economic variables in order to investigate the crime rates fluctuation in Great Britain.

Many support the view that different methodology approaches used for empirical analysis can lead to ambiguous results. For example, Levitt (1999) expressed that the national time series data usually fail to show a crime-unemployment relationship

due to the fact that the fore mentioned variables perform divergences in local levels. So, he suggests the use of cross-section data and panel data as a more effective way of solution.

The failure for the crime-unemployment relationship consensus usually derives from the belief that total unemployment is not a proper way of measure, since the official total number of unemployed in every country or state is proved to be inadequate for giving satisfactory answers to fix this problem. For example, the prohibition of a large percentage of long-term unemployed is one of the most prevalent cases. That is because of their frustration and the quit of the labor search, since the lack of specialty does not allow them to meet the high standards of the labor supply. So a stoppage from labour search causes an underestimation of unemployment, because it is assumed wrong that the present percentage does not belong to the workforce, and as a result, they are not considered as unemployed.

3. Data and specification of the model

The present model is mostly based on Becker's (1968) model, who has expressed the view that an individual's decision to commit a crime depends on the income returns of legitimate activities, the possibility for the crime to succeed and the severity of punishment that can be imposed, if the person gets arrested.

Other researchers have designed their Economics Crime Models (ECM) based on Becker's view as well (Pyle and Deadman, 1994), but some adjustments must be made in the present paper. For example, the justice system function would be more preferred than the total force of the authorities because the high probability for someone to be sentenced or convicted could be a more effective way to prevent crimes. Moreover, the variable that refers to migration could be inserted into the model, considering the two major immigration flows that took place recently in Greece: the first was the comeback of many exiled people after the dictatorship period in 1974, and the second in the early 90's, where a massive flow of immigrants appeared, especially coming from the former socialistic countries-unions.

After the content of the model has been defined, its form must then be examined. Since the present paper works on the application of recent econometric techniques, the main is the existence or not of stationarity and long-term equilibrium among the time series data. So, the present paper must use time-series of raw data and the following model will be used in the economic analysis of crime rates in the case of Greece:

$$CR_t = f(UN_t, RC_t, CONV_t, MIG_t) \quad (1)$$

where:

CR is the number of total offences per 100.000 people known by the Greek police and refers to Greek Penal Code and Special Penal Law infringements,

UN is the number of unemployed per 100.000 people who belong to the work force,

RC shows the real compensation per employee adjusted with GDP deflator and 2000 is used as a base year (2000=100).

CONV is the total number of people who have been convicted by the Greek Courts of Law per 100.000 people, and

MIG is the net migration per 100.000 people, consisting of the algebraic sum of immigrations and emigrations.

The variables represent annual time series, covering the time period 1971-2006. The total offences and the convicted person's data come from the respective bulletins of Justice Statistics by the National Statistical Service of Greece (NSSG). As for the economic variables, real compensation per employee and unemployment, their data come from the AMECO database by Eurostat and finally the total population data, as well as the net migration data come from the respective Statistical Yearbooks of NSSG. All variables will be expressed in logarithms to explain the multiplicative effect of the time series and they will be symbolized with the letter L in front of their names.

3. Unit root tests

Many macroeconomic time series contain unit roots that are characterized by the existence of stohastic trends (Nelson and Plosser, 1982). Unit root tests are essential for the existence of stationarity of time series, because a non-stationary regressor can rule out many empirical results. The existence of stochastic trends is determined by the tests for the existence of a unit root among the time series. In the present research, the unit root is checked by the Augmented Dickey-Fuller (1979) and Phillips-Perron (1988) tests.

Table 1 presents the Augmented Dickey-Fuller (1979) and Phillips-Perron (1988) tests for the variables of total offences, unemployed people, real compensation, convicted people and net migration. The results, according to the calculated ADF and PP statistics, show that all the explanatory variables are integrated of order one I (1).

Table 1: Unit root tests

Variables	DF	PP
LCR	-1.528	-1.672
ΔLCR	-5.178**	-12.479**
LUN	-2.198	-0.960
ΔLUN	-3.828**	-3.828**
LRC	-1.683	-1.683
ΔLRC	-4.171**	-4.193**
LCONV	-0.217	-0.209
ΔLCONV	-4.396**	-7.212**
LMIG	-2.756	-3.149
ΔLMIG	-3.690**	-7.642**

Notes:
Δ denotes the first differences.
DF = Dickey-Fuller PP=Philips-Perron (unit root tests).
The critical values for 1% and 5% levels of significance are -3.95 and -3.08 for DF and PP.
* and ** denote 5% and 1% levels of significance respectively.

4. Cointegration tests

Since it has been determined that the crime and the socioeconomic variables under examination are integrated I(1), then the cointegration techniques of Johansen (1988) and Johansen-Juselius (1990, 1992) can be performed, determining the number of available cointegrating vectors through the variables. The present approaches are used for the number of cointegrating vectors, taking into account that all variables can be endogenous, thus avoiding the arbitrary choice of the dependent variable. Moreover, they provide a unified framework for the estimation of the cointegrating relations within the Vector Error Correction Model (VECM). The estimation method of Johansen-Juselius presupposes the estimation of the following form:

$$\Delta Y_t = \mu + \Gamma_1 \Delta Y_{t-1} + \Gamma_2 \Delta Y_{t-2} + \ldots\ldots + \Gamma_{p-1} \Delta Y_{t-p+1} + \Pi Y_{t-p} + u_t$$

where:

Y_t is a 5X1 vector of stochastic variables,
μ is a 5X1 vector of intercepts,
Γ_i (i=1,2…p-1) is a 5X5 coefficient's matrix,
Π is a 5X5 coefficient's matrix,
e_t is the 5X1 residuals vector.

Before the application of the Johansen technique, a sufficient lag length is required for the VAR model estimation, so a procedure based on Likelihood Ratio tests (Sims, 1980) is first applied. The results showed that a lag length p = 2 is the best specification, so the order of the model is VAR(2). The next step is to determine the number of cointegrating relations, under the condition that the rank of the Π matrix is $r < n$ (where n = 5). Table 2 presents the results of the cointegration analysis for the long-run equilibrium relationship:

Table 2: Cointegration tests based on the Johansen and Johansen-Juselious approach (LCR, LUN, LRC, LCONV, LMIG VAR lag = 2)

	Trace test	**5% critical value**	**1% critical value**
H_0: r = 0	76.59	68.52	76.07
H_0: r ≤ 1	40.27	47.21	54.46
H_0: r ≤ 2	19.82	29.68	35.65
H_0: r ≤ 3	9.470	15.41	20.04
H_0: r ≤ 4	2.690	3.76	6.65

Notes:
Critical values are taken from Osterwald – Lenum (1992).
r denotes the number of cointegrated vectors.
Akaike Criteria (FPE) was used to select the number of lags required in the cointegration test.

The results according to the above Table confirm the existence of one cointegrating relation that describes the long-run crime rates in Greece (with absolute asymptotic t-statistics in brackets):

LCR = 4.003 + 0.774LRC + 0.094LUN - 0.055LCONV + 0.026LMIG
[4.999] [-5.771] [3.983] [1.064] [0.796]

where the coefficients estimated in the above relation show a significant elasticity of crime rates in unemployment rates and real compensations, an insignificant elasticity in net migration flows, and an insignificant inelasticity in conviction rates.

No restrictions a priori should be imposed, due to the unconcensus of the results in previous references, except for the intercept, where a positive sign must be expected. That is because criminal actions consist of multiple factors, some of them have not been entered into the present model and others are unable to be measured in a quantitative analysis. Since the above restriction is satisfied, the residuals of the cointegrating vector can then be used in a Vector Error Correction Model (VECM).

5. VAR model with an Error Correction Mechanism

After determining the cointegrating vector among the model variables, the residuals can be used as an error correction term in the VEC model, which is resulted from the long-run equilibrium relationship and is expressed as:

$$\Delta LCR_t = \text{lagged}(\Delta LCR_t , \Delta LRC_t, \Delta LUN_t, \Delta LCONV_t, \Delta LMIG_t) + \lambda u_{t-1} + V_t \quad (2)$$

where Δ denotes the first differences of the variables,

u_{t-1} are the estimated residuals of the cointegrating regression (long-run relationship) and represents the deviation from the equilibrium state, during a time period t,

$0< \lambda<-1$ is the short-run convergence coefficient, which represents the dependent variable's reaction from the equilibrium state in the beginning of each time period t,

V_t is the 5X1 vector of white noise errors.

The purpose of the VECM estimation is to determine the way in which the short-run dynamics of the time series eventually get to a stable long-run equilibrium state. The estimation of the dynamic VEC model of crime rates in the case of Greece is expressed in Table 3:

Table 3: Estimation of the VEC model

$$\Delta LCR_t = 0.234\Delta LUN_{t-i} + 0.052\Delta LMIG_{t-i} + 0.135\Delta LCONV_{t-i} - 0.433\Delta LRC_{t-i} - 0.990\ \lambda u_{t-1}$$
[0.0039] [0.1838] [0.1762] [0.0013] [0.000]

$R^2 = 0.638$ DW = 2.43

A: $X^2[1] = 3.910$ [0,047]
B: $X^2[1] = 0.159$ [0,689]
C: $X^2[2] = 0.038$ [0,981]
D: $X^2[1] = 1.030$ [0,449]

A: Lagrange (LM) multiplier of residual serial correlation
B: Ramsey's reset test for the functional form of the model
C: Jarque-Bera's normality test based on a test of skewness and kurtosis of residuals
D: White heteroscedasticity test (no cross terms)

The above Table shows the VECM estimation results, including the sum of statistically significant variables, the error correction term which should be negative and statistically significant as well, measuring the convergence velocity in the present dynamic model required for the equilibrium restore and the diagnostic tests for the VECM residuals. In particular, a short-run rise in both the macroeconomic variables (unemployment and real compensations) can actually affect the decision to engage in illegitimate activities, while a rise in sentenced persons and in migrant flows has a small affluence in crime rates, due to their insignificant coefficients. Finally, the error correction term coefficient and its t-ratio present a normal convergence to the long-run equilibrium state.

6. Conclusions

The analysis of crime rates by using statistical and econometric techniques is of great importance for two main reasons: First, to find the appropriate socioeconomic factors that affect more intensely the trend for criminal actions in every country and second, according to the possible results, proper actions for a successful reduction and an effective prevention of crime rates can be applied.

First, the ADF test for non-stationarity is performed for the integration order of the individual time series. The same integration order leads the path for Johansen's maximum likelihood procedure, where the existence of a long-run equilibrium relationship among total offences, unemployment, real compensations and convicted persons is supported within the examined period. The estimated cointegrating residual is then used as an error correction term in the VECM, where the short-run dynamics are appeared through the statistical significance of all the regressors. Moreover, the negative and statistically significant sign of the error correction term shows that there is a convergence from a short-run condition to the state of a long-run equilibrium.

Concerning the economic activities' behaviour towards the crime rates, it appears that the results yielded are mixed. Both the macroeconomic series (unemployment and real compensation) used in the present model cause an effect to crime rates through different directions. Specifically, a rise in wages operates as an 'opportunity effect' in crime rates, whereas the unemployment rise has a 'motivation effect' to criminal activities with higher sensitivity appeared in the case of wages and compensations, as proved from the variables coefficients. This means that, during fluctuations of the business cycles, an economic depression creates the motive for criminal activities, whereas in times of economic prosperity more opportunities are created for gaining profits from illegitimate actions.

The conviction rates from the Greek justice system can be one of the factors to successfully combat crime, but it proves to be of lower significance. So, further measures concerning the structure and the function of the judicial authorities must be taken in order to increase the prevention from criminal activities.

As for the migration contribution to criminal activities, it proves to be much more insignificant than conviction rates. Perhaps there should be a search in illegal immigrants, because their economic incentives are much greater than the rest immigrants.

There is not certainty from the results yielded that the present variables can best explain the criminal's behaviour. Gross Domestic Product, for instance, could be an alternative type of economic activity, accepted by many economists, although it has the drawback that every monetary exchange is considered as a measure of prosperity, while a percentage of the exchanges are sometimes proved to be baneful for economic development. Another suggestion is the use of other variables that better describe the Greek reality, such as the alcohol consumption, a factor mostly related with violent assaults and car accidents[1], but there is a difficulty due to the limitations of Greek statistics data.

Nevertheless, further analysis of crime rates in the case of Greece must be made, so as to extract more reliable results and be used as policies for their best combating.

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The use of the DEA method for simultaneous analysis of the interrelationships among economic growth, environmental pollution and energy consumption

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Abstract

In this study Data Envelopment Analysis (DEA) is used not only to develop an efficiency index which combines economic activity, CO2 emissions and energy consumption of the production process in the 31 countries of Europe for the year 2004, but also to make estimates about the margins of long term increase or decrease in the consumption levels of exhaustible energy resources of a selected sample (Switzerland, Greece, United Kingdom, and Luxembourg) of European countries (out of 31) which belong to the high income group of OECD members.As shown, each country can achieve better TE when its increased economic activity is combined with improved ecological performance. It can be noticed from the analysis that the developed economies that tend to stabilize their environmental degradation through time (Switzerland), as the GDP (per capita GDP) increases, ensure satisfactory margins for the increase in the consumption of the 'dirty' energy index (DEI) in the long term, and thus contribute to sustainable economic development. This fact is significantly different in countries showing either intense deterioration (Greece) or temporary improvement (United Kingdom, Luxemburg) in the pollution levels without any indications of a temperate stabilization of environmental degradation.

Keywords: Technical Efficiency index, Sustainability, Energy Consumption, Environmental Pollution, Economic Development, DEA, Future Estimations.

JEL classification: Q01, Q32.

1. Introduction

The Data Envelopment Analysis (DEA) developed by (Charnes *et al* in 1978, is one of the most established methods for assessing efficiency and comparative analysis of Decision Making Units (DMUs) which function in a system that consists of uniform units.

The (DEA) method is based on a model of linear programming in order to define the TE levels, in cases of constant or variable returns to scale. The DEA in particular can be carried out either with the assumption of Constant Returns to Scale

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(CRS)[1] (Thanassoulis, 2001) according to the model of (Charnes *et al.*, 1978) or with the assumption of Variable Returns to Scale (VRS)[2] (Thanassoulis, 2001) according to the model of (Banker *et al.,*1984).

Furthermore, the technical efficiency as defined by the DEA method for constant or variable returns to scale, can be calculated either based on output orientation, thus resulting in a model that attempts to maximize outputs holding the observed amount of any input constant, or based on input orientation thus resulting in a model whose objective is to minimize inputs, keeping the observed amount of any output constant (Coelli et al., 2005).

In the present study, the Technical Efficiency index (TE) is defined as an output maximization linear programming problem for constant inputs, applied for constant returns to scale. This index (TE) which functions as an efficiency measure of the productive process in the economic systems of the Decision Making Units (DMUs) (which are European countries), is related to how well the inputs are transformed into outputs.

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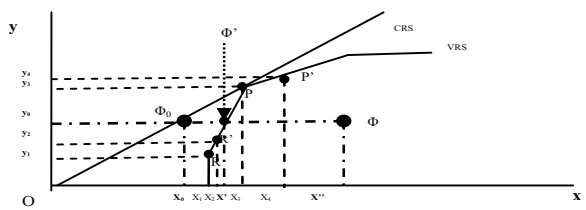
[1] In the DEA model of Constant Returns to Scale (CRS) (Charnes, Cooper and Rhodes (1978)), the more x increases (which constitute the inputs or, in other words, the production factors used in the productive process), the more y increases (which constitute the output produced), at an equivalent quota. E.g. if the number of the productive factors is doubled, then the quantity of the output is doubled as well). Diagram 1 shows how an input (x) is used to produce an output (y). If assumed that the output is changed in direct proportion to the input (Constant Returns to Scale), the efficiency frontier is defined by a straight line starting from the beginning of the axes (which determine the production function) and passes through the point of the unit with the highest ratio of outputs to inputs (Charnes *et al*., 1978). These units are (Φ_0 or P). Unit (Φ)-is 'inefficient' since it could produce the same amount of output with less amount of input by (X''-X_0). The inefficiency of Φ is determined by the ratio $TE=y_0\Phi_0/ y_0\Phi$.

[2] In the case of Variable Returns to Scale (VRS), when x increases then y increases either less (descending returns to scale), or more (increasing returns to scale) than the increasing quota of x.

The DEA model of Variable Returns to Scale (Banker, Charnes and Cooper (1984)) is chosen when it is not previously known if a percentage change of inputs would cause an equivalent percentage change in output/s. More specifically, in the case of increasing organizational complexity of the DMUs due to an increase in the size and the variety of their activities, the outputs are not modified in a way directly proportional to the inputs (Variable Returns to Scale) (Banker *et al.*, 1984). According to (Diagram 1), the DMUs R, R', P, P' that are found on the curve of the variable returns to scale are efficient. The efficiency frontier is formed if the efficiency data (outputs/inputs) of the specific DMUs are joined with straight lines. As a result, concerning VRS, the inefficiency of the organization (Φ) is expressed using the ratio $TE=y_0\Phi'/ y_0\Phi$. This ratio shows that the magnitude of inefficiency is less in this case than when we have constant returns to scale such as $OX'/OX'' > OX_0/OX''$.

Diagram 1: Determination of TE both in Constant and Variable Returns to Scale



- A move from R → to R' on VRS, states increasing returns to scale
- A move from P → to P' on VRS states decreasing returns to scale

Source: Adapted from Charnes A., Cooper W.W., Rhodes E., (1978), 'Measuring the efficiency of decision making units', *European Journal of Operational Research,* 2: 429-444.

The cases where the index has high values are a result of the countries' orientating towards exploitation of cleaner forms of energy, through gradual substitution procedures between dirty and clean energy. The more a country abstains from the consumption and flaring of fossil fuels, the greater the convergence between the quantitative increase and the qualitative improvement of the product (total output) since the maximization of the desirable output (GDP) comes with the diachronic stabilization of the undesirable byproduct and therefore from the preservation of exhaustible natural resources stock or alternatively of fossil fuels (oil, coal, and natural gas). The qualitative improvement of the product can guarantee a) the stabilization of environmental degradation by controlled exploitation of fossil fuels and b) better prospects for a long-term sustainable economic activity.

2. Definition of sustainable economic development

The concept of sustainability which refers to development (qualitative improvement of the product) (Pezzey, 1989; Toman, Pezzey and Krautkraemer, 1995) rather than to growth (the quantitative increase of the product (i.e. increase of Gross Domestic Product)) – *according to Herman Daly's definition that sustainable development is 'development without growth in throughput of matter and energy beyond regenerative and absorptive capacities.'* Renders the concepts of sustainability and growth totally incompatible. The theoretical approaches to the subject of sustainable economic activity are those of environmental economics (as a subset of neoclassical economics) and of ecological economics. In particular, neoclassical economics claim that the sustainability of economic systems is achieved by economic growth processes whereas ecological economics support economic development.

In the neoclassical approach of environmental economics the relation between economy and environment is clearly explained. No longer does the welfare or the utility analysis depend only on consumption levels, but also on other factors, such as the environmental quality, natural resource stock, and pollution (Grossman *et al.*, 1995; Wagner, 2006). In this case, the productive process is the result of the combination of capital, labor and natural resources, while the pollution factor is an externality, something which leads to failure to fully assess the environmental degradation (Goodland et al., 1987). For instance, according to environmental economics, the scarcity of the natural resources which is reflected in the market system through the gradual increase in the price of these resources, is 'treated' by procedures of continuous substitution between the industrial and natural capital, of full recycling of the material, whenever possible, and by using various technological innovations in the production process. According to neoclassical economics, these mechanisms render the economic system effective and guarantee continuous economic growth without having to impose certain limits on the economic activity.

On the other hand, the connection between ecosystems and economic systems is the structure of the so-called 'arising new paradigm'. In this case, not only do we have the relationship between the economic system and the environmental system (in which all forms of life are preserved) but also the culture, technology, organization of politico-

economic system, and the size of population, which constitute compound elements of the multilateral ecological system (Christensen, 1989). In ecological economics, the economic development is regarded as an improvement of the natural dimensions of the economy. The productive process is examined as a process of material transformation through the use of energy and the use of capital and labor, considering the waste as an inevitable by-product. Great importance is placed on the differentiation between individual and social values, as well as on the evolution, preservation of mass, non-irreversibility, and the possibility of a gradual substitution among certain natural resources (Hediger, 1997) as the substitution possibilities among the various capital forms (i.e. between manufactured and natural capital) are quite limited and even nonexistent at times (Daly, 1992, Turner and Pearce 1992). Supporters of ecological economics insist on the fact that the damages inflicted on nature and the environment can lead to a potential ecological devastation through continuous economic growth. Furthermore, they are very worried about the adaptability levels of the ecosystems which depend on the complex links between the global geo-biochemical procedures and on the biosphere functions related to 'life provision' and are signi-ficantly aggravated due to human activities.

In this paper, which forms a part of the theoretical setting of ecological economics, the concept of Economic Development refers to a combination of both quantitative and qualitative dimensions. The definition of the TE index, through the Data Envelopment Analysis (DEA) method, successfully describes the intense interaction between ecological performance and economic activity. This index is a clear indication both of the levels of sustainability of the economic activity – as at the same time it calculates the intense interrelation between environmental pollution, energy consumption, and economic activity in the productive process (Ramanathan, 2002) – and the long term possibilities of gradual substitution[3] among energy resources.

3. DEA characteristics

The DEA is an alternative non-parametric approach, in which the evaluation of the efficiency of the system is carried out with empirical data, without formerly adopting specific production functions that relate inputs with outputs. It is important that the DEA is not influenced by a small data sample. So that comparative evaluation between two or more DMUs is achieved, the methodology can be used for a combination of inputs/outputs that consists of at least two inputs and one output or two outputs and one input. This technique is not bound by the units of measurement of multiple inputs-outputs, since they can differ significantly.

These characteristics of the DEA method, and in particular a) the lack of commitment to using a specific production function that relates input(s) to output(s) and b) the possibility of using simultaneous multiple inputs and outputs, which can be specified by different units of measurement, provide the researcher with the possibility of undertaking alternative approaches, alternative input and output combinations and thus more in-depth examination of complicated issues.

[3] The substitution possibilities for sustainability concern either the DEI and CEI indexes, or the partial DEI indicators (e.g. substitution of the more dirty oil and coal indexes with the less dirty natural gas, which, however, is still exhaustible like the other two).

This paper is centered on sustainable economic development procedures and not on economic growth procedures. This means that the result of the production process is not limited to the GDP production but integrates the environmental degradation factor (CO2 emissions) as an inevitable byproduct of the production process (Lozano and Gutierrez 2008). The input, which in this case is responsible for the simultaneous production of both the desirable product (GDP) and the undesirable byproduct (CO2 emissions, from the consumption and flaring of fossil fuels) is the total energy consumption, composed of the renewable and exhaustible energy resources.

In contrast to the econometric approaches that attempt to define the absolute efficiency of the organization in relation to one comparative reference point (benchmark) that has been externally defined as standard, the non-parametric or non-econometric approaches aim to evaluate the efficiency of an organization either with another DMU in the same system of uniform units (European countries), or with a combination of DMUs. As a consequence, DEA constitutes a good evaluation standard of the relative efficiency of a DMU, but not of the absolute efficiency, as there is no comparison with what is regarded as maximal (Cooper *et al*., 2006).

Furthermore, the DEA which actually embodies all the production possibilities that are observed for a specific sample of uniform Decision Making Units (DMUs), adopts a linear programming approach so as to produce a non-parametric linear curved frontier, so that all studied units are enveloped by this frontier (Thanassoulis, 2001). By using this empirical frontier[4], based on the DEA method, the efficiency levels of each

[4] Definition of the Efficiency Frontier through an output oriented model of Constant Returns to Scale: In order to define the Efficiency Frontier through an output oriented model of Constant Returns to Scale, we take the simple case of two outputs and one input. By comparing the combination of the existing and the optimal inputs and outputs, the so called efficiency frontier is formed, which represents the best practice technology. The efficiency frontier is formed by a line joining the adjacent points corresponding to those organizations (countries) that in the production function present the highest ratio of outputs to inputs. As such, the frontier formed by such a procedure covers the non-efficient Decision Making Units as well (Cooper *et al*., 2006).
The 'Units' found on the efficiency frontier (which represents the best practice technology), are characterized as 'Units' of full efficiency or best practice 'Units' and they are no other than the units/countries with the most effective combinations of production factors for a specific period of time (Cooper *et al.,*2006). The maximum efficiency is defined in relation to the various production possibilities that result from the already existing mixture of inputs and outputs, so that the outputs can be maximized by using available inputs (output oriented efficiency) (Coelli *et al*., 2005) (Diagrams 2, 3). The most efficient 'Unit' becomes the benchmark for the other units/countries, the efficiency deficit of which is determined by their distance from the frontier.
Alternatively, the efficiency frontier serves the benchmarking of goals and constitutes a point for comparative analysis of the inefficient 'Units', since the deficit 'Units' can under certain circumstances imitate the productive practices that best practice 'Unit' implements, and thus become efficient themselves.
For example, the inefficiency of a 'Unit K' (Diagram 3) depends on its distance from the efficiency frontier for a specific mixture of inputs and outputs which is exclusive to 'Unit K'. Consequently, the distance of an inefficient unit/country from the efficiency frontier expresses the lack of its efficiency, which is related to how much it must improve in order to become efficient.

(DMU) are determined by their distance from the frontier (Diagrams 2, 3). In this way, all the potential efficient combinations of outputs that a 'Unit' can produce at a specific time can be described. It is all about a non-stochastic approach, since it considers that every deviation from the frontier is the result of the lack of efficiency. When considering large problems, the separate application of linear programming for every DMU results in intensified calculations, thus placing the method at a dis-advantage.

The non-parametric nature of the DEA method does not allow for the application of statistical tests since the statistical error that can be caused by lack of data, measurement errors, etc. is not taken into account. Even if the noise is regular with zero mean, it can cause important problems in the evolution of an empirical analysis. It is important that what the DEA considers as 'inefficiency', for the parametric econometrical methods it is a combination of two components: the real 'inefficiency' and the statistical error. On the other hand, being a non-parametric method (in which the efficiency is calculated without considering parameters), DEA provides the researchers a significant freedom in defining inputs, outputs and production functions.

4. The model (DEA formulation)

The DEA is a multi-factor productivity analysis model for measuring the relative technical efficiencies of a homogenous set of decision making units (DMUs). This index, in the presence of multiple input and output factors, is defined as: The ratio of the sum of outputs to the sum of inputs that have been weighed with weighted factors

$$TE = \frac{\text{Weighted Sum of Outputs}}{\text{Weighted Sum of Inputs}} \qquad (1)$$

It is characteristic that DEA gives separate weights to each input and output, weights which are extracted after all possible linear combinations of peer DMUs (which produce at least the same result as the Decision Making Unit examined) have been checked.

Diagram 2: Output orientation in the case of Constant Returns to scale

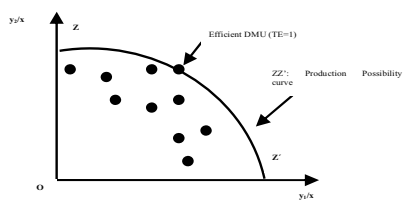
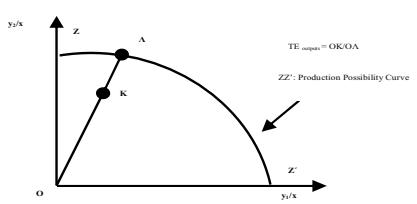


Diagram 3: TE in the case of output orientation based on Constant Returns to Scale



Source: Cooper W., Seiford Lauwrence M., Tone Kaoru, (2006), *Introduction to Data Envelopment Analysis and its uses with DEA-Solver Software and References*, Springer, USA.

Assuming that there are n DMUs, with m inputs and s outputs each, the level of relative efficiency of one of them (even of p DMU) arises as a result of the solution of the following model, described by (Charnes et al., 1978):

$$\max \frac{\sum_{k=1}^{s} v_k y_{kp}}{\sum_{j=1}^{m} u_j x_{jp}}, \qquad \text{s.t} \frac{\sum_{k=1}^{s} v_k y_{ki}}{\sum_{j=1}^{m} u_j x_{ji}} \leq 1, \qquad \forall i \;\; v_k, u_j \geq 0 \;, \qquad \forall k, j \quad (2)$$

where

k=1 to s,
j = 1 to m,
i = 1 to n,

y_{ki} = amount of output k produced by DMU i,

x_{ji} = amount of input j utilized by DMU i,

u_k = weight given to output k,

u_j = weight given to input j.

The model that we apply in this study is valid for units that work under constant returns to scale. The weighted ratio of outputs to inputs will range between 0 and 1 for all the DMUs of the model.

The fractional program shown as (2) can be converted to a linear program if either the denominator or numerator of the ratio is forced to be unity. By setting the denominator of the ratio equal to unity, one can obtain the following output maximization linear programming problem for constant inputs.

$$\max \sum_{k=1}^{s} v_k y_{kp} \quad \text{s.t} \quad \sum_{j=1}^{m} u_j x_{jp} = 1 \;\; \sum_{k=1}^{s} v_k y_{ki} - \sum_{j=1}^{m} u_j x_{ji} \leq 0, \quad \forall i \;\; v_k, u_j \geq 0, \;\; \forall k, j \qquad (3)$$

The above problem is run n times in identifying the relative efficiency scores of all the DMUs. Each DMU selects input and output weights that maximize its efficiency score. In general, a DMU is considered to be efficient if it obtains a score of 1, and conversely considered inefficient if the score is less than 1.

5. Data

In this study, in order to estimate the technical efficiency index of the production process in the 31 countries of Europe for the year 2004, we apply through DEA a model with two inputs (CEI, DEI) and two outputs (GDP, CO2 emissions). For *the economy machine to 'work',* we need primary[5] energy consumption, broken down into two indexes: a) the 'dirty' energy consumption index (DEI) and b) the 'clean' energy consumption index (CEI). The DEI index is the sum of the consumption of oil (DPET), coal (DCOA), and natural gas (DNAT) while the CEI index is the sum of the

[5] Primary energy is the energy content of the energy carriers that still has not been modified or processed.

consumption of nuclear (CNE), geothermal (CGSW) and hydro-electric (CHP) energy. The exploitation of these natural resources in the productive process, yields one 'desirable' (GDP) and one 'undesirable' output, which is the environmental pollution (CO2 emissions) (Schmalensee *et al.*1998).

An essential point regarding the inputs and outputs is that they are not specified in the traditional sense of DEA. GDP and CO2 emissions are therefore not the outputs solely due to fossil and non-fossil energy consumption. The context of the current application demands them to be interpreted as the representative outputs and inputs relevant to the calculation of the efficiency index. An analogous macro economic context of DEA applications have been described/presented in the literature (Ramanathan, 2006; Golany and Thore, 1997).

In order to treat the undesirable factor in the model, a nonlinear monotone decreasing transformation 1/b is applied to the CO2 emissions, which in this study are considered as by-product, a direct consequence of the productive process. Specifically, the undesirable[6] output (CO2 emissions), is entered as its reciprocal value (1/CO2) in the DEA model**.** The data used cover a time period of 25 years from the 1980's to the mid 2000's. For this specific time period, having studied a selected sample of European countries (out of 31) which belong to the high income group of OECD members, we can under certain circumstances estimate (*applying a procedure (Appendix B) similar to those implemented by* (*R.Ramanathan, 2006)*) the margins of long term increase or decrease in the levels of exhaustible energy resources of these countries (i.e. in 2025/2030). These estimations depend directly on the maximization of the TE index in 2025 and 2030 respectively. At the same time, we consider that a) CO2 emissions at that time *(2025 or 2030)* are maintained at the same levels as in 1990 and that b) the definition of the indexes of 'clean' energy (CEI) and GDP for the same year *(2025 or 2030)* is based on a reference case[7].

6. Empirical applications of the model

6.1 Definition of the TE index for 31 European countries by using the DEA method

In the following table (Table 1) the 31 countries of Europe are classified according to the index of technical efficiency (TE) and the per capita indexes of: GDP, environmental pollution (CO2 emissions), and energy consumption (DEI, CEI) for the year 2004. The formation of the TE index is the result of the information that it contains and concerns the intensity of the economic activity, the extent of ecological degradation, and the management of energy resources of each country.

[6] Other methods for treating undesirable factors in DEA:

- Ignoring undesirable factors in Dea models
- Treating undesirable outputs (inputs) as inputs (outputs)
- Treating undesirable factors in nonlinear DEA model (Fare et.al., 1989)
- Using a linear monotone decreasing transformation to deal with undesirable factors (Seiford and Zhu, 2002)
- Directional distance function approach (Fare and Grosskopf, 2004a)

[7] The reference case describes what will happen if, the already observed, economic and technological tendencies continue. Aim of the reference case is to quantify the energy-economic evolution, in a way that it can prove useful as a reference point for the evaluation of alternative energy policies.

Table 1

04' Countries	TE	R TE	GDP p.c	R GDP p.c	CO2pc	R CO2 pc	CEIpc	R CEI pc	DEI Pc	R DEI Pc	POP	R POP
Albania	**0,294**	**16**	1,945	28	1,1894	1	0,0152	17	0,0175	1	3,54	27
Austria	**0,494**	**8**	24,870	10	8,5364	17	0,0489	7	0,1342	20	8,17	17
Belgium	**0,295**	**15**	23,377	13	14,266	29	0,0479	8	0,2109	29	10,35	13
Bosnia & Herzegovina	**0,077**	**29**	1,265	30	3,0387	2	0,0140	18	0,0433	2	4,35	25
Bulgaria	**0,058**	**30**	2,021	27	6,2687	11	0,0272	13	0,0921	10	7,52	18
Croatia	**0,175**	**22**	4,874	22	4,8036	6	0,0110	22	0,0737	7	4,50	24
Czech Republic	**0,112**	**25**	6,105	20	10,970	25	0,0300	11	0,1443	22	10,25	14
Denmark	**0,570**	**5**	30,684	5	10,261	22	0,0180	16	0,1434	21	5,41	21
Finland	**0,409**	**11**	25,212	9	11,789	27	0,0903	4	0,1641	27	5,21	22
France	**0,576**	**4**	23,402	12	6,7099	13	0,0836	5	0,1083	15	60,46	3
Germany	**0,414**	**10**	23,732	11	10,460	23	0,0267	14	0,1528	25	82,42	1
Greece	**0,259**	**18**	12,420	17	9,9677	21	0,0055	28	0,1275	18	10,65	11
Hungary	**0,155**	**23**	5,453	21	5,6201	8	0,0123	19	0,0937	11	10,03	15
Iceland	**0,558**	**6**	31,498	4	12,099	28	0,3414	1	0,1497	24	0,29	31
Ireland	**0,497**	**7**	29,256	6	10,694	24	0,0034	30	0,1558	26	3,97	26
Italy	**0,406**	**12**	19,182	15	8,3493	16	0,0102	24	0,1259	17	58,09	5
Luxembourg	**0,276**	**17**	47,436	1	26,621	31	0,0048	29	0,3971	31	0,46	30
FYR Macedonia	**0,094**	**27**	1,791	29	3,7472	4	0,0067	25	0,0487	4	2,04	28
Netherlands	**0,256**	**20**	23,295	14	16,361	30	0,0062	27	0,2424	30	16,32	9
Norway	**0,618**	**3**	39,146	2	11,178	26	0,2376	2	0,1687	28	4,57	23
Poland	**0,134**	**24**	4,840	23	7,4557	15	0,0008	31	0,0960	12	38,58	7
Portugal	**0,299**	**14**	10,31	19	6,027	10	0,0117	20	0,0917	9	10,52	12
Romania	**0,085**	**28**	2,098	26	4,2625	5	0,0104	23	0,0653	6	22,36	8
Serbia & Montenegro	**0,043**	**31**	0,969	31	4,8689	7	0,0112	21	0,0600	5	10,83	10
Slovakia	**0,112**	**26**	4,461	24	7,0891	14	0,0432	10	0,1056	14	5,42	20
Slovenia	**0,258**	**19**	10,782	18	9,0757	19	0,0469	9	0,1110	16	2,01	29
Spain	**0,325**	**13**	16,261	16	8,9844	18	0,0283	12	0,1332	19	40,28	6
Sweden	**0,797**	**2**	28,876	7	6,5733	12	0,1612	3	0,0965	13	8,99	16
Switzerland	**1**	**1**	33,906	3	6,0003	9	0,0824	6	0,0904	8	7,48	19
Turkey	**0,200**	**21**	3,328	25	3,0727	3	0,0067	26	0,0443	3	68,89	2
United Kingdom	**0,476**	**9**	26,187	8	9,6179	20	0,0181	15	0,1465	23	60,27	4

Source: IEA (2004), World Bank (2006).

6.2 Estimations regarding the possibilities of long-term exploitation of exhaustible energy resources in four European countries (Switzerland, Greece, United Kingdom, Luxemburg), which belong to the high income group of OECD members

In this section we take the cases of 4 countries (Switzerland, Greece, United Kingdom, and Luxembourg) that belong to the high-income OECD members and we examine them separately (Appendix B). For each country we determine the average annual percentage change of per capita GDP and per capita CEI for the period 1980-2004 and based on the reference case we evaluate the indexes (GDP and CEI) for the year 2025/2030. In order for the emission levels of CO2 (in 2025/2030) not to exceed those of 1990, we find (through DEA) the percentage change in the index of 'dirty energy consumption' (DEI) for the year 2025/2030 in relation to 2004, so as to achieve maximum efficiency for 2025/2030.

In the following analysis, it becomes obvious that the estimations of the sustainability possibilities concerning the sample of four European countries are directly connected with the significant differentiations that are being observed in the trends of the curve that expresses the course of the index of environmental pollution, as the per capita GDP is being raised (Figures 2, 3, 4, 5). The curve in question, for the time interval being studied (1980-2004), is a result of the way that the energy intensity is formed in the developed economic systems of the four countries belonging to the sample (Figure 1). The energy intensity is determined both from the degree of substitution between energy resources and the type of the substitution (i.e. whether it exists between renewable and exhaustible natural resources, or exclusively to exhaustible resources (i.e. between oil and natural gas). Therefore, the allocation between the two types of energy that each country chooses to use shapes the structure of the entire environmental and economic system that it belongs to and, thus, provides clear markings regarding the margins for long-term, smooth and sustainable economic activity.

The economic activity of developed economies of the sample of four European countries is mainly based on exhaustible energy resources, the combustion of which results in high levels of CO2 emissions. Exhaustible energy resources are the dominant but not the only form of energy exploitation, as the countries appear active in the use of renewable energy resources (Figure 1), the consumption of which does not cause environmental degradation (CO2 emissions), and therefore can guarantee long-term sustainable economic activity. The more a country turns to using more clean forms of energy, the better its TE index, calculated by the ratio of the weighted sum of outputs (total output) to the weighted sum of inputs (total input). In other words, the amelioration in quality of the total product (total output), for given levels of total energy input, is achieved when a substitution exists between the components of total energy input and more specifically when dirty energy consumption is substituted with clean energy consumption, keeping the total energy power which is necessary for the production process constant.

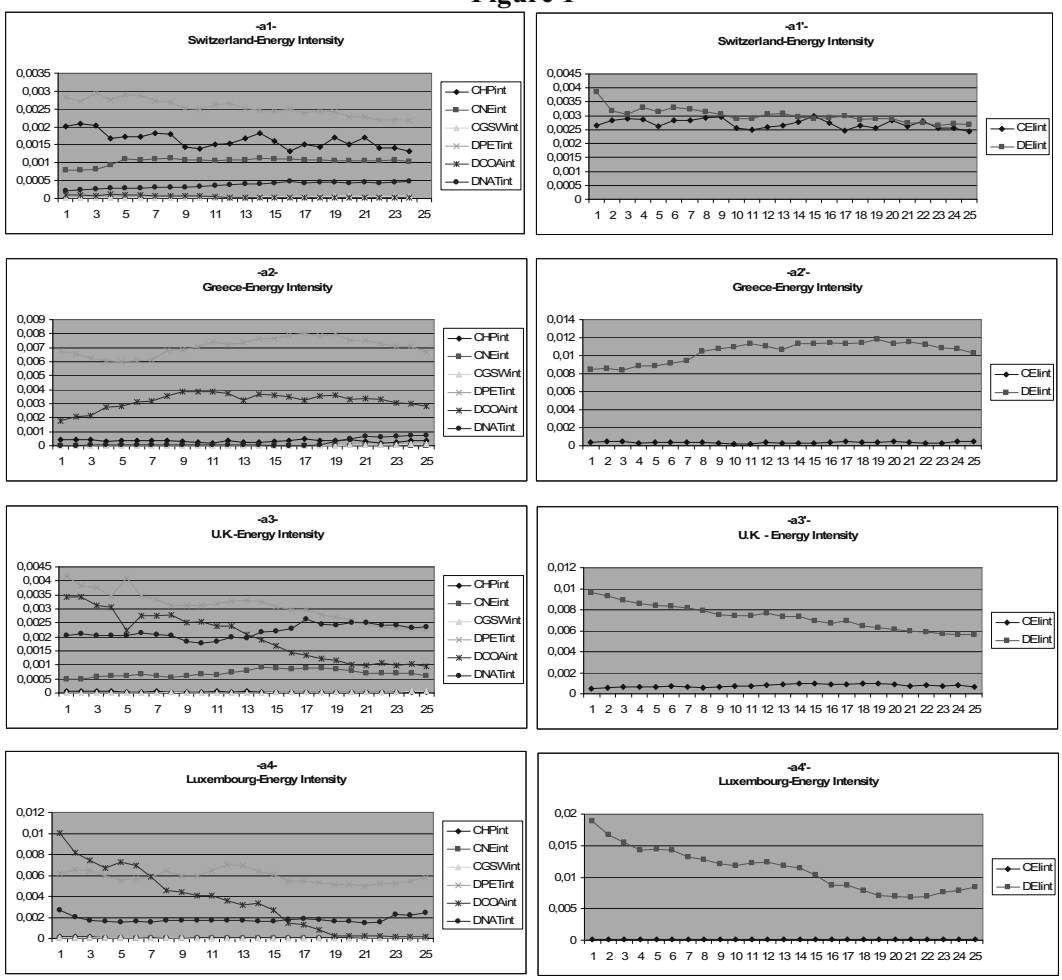
The cases of four countries

Switzerland: For the period 1980-2004 there is a gradual disengagement of Switzerland (Figure 1 -α1-) from oil consumption, which is the main form of energy exploitation in this country. A significant part of the energy power from the consumption and flare of oil, which is responsible for the larger part of CO2 emissions, is substituted mainly by the consumption of natural gas (considered to be the least polluting fossil fuel of the three). Switzerland is the only country in the sample that extensively uses hydro-electric and nuclear energy. The exploitation of these forms of energy has an advantage over natural gas and coal (the consumption of which the country is almost totally free from) (Figure 1 -α1-). Moreover, during the final decade, Switzerland is visibly trying to support the exploitation of geothermal energy, something which increases the prospective for further withdrawal from oil consumption, as the GDP production increases. The formation of the energy intensity in Switzerland during 1980-2004 is responsible for the diachronic stabilization of per capita CO2 emissions as the per capita GDP increases (Figure 2).

The over time stabilization of per capita CO2 emissions (resulting from the abovementioned) as the per capita GDP increases (Figure 2), explains the strong tendency of Switzerland to long term sustainable economic activity that clearly outweighs the rest of the countries in the sample. More specifically, the CO2 emissions assimilation capacity by the natural environment and the ensurance of stabilization of the exhaustible natural resources stock can be satisfactorily achieved by the year 2025 (→provided maximum efficiency) with an increase in the consumption limits of 'dirty energy sources' by 28,827% in relation to 2004 levels (DEI_{2025}=0,872 Quadrillion (10^{15}) Btu).

Similarly, to reach evaluations concerning the year 2030 (→provided maximum efficiency), the increase in the consumption limits of 'dirty energy sources' is about 37,100% in relation to 2004 levels (DEI_{2030}=0,928 Quadrillion (10^{15}) Btu).

Figure 1



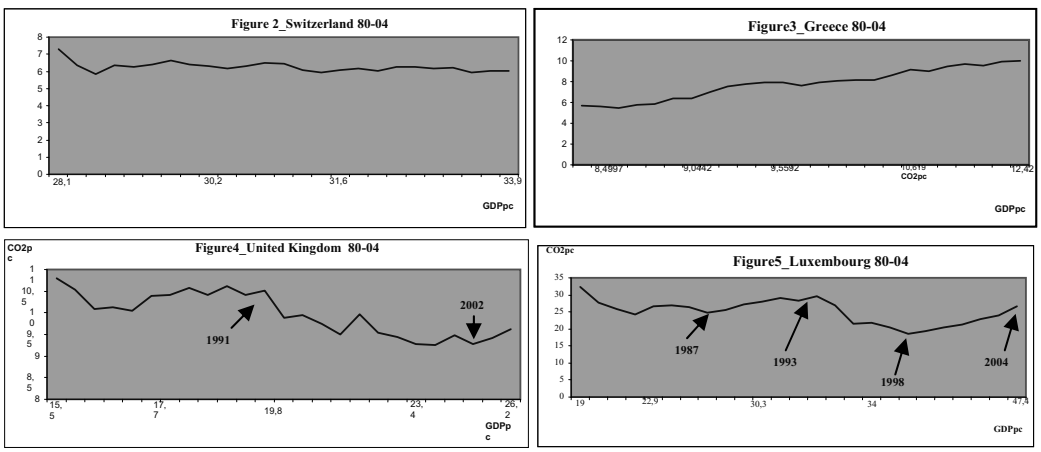
Source: Figure 1 presents the Energy Intensity Indexes, from the processing of data that were furnished by the organizations IEA (2004) and World Bank (2006).

The indexes of Dirty and Clean Energy intensities: *Petroleum=DPETint, Coal=DCOAint, Natural Gas=DNATint, Nuclear Energy=CNEint, Geothermal Energy=CGSWint, Hydroelectric Energy=CHPint*

Dirty Energy Intensity=*DEIint,* Clean Energy Intensity=*CEIint*. *(*The *DEI* index is the sum of the consumption of *(DPET), (DCOA)* and *(DNAT)* while the *CEI* index is the sum of the consumption of *(CNE), (CGSW)* and *(CHP))*.

Greece: In contrast to Switzerland, Greece is one of the worst cases among high income OECD countries concerning the possibilities for long term sustainable economic activity. The diagrams in (Figure 1 -a2-) clearly show a relatively positive evolution in the last few years, mainly from 1999 onwards. As GDP production increases, the mild decline in the consumption of oil and coal is accompanied by a parallel increase in the exploitation of natural gas and geothermal power.

This tendency should be preserved and perhaps continued with an intensified pace for a prolonged period of time, until the stabilization of the per capita CO2 emissions is achieved in relation to the constantly increasing GDP per capita (Figure 3). The case on which the estimations are based for the achievement of full efficiency in 2025/2030, is determined by the behavior of the efficiency index of each country for the period 1980-2004. Resulting from the estimations concerning Greece, the index (DEI) should be reduced by 64,95% by 2025 and by 64,77% by 2030 in relation to the 2004 levels (DEI=0,4758 Quadrillion (10^{15}) Btu for 2025) and (DEI=0,4782 Quadrillion (10^{15}) Btu for 2030) so as to have a significant decrease in the average annual percentage increase of CO2 emissions (2,857% for the period 1980-2004) and be in a position to further consider possibilities of long term sustainability.



Source: The figures 2 to 5 present the results from the processing of data that were furnished by the organizations IEA (2004) and World Bank (2006), and refer to the emission indexes of CO2 and GDP respectively, and by extension to their per capita sizes (CO2pc., GDPpc.).

United Kingdom - Luxembourg: This is a typical example of the United Kingdom with continuous short-term changes in the index of environmental pollution as the per capita GDP increases. Figure 4 shows the per capita emissions of CO2 decreasing, in relation to the constantly growing GDP per capita from 1991 onwards. Such an evolution can be explained if we take into consideration the fact that CO2 emissions where classified as harmful only in the late 1980s, consequently no measurements for the protection of the environment were made until that time. This fact is also confirmed by (Figure 1 -a3-) where from the late 80's, the country's tendency to break free from the exploitation of polluting fuels (oil and coal) and to promote the less dirty natural gas is (clearly) visible.

Thus, a gradual substitution occurs between the more and the less dirty energy resources. Concurrently, the increase in the use of nuclear energy as the GDP increases implies the possibility of the substitution of the exhaustible (dirty) energy resources with the renewable (clean) energy resources. It is known that the United Kingdom is one of the countries that invest in environmental protection to ensure long term sustainable economic activity. This allows the U.K to increase the consumption of dirty energy by 0,454% by the year 2025 and by 3,563% by 2030, in relation to the 2004 levels (DEI=8,8691 Quadrillion (10^{15}) Btu for 2025) and (DEI=9,1436 Quadrillion (10^{15}) Btu for 2030).

This rate is obviously considerably lower than that of Switzerland. Consequently, the long run stabilization of the CO2 p.c index, in relation to the constantly increasing GDP p.c index, proves to be more efficient than a short-term decrease in the CO2 p.c index in relation to the GDP p.c. This finding is also confirmed in the case of Luxembourg (Figure 5), which extensively exploits natural gas, something which, combined with the better energy saving technology (as it is the European country with the highest per capita GDP investing in research and technology), can justify the huge decrease in coal consumption as well as the slight decrease (the final decade) in the consumption of oil as the GDP increases. The fact that the structure of the energy system of Luxembourg is still based on exhaustible energy resources implies short term alternations of the index of environmental pollution, as the per capita GDP is being raised, something which hinders the diachronic stabilization of the environmental degradation levels (CO2 emissions). As the study reveals**,** the consumption of 'dirty' energy should be decreased by 12,65% by 2025 and increased by 0,647% by 2030, in relation to 2004 levels -(DEI=0,1605 Quadrillion (10^{15}) Btu for 2025) and (DEI=0,1849 Quadrillion (10^{15}) Btu for 2030)- to achieve full efficiency by 2025 and 2030, respectively. In the case of Luxembourg, the differentiation between the years 2025 and 2030 is attributed to: a) the effort towards, and significant development in a controlled increase of the average annual percentage change of CO2 emissions for the period 1980-2004 and b) the enlargement of the time horizon by 5 years, which ensures the better assimilation of the country's energy policy measures.

From the behavior of the curve of the U.K (Figure 4), this descending line is reversed from 2002 onwards. Something similar is observed in Luxembourg (Figure 5), where the per capita CO2 emissions index increases as the GDP p.c increases, for the periods 1987-1993 and 1998-2004.

Thus far, our analysis has proved that the countries which invest in a) renewable energy resources e.g. Switzerland (CHP, CNE) and the United Kingdom (CNE) and in b) less polluting fossil fuel (DNAT), ensure better prospects for sustainable economic activity, since their energy policy, which, combined with the new technologies of energy saving that they adopt, attempts not only a controlled increase in the index of CO2 emissions but also its stabilization through time. Regarding the cases of Greece and Luxemburg, countries still depending largely on fossil fuels, Luxemburg has the comparative advantage, as it aims to gradually disengage from the consumption of more polluting fossil fuels (oil, coal), through further exploitation of natural gas.

The greater the convergence between the indexes of dirty (DEIint - with a downward trend) and clean (CEIint - with an upward trend) energy intensity (Figure 1 –a1'-, -a2'-, -a3'-, -a4'-), the wider the margins of long term sustainable economic activity.

Clearly the aim of every developed economy is the gradual decrease of CO2 p.c in relation to the constantly growing GDP p.c. However, in order for the economic systems to cope with such a challenge, first and foremost the long run stabilization of per capita CO2 emissions must be ensured.

7. Conclusions

In the present study DEA is employed to develop an efficiency index (TE) for the simultaneous analysis of the interrelationships among CO2 emissions, energy consumption and GDP of the production process in the economic systems of European countries. The TE index, which is defined as the ratio of the weighted sum of outputs to the weighted sum of inputs, functions as an efficiency measure of the production process in the countries of Europe. The degree of efficiency is specified by the convergence of the quantitative increase and the qualitative improvement of the product (total output).

The amelioration in quality of the total product, for given levels of total energy input, is achieved when a substitution is made between the components of total energy input and more specifically between dirty and clean energy, while keeping constant the total energy power which is necessary for the production process. In other words, the amelioration in quality of the total product (total output) is a result of the way that the energy intensity in European countries is formed. The qualitative improvement of the product can guarantee both the stabilization of environmental degradation through the controlled exploitation of fossil fuels and therefore better prospects for long-term sustainable economic activity.

In this study Data Envelopment Analysis (DEA) is further used to estimate the margins of long term increases or decreases in the exhaustible energy resource consumption levels of a selected sample of European countries (Switzerland, United Kingdom, Greece, Luxembourg). The evaluation of possibilities for sustainable economic development that concern the sample of the four European countries, is directly connected with the significant differentiations that are observed in the trends of the environmental pollution index, as the per capita GDP is raised. These trends are described as follows:

- Stabilizing trend in the per capita CO2 emissions, as the per capita GDP is raised [Case of Switzerland – the best possible]
- Upward course of the environmental degradation index, as the per capita GDP is raised [Case of Greece – the worst]
- Continuous short-term alternations of short time intervals of the environmental degradation index, as the per capita GDP is raised [Case of United Kingdom – intermediate tending towards that of Switzerland]
- Continuous short-term alternations of greater time intervals of the environmental degradation index, as the per capita GDP is raised [Case of Luxemburg - intermediate tending towards that of Greece].

The curve in question, for the time interval that was studied (1980-2004), is a result of the way that the energy intensity of the developed economic systems of the four countries of the sample was modulated. The energy intensity is determined both by the degree of substitution between energy resources and the kind of substitution (i.e. whether the substitution exists between renewable and exhaustible natural resources or exclusively among exhaustible resources). Consequently, the method by which every country takes advantage of its energy sources shapes the infrastructure of the entire environmental-economic system that it belongs to, and therefore provides clear indications of the margins for long-term, smooth and sustainable economic activity.

The more a country abstains from the consumption and flaring of fossil fuels (through the gradual substitution of dirty with clean energy), the greater the convergence of the quantitative increase and the qualitative improvement of the product, since the maximization of the desirable output (GDP) is accompanied by the diachronic stabilization of the undesirable byproduct (CO2 emissions) and therefore the preservation of exhaustible natural resources stock.

Through the analysis above, when a European country is unleashed from the consumption of a 'dirty energy resource' like oil, coal or natural gas, wider margins for assimilation of the emitted Carbon Dioxide by the environment are ensured. In this way the country actively participates as an isolated unit in the global effort to deal with the ecological degradation.

Moreover, when a significant disengagement from a dirty energy resource exists for all the developed economies, not only in Europe but in the whole world as well, there is hope for a stabilization through time of i) a significant part of the exhaustible resources stock and ii) the environmental degradation since the per capita GDP increases. Therefore, the way that the energy system is structured - based on substitution relations between the more and the less 'dirty' fossil fuels, as well as the renewable and exhaustible energy resources - is considered to be vital in ensuring the necessary margins of a sustainable economic activity.

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Appendix A

1. European Countries
The 31 European countries studied are as follows:

Albania (L.M.I), Austria (H.I OECD), Belgium (H.I OECD), Bosnia & Herzegovina (L.M.I), Bulgaria (U.M.I), Croatia (U.M.I), The Czech Republic (H.I OECD), Denmark (H.I OECD), Finland (H.I OECD), France (H.I OECD), Germany (H.I OECD), Greece (H.I OECD), Hungary (U.M.I), Iceland (H.I OECD), Ireland (H.I OECD), Italy (H.I OECD), Luxembourg (H.I OECD), FYR Macedonia (L.M.I), The Netherlands (H.I OECD), Norway (H.I OECD), Poland (U.M.I), Portugal (H.I OECD), Romania (U.M.I), Serbia & Montenegro (U.M.I), Slovakia (U.M.I), Slovenia (H.I nonOECD), Spain (H.I OECD), Sweden (H.I OECD), Switzerland (H.I OECD), Turkey (U.M.I), The United Kingdom (H.I OECD).

L.M.I = Lower Middle Income
U.M.I = Upper Middle Income
H.I OECD = High Income OECD
H.I nonOECD = High Income non OECD
Source: World Bank (2006)

Data availability for Former Yugoslavia and Former Czechoslovakia:

- Former Yugoslavia: 1980-1991 Bosnia and Herzegovina, Croatia, FYR Macedonia, Serbia and Montenegro, Slovenia: 1992-2004
- Former Czechoslovakia: 1980-1992 Czech Republic, Slovakia: 1993-2004

The European countries which we have chosen are based on:

a) the geographical classification according to the *World Bank (2006)* (source for the index of economic development) and the *Energy Information Administration EIA (2004)* (source for the index of energy consumption and environmental pollution) and b) the data availability of the four index categories of the countries examined for the period 1980-2004.

2. Indexes

a) GDP

We refer to real Gross Domestic Product (GDP)
Units: Current US$ adjusted to 2000 base (billions of 2000 dollars)
Source: World Bank-World Development Indicators (2006)

b) DEI-CEI

Total primary energy consumption includes the consumption of petroleum, dry natural gas, coal, hydroelectric, nuclear, and geothermal, solar and electric wind power. Total primary energy consumption for each country also includes net electricity imports. This is because the net electricity consumption by energy type data, are in fact net electricity generation data that have not been adjusted to include electricity imports and exclude electricity exports.
Units: Quadrillion (10^{15}) Btu
Source: EIA (Energy Information Administration)-International Energy Annual (2004)

c) CO2 emissions

Total carbon dioxide emissions from the consumption and flaring of fossil fuels, measured in million metric tons of carbon dioxide, include carbon dioxide emissions from: the consumption and flaring of petroleum, coal and natural gas.

Source: EIA (Energy Information Administration) International Energy Annual (2004)
Among the 6 gases responsible for the green house effect (CO2: Carbon Dioxide, CH4: Methane, N2O: Nitrous Oxide, HFCs: Hydrofluorocarbons, PFCs: Perflourocarbons, SF6: Sulfur Hexafluoride), we chose to introduce CO2 (having the highest emission levels compared to the other gases) in the model as a representative index of environmental pollution.

Appendix B

Switzerland

T	GDP	CO2	DEI	CEI	TE
1980	179,88	46,62	0,6918	0,4750	**0,739**
1981	182,72	41,03	0,5787	0,5154	**0,927**
1982	180,10	37,95	0,5495	0,5220	**1,000**
1983	181,01	41,50	0,5976	0,5203	**0,897**
1984	186,49	41,04	0,5885	0,4898	**0,914**
1985	192,86	42,20	0,6360	0,5483	**0,884**
1986	196,00	44,14	0,6365	0,5583	**0,876**
1987	197,44	42,61	0,6196	0,5802	**0,921**
1988	203,58	42,53	0,6206	0,5993	**0,941**
1989	212,42	42,00	0,6184	0,5418	**0,952**
1990	220,37	43,36	0,6351	0,5507	**0,941**
1991	218,61	45,02	0,6641	0,5652	**0,893**
1992	218,33	45,24	0,6701	0,5756	**0,887**
1993	217,28	43,14	0,6421	0,6046	**0,944**
1994	218,44	42,36	0,6325	0,6529	**0,980**
1995	222,66	43,53	0,6504	0,6124	**0,946**
1996	223,82	44,59	0,6668	0,5512	**0,902**
1997	228,09	43,43	0,6518	0,6033	**0,955**
1998	234,46	45,29	0,6803	0,6015	**0,920**
1999	237,54	45,59	0,6859	0,6719	**0,936**
2000	246,05	44,96	0,6725	0,6457	**0,971**
2001	248,61	45,53	0,6826	0,6991	**0,972**
2002	**249,42**	**43,95**	**0,6602**	**0,6354**	**1,000**
2003	248,54	44,72	0,6722	0,6373	**0,977**
2004	253,76	44,91	0,6769	0,6164	**0,976**

Greece

T	GDP	CO2	DEI	CEI	TE
1980	84,00	54,63	0,714330	0,0353	**0,990**
1981	82,70	54,92	0,710607	0,0355	**0,980**
1982	**81,76**	**53,37**	**0,688563**	**0,0371**	**1,000**
1983	80,88	56,67	0,716798	0,0245	**0,938**
1984	82,50	58,17	0,730008	0,0298	**0,947**
1985	84,57	62,99	0,776581	0,0292	**0,914**
1986	85,01	63,73	0,799260	0,0337	**0,897**
1987	83,09	69,78	0,866601	0,0289	**0,807**
1988	86,65	74,88	0,933160	0,0244	**0,779**
1989	89,95	78,20	0,981229	0,0197	**0,765**
1990	89,95	80,45	1,018046	0,0182	**0,736**
1991	92,74	81,07	1,022298	0,0320	**0,768**
1992	93,39	78,78	0,994389	0,0240	**0,789**
1993	91,89	82,41	1,044667	0,0246	**0,740**
1994	93,73	83,94	1,058815	0,0276	**0,748**
1995	94,64	85,03	1,084732	0,0374	**0,742**
1996	96,87	85,80	1,093856	0,0460	**0,756**
1997	100,39	90,27	1,150886	0,0407	**0,743**
1998	103,77	95,98	1,228089	0,0398	**0,720**
1999	107,32	94,72	1,215939	0,0500	**0,755**
2000	112,13	100,28	1,294480	0,0432	**0,740**
2001	116,90	102,26	1,315721	0,0307	**0,755**
2002	121,30	101,52	1,312525	0,0367	**0,788**
2003	126,95	105,29	1,369223	0,0606	**0,795**
2004	132,24	106,13	1,357357	0,0583	**0,835**

Source: IEA (2004), World Bank (2006)

United Kingdom

T	GDP	CO2	DEI	CEI	TE
1980	872,14	608,30	8,3831	0,457673	**0,867**
1981	861,05	593,69	8,0420	0,474231	**0,923**
1982	876,54	568,86	7,8241	0,547458	**0,990**
1983	909,39	570,90	7,7909	0,614824	**0,996**
1984	931,66	566,88	7,8309	0,620148	**1,000**
1985	966,91	588,25	8,0527	0,682019	**0,945**
1986	1007,61	591,23	8,2199	0,665491	**0,926**
1987	1052,23	602,53	8,3701	0,638841	**0,897**
1988	1106,60	595,42	8,2819	0,725745	**0,923**
1989	1129,95	608,00	8,4290	0,819938	**0,894**
1990	1137,39	598,48	8,4273	0,809818	**0,907**
1991	1120,71	606,55	8,5721	0,893173	**0,881**
1992	1121,52	571,86	8,2396	0,974882	**0,967**
1993	1147,63	577,69	8,4074	1,113785	**0,943**

1994	1197,98	567,26	8,3585	1,126419	**0,968**
1995	**1233,52**	**555,00**	**8,2790**	**1,125266**	**1,000**
1996	1266,69	584,01	8,8093	1,180742	**0,902**
1997	1308,38	560,67	8,4556	1,234271	**0,978**
1998	1349,20	557,35	8,4375	1,267855	**0,989**
1999	1386,96	550,20	8,4935	1,225891	**0,997**
2000	1438,28	551,02	8,5493	1,108244	**0,993**
2001	1471,39	566,16	8,6296	1,154986	**0,964**
2002	1497,41	555,29	8,5252	1,147718	**0,995**
2003	1530,27	566,46	8,6564	1,211457	**0,966**
2004	1578,28	579,68	8,8290	1,093179	**0,932**

Luxemburg

T	GDP	CO2	DEI	CEI	TE
1980	6,93	11,77	0,13107	0,00119	**0,556**
1981	6,89	10,12	0,11526	0,00134	**0,721**
1982	6,97	9,48	0,10849	0,00122	**0,801**
1983	7,17	8,88	0,10210	0,00121	**0,899**
1984	7,62	9,80	0,10983	0,00128	**0,781**
1985	7,84	9,90	0,11226	0,00109	**0,749**
1986	8,45	9,70	0,11154	0,00121	**0,782**
1987	8,65	9,16	0,11005	0,00149	**0,850**
1988	9,54	9,64	0,11531	0,00146	**0,788**
1989	10,48	10,24	0,12393	0,00113	**0,695**
1990	10,71	10,72	0,13055	0,00106	**0,637**
1991	11,37	11,29	0,14041	0,00124	**0,584**
1992	11,88	11,13	0,14057	0,00102	**0,586**
1993	12,91	11,79	0,14705	0,00107	**0,548**
1994	13,45	10,87	0,13934	0,00161	**0,638**
1995	13,94	8,83	0,12081	0,00141	**0,861**
1996	14,40	9,02	0,12494	0,00102	**0,802**
1997	15,60	8,61	0,12287	0,00132	**0,877**
1998	**16,67**	**7,95**	**0,11838**	**0,00170**	**1,000**
1999	17,98	8,42	0,12529	0,00152	**0,913**
2000	19,60	8,94	0,13228	0,00202	**0,858**
2001	19,91	9,41	0,13898	0,00221	**0,794**
2002	20,40	10,37	0,15654	0,00198	**0,660**
2003	20,99	10,96	0,16498	0,00168	**0,604**
2004	21,95	12,32	0,18374	0,00221	**0,514**

The process that we apply in order to draw estimations regarding the sustainability possibilities of the 4 countries is as follows: → The performance of the countries for the year (2025 or 2030) is included in the table for each country as a new 'DMU'. → We use GDP, CEI data for year (2025/2030) from the reference case. → We consider that CO2 emissions at that time are equal to the emissions for the reference case year 1990.

In the beginning, in order to run the program we assigned an arbitrarily high value for the fossil fuels consumption index (DEI), so that at first, the studied country appeared as inefficient (in 2025 or 2030 respectively). Then we gradually reduced the value that we set until the point that the country showed full efficiency (with TE=1) in 2025 or 2030 respectively, and simultaneous inefficiency (from 1,000 to 0,999) for the year that rendered it fully efficient before the introduction of the additional 'DMU'.

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Cost Effectiveness of Paying Value Added Tax from the Viewpoint of Businesses

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Abstract

Value added tax has been part of the economic reality in the business environment of the Slovak Republic for more than 16 years. It is a tool of general indirect taxation of the final consumption. The aim of this paper is to present partial results of the value added tax complex analysis in terms of cost ratio. The object of this research involves the share of incurred cost of businesses and the amount of tax liability in case of value added tax. The classification of questionnaire research respondents is done according to the division of businesses into small, medium-sized and large businesses in Slovakia.

Keywords: Value Added Tax, Incurred Costs, Small, Medium-Sized, Large Businesses.

JEL classification: M41, H25

Introduction

From the historical perspective, indirect taxes are considered younger than direct taxes. From the very beginning these taxes burdened end consumers and did not take into account their incomes and property. Since its establishment on 1 January 1968 (the first country to introduce value added tax was France), value added tax has been considered unfair due to its rate equal for all subjects irrespective of the amount of income. On the other hand, businesses as registered taxpayers serve as unpaid collectors of this tax. Besides paying the tax (at the level of businesses), value added tax incurs, above all, macroeconomic effects as indirect taxes make a significant part of budget incomes in European countries. Every year the revenue from indirect taxes makes approximately 60 % of tax revenue of the Slovak state budget.

1. Value added tax in the Slovak Republic and other countries of the European Union

There are a number of sources that bring different opinions and definitions of value added tax. Summarizing these opinions we can characterize this statutory, non-equivalent payment to the state in certain periods and amounts as a multi-phase excise tax of general character, which can be connected with the process of taxing the added value. Through the prices of goods and services it is a burden for the end consumer (Sopkova, Spisiakova, 2007). The payers of this tax are subjects that supply, import and export goods and services and that collect value added tax from customers.

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The tax is indirect in the sense that the taxpayer (bearer of tax burden) and the tax collector are independent subjects, which is a characteristic feature of excise taxes. The European Commission (2000, p.13) defines this tax as 'a general consumption tax, which is directly proportional to the price of goods and services. It is collected fractionally, i.e. on each transaction in the economic chain, and is neutral'.

Compared to other turnover taxes, this tax has a great advantage in its final share of the price of outputs being set as a statutory rate and not discriminating commodities with several stages of processing.

1.1. International context of value added tax

Besides the mentioned economic effects, value added tax has also an international dimension. The on-going discussion within the European Union is whether the harmonized system of this tax is efficient. The EU market consists of a number of economies with different legal systems and structures. The important instruments to harmonize value added taxes are various regulations and directives. The most important directive before 31 December 2006 was the Sixth Council Directive of 17 May 1977 harmonizing legal regulations of the member states for turnover tax – a common system of value added tax, a single base for its setting No. 77/388/EEC. Its main goal was to harmonize and exactly define notions related to value added tax. In order to make it simpler and more rational this directive was replaced by Directive 2006/112/EC on the common system of value added tax. It came into effect on 1 January 2007 and includes the rules on value added tax applied in the whole European Union. They are clearly formulated: the lowest base of value added tax must not go below 15%; member states can apply one or two lowered tax rates for exactly specified goods and services. Nevertheless, the rate must not be lower than 5%, and meeting the requirements, the countries can use the lowered rate with particular personal services. Yet, these rules are too complicated due to a number of exemptions allowed to some countries at their admission to the Union. These exemptions lead to a lack of consistency of the taxation system.

Currently, the base rate of value added tax in EU countries ranges from 15% to 25%. The average rate of the tax is 19.7%. The highest rate is levied in Sweden and Denmark and the lowest in Cyprus and Luxembourg. The so-called 'parking' rate can be 12% and more. At present, this rate is applied in four countries of the European Union, and these are: Belgium, Ireland, Luxembourg and Austria. Another exception is super lowered tax, which allows to levy a tax lower than 5% on some goods and zero rate completely exempts some goods and services from tax. Tax specialists from individual European countries search for optimum indirect taxes at different levels (Nerudova, 2007) and there are continuing discussions on tax harmonization in relation to the sources of finance. Implicit from this analysis is the fact that in spite of the effort to unify tax systems in Europe, it will not be an easy task.

1.2 Value added tax and small and medium-sized businesses

Owing to the object of research we pay a closer attention to the Document 3.2 of the Council Directive of 28 November 2006 on the common system of value added tax, Title XII – Special schemes. In Chapter I titled Special scheme for small enterprises there are set simplified procedures for charging and collecting VAT. The basic principle is that member states that might encounter difficulties in applying the normal VAT arrangements subject to such conditions and limits as they may set, and after consulting the VAT Committee, can apply simplified procedures (e.g. flat-rate schemes). This is referred to in Articles 281 to 292 of the document.

The legislation on taxation of the Slovak Republic (Article 287) has exempted persons with a yearly turnover below a set limit. In Act No. 222/2007 on value added tax the limit was set at 1,500,000 Slovak crowns, which had been in effect from 1 May 2004. On 1 January 2009 an amendment (Act 465/2008) on value added tax set the limit at 35,000 euros of yearly turnover. Within anti-crisis measures the Slovak Republic applied for increasing the limit and since 1 July 2009 (Act No. 258/2009) this has been increased to 49,790 euros of yearly turnover. In case a business goes over the limit within a period of 12 successive months, it is obliged to register for VAT starting from the 20th day of the month following after reaching the limit.

The European Directive in its Articles 295 and 305 gives the possibility to apply simplified schemes also to agricultural, forestry and fisheries businesses. The Slovak Republic does not apply these special schemes in value added taxation.

The current rates of value added tax applied in the Slovak Republic (19% and 10%) correspond to the expected development of indirect taxation. It is necessary to point to the fact that it is just the rate which influences tax liabilities and from the point of view of the tax burden for the taxpayer, the amount of tax is one of the criteria to measure economic effectiveness of value added tax. The other criterion to determine economic effectiveness of paying value added tax is indirect administrative cost of taxpayers.

2. Administrative cost of value added tax

Value added tax has a number of advantages, e.g. free movement of goods and services, neutrality of taxation, universal character of application or multi-phase character of the tax. On the other hand, it has also some disadvantages, and administrative cost for taxpayers and for the state is one of them. Owing to the subject of research, we will further pay attention only to the economic effectiveness of paying the tax for businesses, i.e. we will deal with value added tax from the microeconomic point of view.

In terms of taxes, Kubatova (2000, p. 40) speaks about transfer of money from individuals and businesses to public budgets, extra costs that lower the overall effectiveness of the economy. Vitkova, Vitek (2002, p. 142) divide the cost of tax system into administrative costs for the public and private sectors.

In the Slovak language incurred cost is also translated as 'cost of adapting to the tax system' on the level of the private sector. Effectiveness is an economic category encompassing the main aspects of the economic activity of businesses (Elexa, 2007). This notion has several meanings and is used in different contexts. Effectiveness is related to economizing, efficiency and quality. The indicator of cost or cent indicator expresses the proportion of inputs and outputs. The most reasonable expression of effectiveness is the ratio of cost and revenue. In our research we took the ratio of incurred cost of taxation of businesses and paid tax as a criterion of effectiveness. Due to a limited space we do not give details of the methods we used in calculating the economic efficiency of the process of applying value added tax. We chose effectiveness as the main indicator of the cost.

3. The effectiveness of value added tax scheme from the point of view of businesses

In order to ensure objectiveness and content validity of the results of our research we used the method of standardized questionnaire.

3.1. The content and structure of the questionnaire

The questionnaire was divided into an introduction and four main parts (I – IV). Out of 29 questions in total, 14 were closed and 7 open. Eight questions with scaling answers were referring to numerical values (e.g. number of employees, amount of tax, amount of incurred cost, etc.).

The first part of the questionnaire (I) contained 5 questions and its aim was to obtain identification data on businesses, in particular:

- the legal form of the business
- the object and place of the business
- total number of employees
- yearly turnover.

In the second part (II) the questions focused on the value added tax and accounting of businesses. The 5 questions of this part were asking about type of accounting, who completes the VAT file and type of VAT registration (on a monthly, quarterly, optional, single basis, etc). The questions were also asking about the yearly amount of the paid VAT (exorbitant VAT allowances) for 2003 and 2004.

The third part of the questionnaire contained two sets of questions about the cost of taxation:

The aim of part III.A (questions 11 – 19) was to obtain data on the cost of taxation in internal processing of value added tax in a business with precisely defined types of incurred cost. The respondents could also add other types of incurred cost and give their absolute value.

Part III.B (questions 20 – 23) was about the cost of taxation in external processing of value added tax. Two questions were referred to the type of suppliers and customers (e.g. domestic, end-users, from member or non-member states of the EU).

The last part of the questionnaire aimed to get the opinions of the respondents about the conditions of VAT taxation in the Slovak Republic (questions 24 – 29). The respondents could express their opinion on the taxation system and were proposing improvements, expressing opinions on the tax reform, etc.

The questionnaire was compiled to make an overall assessment of value added tax scheme from the viewpoint of businesses in the Slovak Republic.

3.2. Research sample

We distributed 200 questionnaires via e-mail, regular post or personally, out of which 137 were filled in and returned. Some of them were incomplete and thus excluded from research. The final number of respondents was 114. The legal form of business of the examined subjects is given in the following table.

Table 1: Legal form of business of the examined sample of respondents

Legal form of business	Number of respondents	Percentage of the sample
Group 1: Individuals	63	55.26 %
A individual farmers	2	1.75 %
B freelancers	1	0.88 %
C sole traders	60	52.63 %
D others	0	0 %
Group 2: Legal entities	51	44.74 %
A private limited companies	31	27.20 %
B public limited companies/stock corporations	16	14.04 %
C cooperatives	2	1.75 %
D other	2	1.75 %
Total sample of respondents	114	100 %

Comparing the number of respondents, we came to a conclusion that the tendencies in the composition of sub-groups reflect the real legal forms of business in Slovakia. The sample was then divided into small, medium-sized and large businesses. We classified the businesses in compliance with the Directive of the European Commission No. 2003/361/EC, which defines individual categories of businesses from the quantitative point of view. Small businesses accounted for 85.1% and medium-sized and large businesses for 14.9%. The examined sample was also classified according to the amount of yearly turnover.

3.3. Results and discussion

Quantitative assessment of the results was based on the criterion of diligence and therefore we chose the year of the least changes in legislation and taxes in Slovakia, the year 2003, as the year of processing. The amount of cost is given in the following table.

Table 2: Costs of applying value added tax according to quantitative division of respondents

Quantitative division of businesses/indicators	Costs of businesses induced by value added tax	Value added tax paid	Costs of applying value added tax
Businesses in total	2,872,923	29,903,389	9.61 %
Small businesses	170,413	387,302	44 %
Medium-sized businesses	382,510	1,951,582	19.60 %
Big businesses	2,320,000	27,951,807	8.30 %

The resulting cost of paying value added tax by small businesses can be interpreted as follows: 10 Slovak crowns of paid tax incurred 4.40 crowns of social cost of paying value added tax. In medium-sized businesses 10 Slovak crowns meant 1.96 crowns of incurred cost of paying value added tax. In big companies – payers of value added tax – 10 Slovak crowns of paid tax incurred 0.83 crown of the cost of paying the tax. On the whole, in all responded businesses 10 Slovak crowns incurred 0.96 crown of the cost. The research continued also in the year of profound changes in taxation and legislative conditions. As it was expected, in that year the incurred cost increased and the most significant increase was recorded in the category of small businesses – by 5.31 percentage points. In medium-sized and large companies the increase of incurred cost of paying value added tax was 3 %. It is obvious that this development resulted in lower economic effectiveness of applying value added tax on the side of businesses (increase of 2.96%).

The indicator of cost was a quantitative synthetic output of the research. The primary data from the questionnaire were processed so they can be used to make further conclusions and initiate discussions and proposals of measures in value added taxation.

From other theoretical and practical conclusions we have chosen the following:

- more than half of respondents (58) considered the legislation as difficult to understand, complicated and time and material demanding,
- as the most positive change the payers reported flat-rate tax scheme, which was applied in Slovakia from 1 January 2004 till 2006; at the same time they expressed a requirement to lower the marginal tax rate to 15%,
- only 4 respondents (3.51%) considered value added tax as a financial means of running a business (in terms of cash flow),
- an overwhelming majority of responded businesses (84.21%) do not particularly follow or calculate the effect of VAT taxation.

We have made recommendations and proposals to optimize the process of VAT taxation for different categories of businesses, in particular domestic businesses that produce for end-users, exporters, and/or suppliers within intra-community trading, customers within intra-community trading and for newly-established businesses. The recommendations should help businesses to make decisions about joining the value added tax scheme, i.e. either to register or not as a VAT payer.

Conclusion

Our research on value added tax encompassed a wider range of issues of general indirect taxation in the Slovak Republic. We have come to an important conclusion that businesses are not able to quantify the real incurred cost of VAT taxation and do not follow the effects of taxation (e.g. as hidden financial reserves). They lack any procedure to follow, register and quantify them in spite of the fact that they are part of everyday economic reality. In terms of the quantified cost of the process of VAT taxation small businesses' administrative burden was five times as much as that of large companies and three times higher in comparison with medium-sized businesses. The results show that despite the long-lasting effort to simplify the taxation process in the Slovak Republic, its legislation should also consider other (simplifying) schemes of applying value added tax, especially with small businesses.

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Macroeconomic effects on D.J.S.I.-World Returns

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Abstract

One of the best known and highly regarded Socially Responsible Investing (SRI) indexes is the Dow Jones Sustainability Index World (D.J.S.I.-World). By using the model of Generalized Autoregressive Conditional Heteroskedasticity (GARCH), the relation between D.J.S.I.-World returns to 10 year bond returns and Yen/U.S. dollar exchange rate is investigated. Research results show that 10 year bond value affects positively the value of D.J.S.I.-World. However, there is a negative relation between Yen/U.S. dollar exchange rate and D.J.S.I.-World with a month delay. According to our results, the total return of D.J.S.I.-World is affected by such macroeconomic factors as the value of 10 year bond, the Yen/U.S. dollar exchange rate and the general economic environment. In this way, investors can understand better the function of SRI market. Additionally, a new channel of information is created and better evaluation of D.J.S.I.-World is enabled.

Keywords: Corporate Social Responsibility, Socially Responsible Investment, GARCH.

JEL Classification Codes: M14, G15, C22

1. Introduction

In recent years there is an emphasis on the concepts of Corporate Social Responsibility (CSR), as the growth of its body increases every year. In 1990 there were only 7 environmental and social reports, while in 2001 these reached the number of 583, (Figure 1).

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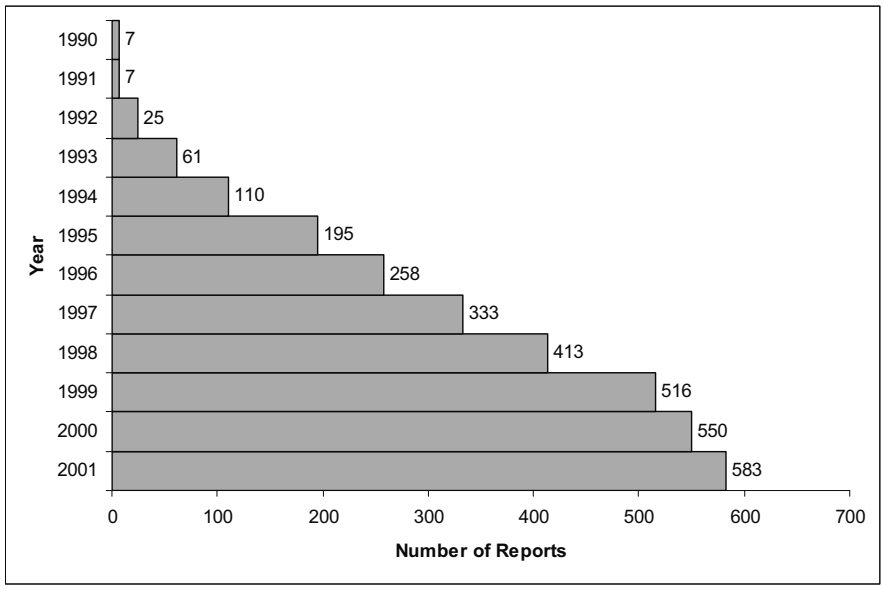
Figure 1: Number of environmental and social reports produced between 1990 and 2001 based on 3411 reports



Source: Corporate Register[1]

The main concept of CSR is whether companies are willing to comply only with the legitimacy or they will move beyond the compliance to legitimacy. The Commission of the European Communities (2001) defines CSR as '*a concept whereby companies integrate social and environmental concerns in their business operations and in their interaction with their stakeholders on a voluntary basis'*. There are plenty of references on the advantages of the companies that integrate CSR. For example, Business for Social Responsibility[2] states the following benefits:

- improved financial performance
- reduced operating costs
- enhanced brand image and reputation
- increased sales and customer loyalty
- increased productivity and quality
- increased ability to attract and retain employees
- reduced regulatory oversight, and
- access to capital.

[1] Data available at: http://www.corporateregister.com
[2] http://www.bsr.org

Regarding the SRI, it is much closer to the CSR concept and it is referred as the process of identifying and investing in companies that meet certain standards of CSR, (SIF, 2006). There are various SRI market indexes which investors take into account so as to identify and invest in companies that meet CSR standards; one of them is Dow Jones Sustainability Index (D.J.S.I.). The concept of CSR is attractive to investors as it aims to increase the shareholder value in the long-term D.J.S.I.

The theoretical background of SRI along with a description of the D.J.S.I. and the GARCH model are illustrated next. A description of the data and the methodology used for the purposes of this research follow along with the presentation and analysis of the results. Finally, a discussion of the results and some concluding remarks are provided.

2. Literature Review

2.1. Social Responsible Investing (SRI)

SRI has attracted significant interest for several years around the world, as many non governmental organizations, governments, scholars and practitioners are involved in its promotion. As in the case of CSR, SRI is a vague conception and various definitions have been proposed.

Some of the main approaches in the international literature are: social investing, socially aware investing, ethical investing, mission-based investing, double-bottom line investing, green investment and sustainable investment, (SIF, 2003; Rapson et al., 2007). The President of KLD Research and Analytics, Inc., Kinder (2005), stated that since 1983 SRI is the incorporation of the investor's social or ethical criteria in the investment decision-making process. According to SIF (2006), '*SRI is an investment process that considers the social and environmental consequences of investments, both positive and negative, within the context of rigorous financial analysis. It is a process of identifying and investing in companies that meet certain standards of Corporate Social Responsibility'*. Another definition is stated by Mansley (2000), who defines SRI as the '*investment where social, environmental or ethical considerations are taken into account in the selection, retention, realization of investments, and the responsibility in use of rights (such as voting rights) attaching to investments'*. The CSR Europe (2003) mentions the SRI in order to '*describe investment decisions informed by CSR considerations. SRI combines investors' financial objectives with their concerns about social, environmental and ethical issues'*. Finally, Sparkes (2002) states the concepts of CSR and SRI as identical:

'...CSR and socially responsible investing are in essence mirror images of each other. Each concept basically asserts that business should generate wealth for society but within certain social and environmental frameworks. CSR looks at this from the viewpoint of companies, SRI from the viewpoint of investors in those companies'.

In this context, the meaning of SRI is similar to SIF (2006). SRI is reported in the supplying of funds in companies that apply CSR standards, whatever form these funds have.

The origin of SRI is placed by some researchers in 1940, when unions and government agencies avoided investments with companies perceived to be engaged in unfair labour practices (Martin, 1986), while Lydenberg (2000) and Schueth (2003) place the origin of SRI in 1960 due to socio - political environment in the U.S. Nowadays the interest in SRI is intense in almost all markets of the world. It is worth noting that the total European SRI assets in 2002 were estimated to 19.8£ billion (Sparkes, 2002) and in the mid of 2004, 354 SRI funds existed in the European markets, 13% more compared to 2003 (Avanzi SRI Research, 2004). As far as the SRI assets of the U.S. are concerned, these are estimated to exceed 2$ billion in 2001 (Sparkes, 2002; Laufer, 2003). More than one out of every nine dollars under professional management in the U.S. today is involved in socially responsible investing and $2.3 trillion out of $24.4 trillion are in professionally managed portfolios utilizing one or more of the three core strategies that define socially responsible investing: screening, shareholder advocacy, and community investing (SIF, 2006). Finally, the study of Deni Greene Consulting Services (2004) identified $21.5 billion SRI assets in Australia as of June 2004.

Numerous SRI indexes have been established in order to support and promote SRI. In this way, SRI investors can avoid companies that produce externalities to society or the environment. In Table 1, 24 SRI indexes created between 1990 and 2007 are presented.

Table 1: Presentation of SRI indexes

Index / -family	**Year**
1. Domini 400 Social Index	1990
2. Ethinvest Environmental Index	1996
3. Natur-Aktien-Index (NAI)	1997
4. D.J.S.I.-World	1999
5. Jantzi Social Index 6. Calvert Social Index	2000
7. ASPI 8. D.J.S.I. STOXX 9. KLD Broad Market Social Index 10. KLD Dividend Achievers Social Index 11. KLD Large Cap Social Index 12. FTSE4GOOD	2001
13. ECPI Index Family 14. Ethibel Stainability Index (ESI) 15. UBAI - UmweltBank- AktienIndex	2002
16. KLD Select Social Index	2004
17. D.J.S.I. North America 18. KLD Global Climate 100 Index 19. HVB Nachhaltigkeitsindex	2005
20. DAXglobal Alternative Energy	2006
21. Global Challenges Index (GCX) 22. GreenTec Climate 30 23. ÖkoDax 24. DAXglobal Sarasin Stainability	2007

Source: Sustainable Business Institute[3]

[3] http://www.sustainablebusiness.org

Finally, investors prefer to invest in companies that meet CSR standards not only because of their CSR sensitivity but also due to the positive relation between CSR and financial performance, making the SRI more attractive. Margolis and Walsh (2001) examined ninety five studies in order to evaluate Corporate Social Performance (CSP) as an outcome of financial performance and concluded that 68% of the studies indicate a positive relationship between CSR and financial performance. Additionally, they focused on eighty studies in order to evaluate whether CSR contributes to Corporate Financial Performance (CFP), and concluded that 58% of the studies show positive relationship between the two concepts. Similarly, Waddock and Graves (1997) indicated that not only does CSP follow CFP but also CSP drives CFP. Generally, SRI funds have lower volatility or Beta compared to unscreened funds (Hamner and Longa, 2003).

2.2. Dow Jones Sustainability Indexes (D.J.S.I.)

The Dow Jones Sustainability Indexes (D.J.S.I.) state the term of corporate sustainability as a business approach that creates long-term shareholder value by embracing opportunities and managing risks deriving from economic, environmental and social developments.

Generally, the term of corporate sustainability is often quite closely related to concepts such as CSR (Clarkson, 1995) and CSR, (Carroll, 1999; Holme and Watts, 2000). Specifically, the adoption of CSR can contribute to a sustainable development. Despite the differences existing for the CSR concept there is a consensus that CSR is closely connected to the concept of sustainable development; corporations should integrate the financial, social and environmental effect in their operations.

The D.J.S.I. conclude five benchmarks; the global, the European, the Eurozone, the North American and the U.S. The D.J.S.I. are the first global indexes tracking the financial performance of the leading sustainability-driven companies worldwide. These indexes were created by the cooperation of Dow Jones Indexes, STOXX Limited and SAM[4] which provide asset managers with reliable and objective benchmarks to manage sustainability portfolios. The family of these indexes was first launched on September 8th 1999.

As stated in D.J.S.I., these indexes satisfy both private and institutional investors providing a global, rational, consistent, flexible and most importantly, investable index to benchmark the performance of their investments.

The D.J.S.I.-World covers the top 10% of the biggest 2,500 companies in the Dow Jones World Index in terms of economic, environmental and social criteria. In order to assess the D.J.S.I.-World, there is a set of criteria (with their weights) for the opportunities and risks deriving from economic, environmental and social developments for the eligible companies. Both general and industry criteria exist with each factor weighting 50%, while each of the economic, environmental and social criteria weights 33% (D.J.S.I., Presentation – Annual Review, 2007). In reference to the general criteria corporate governance, human rights, supply chain management, risk and crisis management are encapsulated, while industry criteria concern the characteristics of specific industries (D.J.S.I. Guide, 2006).

[4] http://www.sam-group.com

A presentation of the three dimensions along with their weightings follows (D.J.S.I.):

1. Economic criteria: corporate governance (6.0), risk and crisis management (6.0), codes of conduct/compliance/corruption and bribery (5.5) and specific criteria to industry (depends on industry).

2. Environmental criteria: environmental performance (eco-efficiency) (7.0), environmental reporting (3.0) and specific criteria to industry (depends on industry).

3. Social criteria: human capital development (5.5), talent attraction and retention (5.5), labor practice indicators (5.0), corporate citizenship/philanthropy (3.5), social reporting (3.0) and industry specific criteria (depends on industry).

No industry is excluded from the selection and composition of the D.J.S.I.-World as

is the case of other SRI indexes (see Jantzi Social Index[5] and Calvert Social Index[6]). In order to provide investors with filters against certain sectors, there are five subset indexes excluding alcohol, ex gambling, ex tobacco, ex armaments and firearms and, ex alcohol, tobacco, gambling, armaments and firearms indexes.

In order to assess companies, there are four sources of information (D.J.S.I. Guide, 2006):

- company questionnaire
- company documentation as sustainability reports, environmental reports, health and safety reports and so on
- media and stakeholders reviewing all document over the past twelve months
- contact with companies, if it is necessary, for any misunderstanding point of the company's operations

Each year, the investable stocks' universe is reviewed based on market capitalization of the D.J.S.I.-World components (D.J.S.I. Guide, 2006). In September 6th 2007, SAM announced the results of the 2007 annual review where 42 new company additions and 33 company deletions were reported in the D.J.S.I.-World (D.J.S.I. Press Release, 2007). According to the D.J.S.I. Review (2007), the D.J.S.I. World is constituted by companies deriving from Australia, Belgium, Brazil, Canada, Denmark, Finland, France, Germany, Hong Kong, Ireland, Italy, Japan, Malaysia, the Netherlands, Norway, South Korea, Spain, Sweden, Switzerland, Taiwan, Thailand, the UK and the USA.

3. Empirical Methodology

The autoregressive conditional heteroskedasticity (ARCH) model, introduced by Engle (1982) and its extension to the Generalized Autoregressive Conditional Heteroskedasticity (GARCH) model (Bollerslev, 1986) have the advantage of taking into account not only the varying conditional variances but the volatility clustering as well. An important weakness of the ARCH and GARCH model though, is that volatility reactions are accounted in positive and negative changes (shocks) in a symmetric way.

[5] http://www.jantzisocialindex.com
[6] http://www.calvert.com/sri_calvertindex.html

A solution was given by the asymmetric models which are capable of capturing the asymmetric features of the data. According to Engle and Ng (1993), who analyzed various models for the daily Japanese stock returns, the best parametric model is the GJR-GARCH one, introduced by Glosten et al. (1993). The diagnostic tests they applied provided evidence that the E-GARCH model, introduced by Nelson (1991), can also capture most of the asymmetry, but it expresses the variability of the conditional variance in a higher than normal level. Another advantage of the GJR-GARCH model is that it has fewer parameters which need to be estimated. The GJR-GARCH is strongly preferred by many researchers who study the impact of various factors on the stock prices volatility in various countries (Brailsford and Faff, 1996; Antoniou et al., 1998; Pan and Hsueh, 1998; Tay and Zhu, 2000; Pilar and Rafael, 2002; Bologna and Cavallo, 2002).

4. Empirical Results

4.1. Data Collection

Log of monthly D.J.S.I.-World prices from December 1993 to October 2007 are applied in this paper. The monthly return data is the first difference of the log of D.J.S.I. prices. In addition, the monthly returns of the 10 year bond and Japan/U.S. foreign exchange rate is used, so that any potential external factors, affecting D.J.S.I.-World, could be estimated.

Regarding the data of the D.J.S.I.-World, these have been obtained from the web site of Dow Jones Sustainability Indexes.[7] The data of the 10 year bond return are available from Yahoo – Finance[8] (BOND), while the Federal Reserve Bank of St. Louis is a source of the Yen/U.S. dollar exchange rate[9] (ER).

As shown in Table 2, the correlation of the D.J.S.I.-World returns of the 10 year bond returns is positive while the lag returns of the Japan/U.S. foreign exchange rate are negative.

Table 2, Correlation of returns

	$D.J.S.I_t$	$BOND_t$	ER_{t-1}
$D.J.S.I_t$	1.000	0.201	-0.138
$BOND_t$	0.201	1.000	0.030
ER_{t-1}	-0.138	0.030	1.000

4.2. Results

Applying the appropriate model presupposes empirical verification of the underlying assumptions. Table 3 provides some statistics for the D.J.S.I.-World returns. Monthly returns of the D.J.S.I.-World tend to have high excess kurtosis of 4.5.

[7] http://www.sustainability-indexes.com/djsi_protected/djsi_world/data/SAM_DJSI_World_U.SD.xls
[8] http://finance.yahoo.com/q/hp?s=%5ETNX
[9] http://research.stlouisfed.org/fred2/series/EXJPUS/downloaddata?cid=95

The mean return of the above index is close to zero, namely 0.009, thus we cannot reject the null hypothesis that the mean return at the 5% level is zero. Furthermore, by using the Jarque – Bera (JB) statistics, we came up to the conclusion that essential departures from normality had occurred while the series had been negatively skewed and leptokurtic. In our attempt to test the hypothesis of independence, we employed the Ljung – Box statistics to estimate the D.J.S.I.-World return series $\{R_t\}$, $\{R_t^2\}$ reported in Table 4. The autocorrelations showed that although there is not statistically significant first moment, the second moment of the sequence of returns is statistically significant showing significant time dependence. In addition, as shown in Figure 2 the variability of returns varies over time and appears in clusters. Also, the application of the Dickey-Fuller test for unit roots shows that the return series of the D.J.S.I.-World is stationary (Table 3).

Table 3: Summary statistics of D.J.S.I.- World returns

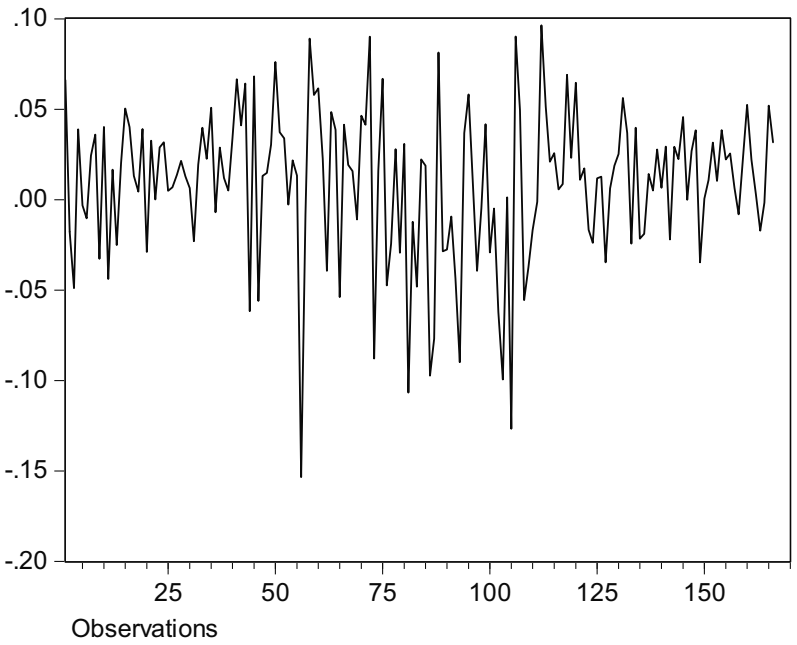
Statistics	D.J.S.I.-World
Observations	166.00
Mean	0.009
Median	0.014
Maximum	0.10
Minimum	-0.15
Std. Dev.	0.04
Skewness	-0.89
Kurtosis	4.50
Jarque-Bera	37.33
Augmented Dickey-Fuller (ADF)	-12.75

Table 4: Test for serial dependence in first and second moments

Returns				Squared Returns			
Lags	Autocorrelation	Partial Correlation	LB(n)	Lags	Autocorrelation	Partial Correlation	LB(n)
1	0.001	0.001	0.0001	1	0.086	0.086	1.254
2	-0.025	-0.025	0.1064	2	0.209	0.203	8.6258
3	0.043	0.043	0.4253	3	0.035	0.003	8.8369
4	-0.034	-0.035	0.6243	4	-0.02	-0.069	8.9074
5	0.06	0.063	1.2504	5	0.018	0.017	8.966
6	0.123	0.12	3.8935	6	0.162	0.188	13.506
12	0.079	0.077	8.7925	12	0.092	0.032	18.509
24	0.121	0.098	24.618	24	-0.01	-0.006	35.361
34	-0.043	-0.044	32.166	34	-0.081	-0.059	52.166
44	-0.063	-0.044	46.784	44	-0.106	-0.083	64.272

Notes: *LB(n) are the n-lag Ljung-Box statistics for R_t and R_t^2 respectively. LB(n) follows chi-square distribution with n degree of freedom; the sample period contains 165 monthly returns. The null hypothesis of strict white noise is not rejected in most cases.*

Figure 2: Monthly returns of D.J.S.I.-World



Bearing in mind the international literature, the preliminary results cited above provide evidence of satisfactory modeling of the D.J.S.I.-World return volatility.

The equations used for out model are the following:

Mean equation

$$DJSI_t = b_1 + b_2 BOND_t + b_3 ER_{t-1} + u_t \quad (1)$$

where,

$BOND_t$ is a variable reflecting the returns of the 10 year bond, and

ER_{t-1} is a variable which reflects the previous monthly returns of Yen/U.S dollar exchange rate.

Variance equation

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

where,

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

The indicative dummy S_{t-1}^- takes the value 1 if $u_{t-1}<0$ and 0 otherwise.

The leverage effect occurs when $\alpha_3>0$, which means that negative news have a greater effect on volatility.

Diagnostic tests on the residuals reveal that the GJR-GARCH(1,1) model is appropriate to describe the first and second moments of the return series of the D.J.S.I.-World. Specifically, the results show that the GJR-GARCH (1, 1) fits the data, given that the LB statistics for the standardized residuals are not significant and the LB test for the standardized squared residuals (Table 5) show that the autocorrelation of the second moment disappears when the conditional variance is assumed to follow the above GARCH process.

In addition, absence of serial correlation in the standardized squared residuals implies that there is no need to encompass a higher order GARCH process. Furthermore, the coefficient estimation v=1.35 for tail thickness regulator with 0.022 standard error, confirms the adoption of the GED assumption. Specifically, the assumption of normal distribution is rejected, a fact that verifies the very first observation of the thick tails in the D.J.S.I.-World returns which have been observed in the descriptive statistics. An LR test of the restriction of v=2 (for v=2 GED distribution is essentially the normal distribution) against the unrestricted models clearly supports this conclusion.

Table 5: LB test for the standardized residuals of the GJR-GARCH (1, 1) model

Standardized residuals				Squared standardized residuals			
Lags	Autocorrelation	Partial Correlation	LB(n)	Lags	Autocorrelation	Partial Correlation	LB(n)
1	-0.026	-0.026	0.114	1	-0.032	-0.032	0.173
2	0.036	0.036	0.335	2	0.017	0.016	0.2219
3	-0.022	-0.02	0.417	3	-0.024	-0.022	0.3154
4	-0.044	-0.047	0.753	4	-0.079	-0.081	1.3858
5	0.064	0.064	1.46	5	-0.033	-0.038	1.5753
6	0.066	0.072	2.21	6	0.035	0.035	1.7909
12	0.069	0.077	5.53	12	0.069	0.058	3.2275
24	0.097	0.106	16.58	24	-0.02	-0.01	9.3257
34	-0.008	-0.046	24.9	34	-0.095	-0.072	34.483
44	-0.069	-0.057	37.4	44	-0.04	0.023	43.124

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 164 observations.*

The results presented in Table 6 show that the 10 year bond returns exert statistically significant positive influence on the mean return of the D.J.S.I.-World index. Table 6 also indicates that the coefficients of Yen/U.S dollar exchange rate at lag one are significant at 10% providing evidence of the dependence of D.J.S.I.-World index on the factors affecting the exchange rate.

In Table 7 the results for the variance equation are presented. The value of α_1 coefficient (0.867), reflects the influence of σ_{t-1}^2, showing for example that older information (residuals u_{t-2}, u_{t-3}, …), is statistically significant proving that volatility shocks (information) are slowly assimilated. Also, the results indicate that the lagged squared error term (a_2), which correlates the price variation of the present month to the price variation of the previous month, and the coefficient a_3, which allows the

conditional variance to respond asymmetrically to positive and negative shocks, are not statistically significant. This implies that despite the fact that strong past shocks affect the conditional volatility of D.J.S.I.-World for a prolong time, each one of these shocks does not affect individually the conditional volatility of D.J.S.I.-World (since coefficient α_2 is not significant).

Table 6: Mean Equation $DJSI_t=b_1+b_2Bond_t+b_3ER_{t-1}+u_t$

b_1	b_2	b_3
0.0150*	0.0962***	-0.1971**
(0.0026)	(0.0052)	(0.092)

Notes: *Standards errors are shown in parentheses. *indicates statistical significance at the 1% level. **indicates statistical significance at the 5% level. ***indicates statistical significance at the 10% level.*

Table 7: Variance Equation $\sigma_t^2 = a_0 + a_1\sigma_{t-1}^2 + a_2u_{t-1}^2 + a_3S_{t-1}^- u_{t-1}^2$

a_0	a_1	a_2	a_3
0.000014	0.867*	0.23209	-0.1456
(0.000048)	(0.082)	(0.164)	(0.1375)

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

5. Discussion of the results

The bond value effect on total return of D.J.S.I.-World can be explained through interest rates. Generally, interest rates affect the level of investments in the economy and are considered to be a measurement of the borrowing cost. When interest rates decrease, companies operate in a stable environment where unexpected negative conditions are limited, whereas the increasing trend of interest rates leads to a more insecure financial environment, which can even lead to bankruptcies (Bautista, 2003). It is well known that there is a negative relationship between interest rates and investment; when interest rates decrease the present value of the returns of investments is expected to increase, so specific investments, which were rejected as inappropriate, would be appropriate for realization. Additionally, when interest rates decrease, the cost of borrowed money is becoming cheaper. The insecure financial environment seems to affect the value of D.J.S.I.-World.

The U.S. economy is regarded as the leading economy in the world and plays a substantial role to all economies. For example, a change in the U.S. interest rate causes usually a consequence not only the change in the interest rate policy of developed economies but also in the evaluation of general business risk globally. This means that even the non U.S. international oriented companies that participate in D.J.S.I.-World are affected from changes in the U.S. economy. Thus, changes in the interest rates in the U.S. affect most of the companies.

In reference to the interpretation of the relation between the Yen/U.S. dollar exchange rate and the D.J.S.I.-World with a month delay there are different explanations.

Many economic indexes are affected by the movements of exchange rates and cause two different effects on investment. When the U.S. dollar is depreciated the price of imported inputs is increased, while the domestic goods become more attractive since they become cheaper than imported goods. Foreign companies are affected by the weak dollar since they can not sell their products easily, as they cost more, and this affects their profits. There are not many studies examining the link between investments and exchange rates and even in those the results are mixed (Cushman, 1985; Cushman, 1988; Bénassy-Quéré et al. 2001 and Harchaoui et al., 2005). U.S. and foreign multinational firms have developed various strategies in order to hedge the risks of changes in the exchange value of the dollar, so that the level of direct investments does not depend too strongly on the depreciation of the dollar (Jackson, 2007).

As stated earlier, when the U.S. dollar is weak, raw material imports are expensive. One of the most important imported raw materials for the U.S. economy is oil, which leads to an uncertain environment for firms' operations and generally for investment actions. Another explanation that interprets the negative relation between the Yen/U.S. dollar exchange rate and D.J.S.I.-World is that traders and investors seek to operate and invest their money in stable economies with stable currency and stable returns and they are oriented to long-term profits (Kwek and Koay, 2006). A weak dollar means that the values of returns from U.S. assets are reduced (Bloningen, 2005), creating uncertain conditions for the U.S. dollar and the economy. Finally, the U.S. dollar is the biggest traded invoice currency, so it is considered as the predominant currency (McKinnon and Schnabl, 2002). The majority reserve of currency is in U.S. dollars, which means that each time the U.S. dollar depreciates, the owners of U.S. dollars loose money, creating a negative environment for investments.

It is important to mention that the Yen is one of the currencies of carrying trade (borrowing cheap currencies in Yen and placing them in values with high returns). When the Yen is becoming stronger investors must pay off the loans in higher price, thus there is need for higher capital in order to pay off the loans. It is obvious that the D.J.S.I.-World is affected at the same time both from the opposite changes of the U.S. dollar and the Yen.

Regarding the effect of the monthly time delay of the Yen/U.S. dollar exchange rate on the D.J.S.I.-World, this is justified by the fact that this exchange rate is treated as transitory, as Harchaoui et al. (2005) state '*...when the exchange rate variability is very high, firms may be uncertain about the persistence of exchange rate movements. As a result, the corresponding changes in the output demand and the price of imported investments are treated as transitory. Firms delay their adjustment process'.* This means that investors are not sure about the new level of the exchange rate and wait a period in order to be sure about the new level and then decide on their actions.

6. Concluding remarks

This paper aims at exploring the relationship between the D.J.S.I.-World returns to the 10 year bond value and the Yen/U.S. dollar exchange rate. According to the findings, a positive relation between the 10 year bond value and D.J.S.I.-World index exists as it is explained by the relationship of the 10 year bond evaluation and interest rate, which affects the general business risk. When the dollar is changed the prices of raw materials and the values of returns from U.S. assets are affected, then negative relationship exists between the Yen/U.S. dollar exchange rate and the D.J.S.I.-World with a month delay. Other explanations that interpret the aforementioned negative relation are provided by the effects caused by the changes of the Yen value, because it is one of the currencies of carrying trade, as the U.S. dollar is considered the predominant currency and each time the U.S. dollar depreciates, the owners of U.S. dollars loose money and generally from the risks of changes in the exchange value of the Yen/U.S. dollar. This paper concludes that these macroeconomic variables affect the stock returns of companies that integrate CSR standards in their operations, even though these companies can identify better emerging issues.

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