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MACROECONOMIC FUNDAMENTALS AND STOCK RETURN DYNAMICS: INTERNATIONAL EVIDENCE FROM THE GLOBAL FINANCE AREA

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Abstract

Through this paper, we seek to shed light on the divergence between expected and observed returns. Empirical theory attributes this divergence to macroeconomic fundamental shocks. We try, via an ECM model, to study the existence of cointegration relations between macroeconomic volatility and stock returns dynamics using monthly data over the period 1986 to 2008, for a sample of developed and emerging markets. Furthermore, we aim at quantifying the marginal explanation power of global risk-factors in the current sustained financial globalisation. Our findings show that local factors have an instantaneous effect on emerging markets but not very significantly on developed markets. However, global factors effect persists over the future periods on emerging markets but it is instantaneous and persistent on developed markets. Furthermore, local risk factors contribute increasingly to the explanation of the forecast error variance decomposition. Nevertheless, global factors contribute instantaneously but persist on future periods for the developed markets. Our findings may provide an additional contribution to the question of stock return dynamics as well as to the prediction of the 'Out-of-sample' stock return.

Keywords: stock return, macroeconomic volatility, local risk factors, global risk factors, ECM, impulse response functions, forecast error variance decomposition

JEL Classification: G12, G14, G15

1. Introduction

Capital market theory supposes that investors require an *ex ante* premium to hold risky assets. Since the *ex-ante* risk premium was not been easily observable; average past returns substitutes expected returns without considering uncertainties attributed to fluctuations of stock prices (Campello *et al.* 2008, 1297). Moreover, recent empirical investigations were interested in ex post mean-variance analysis without considering the statistical properties of stock returns and the problem of estimation risk.

For instance, Jorion (1985, 259) raised the question of ex post return versus ex ante return. Although estimation risk is a rational explanation (e.g. Elton 1999, 1199; Kumar *et al.* 2008, 1037), recent empirical investigation (e.g. Lettau *et al.* 2008, 1653; Boucher 2007, 1), shows that instability of stock returns through time is closely associated to macroeconomic volatility effects. Considering these questions, we aim at several purposes; (i) to clarify the relative influence of local and common macroeconomic factors on equity returns. (ii) To study stock market reactions to macroeconomic volatility and (iii) to study the relative contributions of the local and common factors. Our intentions seem to provide a basic tool to decision-making for international investors as well as for domestic governors.

The remainder of this paper is organized as follows: the second Section presents a review of empirical literature; the third Section presents the methodology and the empirical specification. The fourth Section, presents data and preliminary tests. In the fifth Section, we interpret and discuss our results to conclude some in the sixth Section.

2. Literature review

Theoretical motivations of the article start from a general consensus of a bilateral link between macroeconomic volatility and stock returns dynamics. Indeed, since Fama (1981, 545), Chen *et al.* (1986, 383), the close relation between macroeconomic volatility, real activity and stock prices behaviour has been well documented. For example, Chen *et al.* (1986, 383), noticed that interest rate, anticipated and unanticipated inflation, spread of bond returns and industrial production affects significantly stock returns.

Otherwise, recent empirical literature suggests that stock return dynamics is far from being independent of macroeconomic volatility (e.g. Bekaert and Harvey (1997, 29), Patro *et al.* 2002a, 421; Basher and Sadorsky 2006, 424; Henriques and Sadorsky 2008, 998; Kubo 2008, 83; Abugri 2008, 396). For instance, Patro *et al.* (2002, 421), show that macroeconomic and financial variables leads equity returns via systematic risk and non-systematic risk. Abugri (2008, 396) shows that key macroeconomic variables such as exchange rate, interest rate, industrial production, money supply, MSCI world and world interest rate affect stock returns on Latin American emerging markets.

In the current framework of sustained international financial integration, global factors are likely to carry additional implications to international asset pricing. In this direction, portfolio theory (ICAPM) contends that world market risk is a significant pricing factor. Empirical literature approximates world market risk by changes in world industrial production, and alternatively by MSCI world or S&P 500. (e.g. Ferson and Harvey 1998, 1625; Bekaert *et al.* 2002, 203). However, the world interest rate is a central variable that determines international parities and capital flows. Interest rate determines the mechanisms of international asset allocation and stimulates reflections to make wealth from arbitrage opportunities. (e.g. Bekaert *et al.* (2002, 203), Abugri 2008, 396).

Beyond these usual factors, empirical literature contends that since oil transactions have been started to be denominated in American dollars, oil prices has been taken a global feature (e.g. Lanza *et al.* 2005, 1423; Basher and Sadorsky 2006, 224; Henriques and Sadorsky 2008, 998). Recent empirical literature, such as Henriques and Sadorsky (2008, 998); Aloui and Jammazi, (2009, 31), contends that crude oil prices have been acquired a global feature that shifts equity market behaviour. Furthermore, Jones and Kaul (1996, 463), contends that this close relation can be explained by the impact of oil shocks on firms' cash flows. Sadorsky (1999, 449) noticed that oil price movement explains a large part of forecast error variance decomposition of real stock returns well than interest rates. Moreover, the relevant inference to rise in the empirical literature is that oil prices prove an asymmetric effect on real economy. Indeed, positive shocks on oil prices affect stock returns and economic activity more significantly than negative shocks.

Papapetrou (2001, 511), employed a VAR methodology to examine the dynamic interaction between real stock returns and interest rate, real economic activity and oil prices on Greek market. Their empirical results show that macroeconomic chocks affects significantly market behave and employment. Sadorsky (2003, 191) supports the close relation between conditional volatility of industrial production, oil price, interest rate, default premium, consumer price index and exchange rate and conditional volatility of stock returns. Basher and Sadorsky (2006, 224), show that shocks on oil prices influence well stock prices. Henriques and Sadorsky (2006, 998), affirm that even if the investigation (via causality tests) is implemented over a shorter period, changes in oil prices and interest rates provide a marginal explanatory power to stock returns.

Otherwise, the remark which deserves to be noted is that empirical literature does not provide enough of implications on horizons feature of this relation. Similarly, previous works are not very interested in the identification of marginal contribution of macroeconomic and financial variables to forecast stock returns. In the same way, empirical investigations are only interested in developed markets or in emerging markets. We test the advantage of admitting both developed markets and emerging markets as well as over one large period. Our study is aimed at considering several intentions; (i) assess the relative effect of local and global macroeconomic shocks on stock returns in the current framework of financial globalisation. The question which arises here is that response to the global factors depends on international financial integration of a given domestic equity market as well as it depends on international transmissions mechanisms. (ii) Clarify the nature of reactions between equity markets and macroeconomic volatility and (iii) be interested in the marginal contribution of local and global variables via the forecast error variance decomposition, since few works were been interested in this question.

3. Model and methodology

3.1. Model and empirical specification

Seeing the success of autoregression models in the modelling of endogenous dynamic relations, VAR model become a frequently used approach by analysts and financial economists. In this direction and to be exact

to our objectives, we employ a VAR approach. This specification allows modelling the potential interconnections between the two sides.

We consider $\{y_t\}$ denote an n-dimensional vector time series. Let us assume that $\{y_t\}$ is generated by an unrestricted VAR model of the form:

$$A(L)y_t = \delta + \varepsilon_t \quad (1)$$

Where, L is the lag operator, i.e. $L^j y_t = y_{t-j}$ for any integer j. the n-dimensional vector sequence of the reduced form $\{\varepsilon_t\}$ is assumed to be Gaussian white noise, that is, ε_t and ε_s are independent for $s \neq t$, and $\varepsilon_t \sim N(0,\Sigma)$ for all t. Σ is a positive definite matrix. Furthermore, the n x n matrix polynomial $A(\lambda) = I_n - \sum_{j=1}^{p} A_j \lambda^j$ satisfies $\det[A(\lambda)] = 0$, for all λ on and outside the complex unit circle so that explosive $\{y_t\}$ processes are ruled out. In other words, the only form of non-stationarity is due to unit roots. Moreover, if $\{y_t\}$ is generated by (1), then the process is integrated of order d, where d is a non-negative integer (for a definition of integration, see Johansen 1991, 1551).

If $\{y_t\}$ in (1) is cointegrated of order (1,1) with r cointegration vectors, we will know from Granger's Representation Theorem (GRT) that (i) rank [A(1)] = r, and (ii) $A(1) = \alpha\beta'$. The matrix α and β are then of dimension $n \times r$, which have both rank r, and the columns of β are called the cointegration vectors (see Engle and Granger 1987, 251; Johansen 1991, 1551). Moreover, β is a matrix representing the r cointegration relations such that $\beta' y_t$, is stationary. Commonly, $\beta' y_t$ is interpreted as the long run equilibrium relation between the y variables. Since this relation was been often of interest, it follows by Granger's representation theorem that an alternative form of (1) is:

$$A^*(L)\Delta y_t = \delta - \alpha z_{t-1} + \varepsilon_t \quad (2)$$

Here $\Delta = 1 - L$, is the first difference operator and polynomial matrix $A^*(L) = I_n - \sum_{i=1}^{p-1} A_i^* \cdot L^i$ is related to A(L) through $A_i^* = I_n - \sum_{j=i+1}^{p} A_j$ for i = 1, ..., p-1. In this representation, widely known as the VEC model, it becomes quite obvious that deviations from the equilibrium relations $z_{t-1} = \beta' y_{t-1}$ form a stationary process. The term αz_{t-1} represents correction of the change in y_t due to last period's long run equilibrium error. Note that the major difference between Eq. (1) and Eq. (2) is that the latter representation is conditioned on cointegration while the former is merely consistent with unit roots.

Engle and Granger's (1987, 251) version of GRT is based on the Wold representation of the vector moving average (VMA) of the form:

$$\Delta y_t = \rho + C(L)\varepsilon_t \quad (3)$$

The polynomial matrix $C(L) = I_n + \sum_{j=1}^{\infty} C_j \cdot L^j$, is assumed to be 1-summable in the sense of Brillinger (1981), i.e. $\sum_{j=1}^{\infty} j|C_j|$ is finite. In other words, time series $\{\Delta y_t\}$ is jointly stationary.

Quantities of interest in the following are the impulse responses or dynamic multipliers that represent the effects of shocks in variables of the system. To obtain their estimates, we must know how to invert the VECM. Note that $c_{ik,n}$ is the ik^{th} element of C_n and represents the response of Δy_i to a unit shock in variable k, n periods ago. Seeing that we are based on reduced form, this shock may be a linear combination of other variables. To exert a shock that is purely attributed to only one variable and to clean effects of other variables of the system, in many econometric studies responses to orthogonalized impulses are preferred. They are defined as $R_n = C_n \Gamma^{-1}$, where, Γ, $n \times n$ non-singular matrix, is the lower triangular cholesky decomposition of Σ, such that $\Gamma\Sigma\Gamma'$ is diagonal. We then have:

$$\Delta y_t = \delta + C(L)\varepsilon_t = \delta + R(L)\upsilon_t \quad (4)$$

Where, $R(L) = C(L)\Gamma^{-1}$, $\nu_t = \Gamma\varepsilon_t$, and $E(\nu_t\nu_t') = I_n$.

Here, the component $R(L)\nu_t$ denotes the orthogonalized impulse response function of Δy_t. Thus, a unit impulse has size one standard deviation in this case. Moreover, suppose that we shock Δy_t at $t = t^*$, by a one standard deviation change in ν_{t^*}. The dynamic responses in Δy_{t^*+s} are given by:

$$resp(\Delta y_{t^*+s}) = R_s \tag{5}$$

Where, $resp(\Delta y_{inf}) = \lim_{s\to\infty} resp(\Delta y_{t^*+s}) = 0$. Similarly, the responses in the levels y_{t^*+s} are given by:

$$resp(y_{t^*+s}) = \sum_{j=0}^{s} R_j \tag{6}$$

Where, $resp(y_{inf}) = \lim_{s\to\infty} resp(y_{t^*+s}) = R(1)$.

Here, $R(1) = C(1)\Gamma^{-1}$ is called the total impact matrix. Let Φ_s denote the VMA parameters s of responses in the level, such that $\Phi_s = \sum_{j=0}^{s} R_j$. Note that for both types of impulse responses, difference to the stationary case that the shocks effect in one of the variables will, in general, not die out in the long run. Moreover, the variables may not return to their initial values even if no further shocks occur. In other words, a onetime impulse may have a permanent effect in the sense that it shifts the system to a new equilibrium (e.g. Lütkepohl 1990, 116). Other quantities of potential interest are forecast error variance decompositions. They are also available for cointegrated systems and are computed using the same formulae as in the stationary case but with the VMA parameters of integrated process of order (1) (Lütkepohl and Poskitt (1991, 487).

Mean squared error matrix of the optimal h-step ahead forecast of the y_t process is determined as follow:

$$MSE(h) = \sum_{s=0}^{h-1} \Phi_s E(\nu_t\nu_t')\Phi_s' \tag{7}$$

One recalls that the innovations ν_{it} have, by construction, a unit variance and are sullied neither with serial correlations nor of instantaneous correlations. Similarly, we can compute the mean squared error of the optimal h-step ahead forecast of the variable y_i as follows:

$$\sigma_i^2(h) = \sum_{s=0}^{h-1}(\varphi_{i1,s}^2 + \cdots + \varphi_{in,s}^2) = \sum_{j=1}^{n}(\varphi_{ij,0}^2 + \cdots + \varphi_{ij,h-1}^2) \tag{8}$$

Where, $\varphi_{ij,s}$ is the ijth element of Φ_s. $(\varphi_{ij,0}^2 + \cdots + \varphi_{ij,h-1}^2)$, is the measure of the contribution of variable y_j in the variance of y_i in horizon h. In other words, this quantity represents a measure of the contribution of the variable y_j in the explanation of the volatility of y_i in the horizon h. In terms of percentage, we define $w_{ij}(h)$, as the proportion of y_i volatility at the horizon h, attributed to the specific shock of y_j, such as:

$$w_{ij}(h) = \frac{(\varphi_{ij,0}^2 + \cdots + \varphi_{ij,h-1})}{\sigma_i^2(h)} \tag{9}$$

The result in Eq.(9) involves that $\sum_{j=1}^{n} w_{ij}(h) = 1$. Moreover, $w_{ii}(h)$ is the measurement of the proportion of the volatility of y_i inherent to its own shocks? Furthermore, if $w_{ii}(h) = 1, \forall h$, then we will conclude that the volatility of y_i is independent of other variables fluctuation.

Finally, we can deduce that the forecast error variance decomposition (FEVD) is an indicator of causality between variables. Note that the major difference between the FEVD and Granger-causality is that the latter recalls interrelations of variables of the systems within the period of studies, while the former informs us about the dynamic behaviour of the different variables in the out-of-sample.

3.2. Selection of variables

We employ as candidate variables a vector of macroeconomic and financial variables. For stock return, we use stock indices with reinvested dividends (return index) denominated in American dollars. The use of data expressed in US dollars, is justified by an intention of conformity of the data for the perspective of an international investor rather than a domestic investor. To justify choice of the variables, we make use of, in first time, existing literature and, in second time, the role of each variable in firms' performance control, value of stock market and stock market equilibrium, as well as these variables are external to stock markets. The macroeconomic variables consist of two groups; local variables and global variables. The first group represents changes of exchange rate against the US dollar (Exchg), the consumer price index (CPI) and the foreign trade (Wtrade). Whereas, the second gathers MSCI world index (MSCI), world interest rate (TBill), and crude oil prices (Oil).

First, the exchange rate is measured by the number of units of domestic currencies against one American dollar. Thus, an increase (decrease) in the exchange rate represents depreciation (appreciation) of the local currency. The link between exchange rate and stock return is based on the simple intuition of the financial theory. The appreciation of domestic currency should decrease the cost of imports and that of the production and therefore increase firms' profitability and in turn their stock returns. Appreciation of a currency is generally accompanied by an increase in money supply and a decline in interest rates. This decline –associated with a reduction in cost of capital– involves an increase in stock returns. Second, the consumer price index is employed as a proxy to domestic inflation (Inf). Stochastic inflation informs about the economic stability of a given country in so far as the stability of the price general level improves consumers and investors' confidence and the national production. Inflation is an explicative factor of interest rates, exchange rates and external financial dependence.

Pioneers work by Adler and Dumas (1983, 925), Cooper and Kaplanis (1994, 46), affirms that international investors prefer domestic assets to hedge local inflation risk. In this case, the more local inflation is rising, the more preference is for domestic assets. The argument is that inflationary economies will have a currency which depreciates likely to create adverse conditions for local stock market and financial activity. Adler and Dumas (1983, 925), consider that the effect of stochastic inflation on stock market in the absence of purchasing power parity forms a central vector that affects stock return dynamics. Third, the trade activity (wtrade) is defined by exports over imports over GDP. Trading development is a determinant factor of economic growth and a stimulus of financial development. Indeed, a good economic performance and an eminent external trading position are likely to attract international investors. Generally speaking, local risk factors characterize the economic and financial situation and allow integrating the role of domestic economic cycles, in so far as the risk of domestic market and deviations from international parities are leading domestic market returns.

As for global variables, MSCI world index is used a proxy for the effect of the overall economic situation and the international business cycle. Economic intuition shows that probability distributions of firms' cash-flows are affected by changes in aggregate estimation risk which is driven by innovations in macroeconomic variables.

For instance, innovations in oil price, interest rates, exchange rate volatility determine cash-flow prospects of firms. World interest rate is employed as an explanatory variable of stock return dynamics in the sense that it contributes to the definition of firms' cost of capital. Accordingly, it increases uncertainty on expected returns. Since, oil transactions were been expressed in US dollars, they becomes a strategic commodity as well as acquires a global feature. Thus, oil price is used as global macroeconomic factor. Indeed, it is often mentioned like a significant economic variable in the absence of theoretical or empirical contending that innovations in oil prices should have the same degree of influence as interest rate, money supply, industrial production, etc... We admit the price for the crude oil to assess its marginal contribution in the explanation of stock returns.

4. Data and preliminary tests

We consider a sample of 15 developed and developing markets. The sample consists of two groups; the eight major emerging markets (Argentina, Brazil, Chile, India, Korea, Malaysia, Mexico and Thailand), and the group of G7 (Canada, France, Germany, Italy, Japan, UK and USA). We employ monthly series of national stock returns expressed in American dollars with dividends reinvested (return indexes) for the period February 1986 to June 2008. Beginning dates differ for each stock market according to the availability of the data.

Data on bilateral exchange rates are extracted from the database Datastream (mnemonic: I..AE.). For European markets which belong to the euro zone and to neutralize effects of breaking data since the introduction of the Euro in January 1999, we use a synthetic exchange index of the major currencies more circulating outside

the country of issue[1]. This index is calculated by Federal Reserve Board. Data on the consumer price index are extracted from Datastream (code: I64... F). External trade activity is measured by the ratio 'X/M' expressed in US dollar and extracted from Datastream (code: I70..DA and I71..DA). Employing series denominated in US dollars, allows preserving conformity of the data as well as neutralizing the effect of international exchange parities on external trade positions. The MSCI world index is extracted from the 'mscibarra'. The world interest rate (Tbill) is the three months Eurodollar deposit-rate obtained from the Federal Reserve Board. Crude oil prices series are extracted, in monthly frequency, from EIA and denominated in dollars by Barrel. The studied data were expressed in logarithmic form in order to log-linearize the series. On the other hand, estimated coefficients in the system are interpreted as elasticities between variables (Lanza *et al.* 2005, 1423).

Table 1. Descriptive Statistics of excess returns

Panel A. Eight major Emerging Markets

Country	Argent.	Brazil	Chile	India	Korea	Malays.	Mexico	Thail.
Mean	14.58	10.52	1.301	0.947	-1.491	5.188	5.650	2.891
Min.	6.067	10.45	0.418	0.490	-2.813	3.465	3.713	1.919
Max.	16.24	10.58	2.445	1.516	-0.174	6.246	7.215	3.824
Std. Dev.	1.842	0.039	0.484	0.226	0.517	0.624	0.727	0.497
Skewness	-2.976	-0.048	0.706	0.689	0.4801	-0.572	-0.027	0.147
Kurtosis	12.456	1.803	2.891	2.828	3.4797	2.819	3.379	1.875
JB.	1227.6a	10.09a	16.49a	17.87a	12.05a	15.06a	1.41	7.49a

Panel B. Developed Markets

Country	Canada	France	Germ.	Italy	Japan	UK	USA
Mean	6.874	8.117	7.102	8.195	1.600	7.774	7.266
Min.	5.609	6.387	6.273	7.217	0.636	6.748	5.767
Max.	8.526	9.573	8.130	9.346	2.029	8.477	8.356
Std. Dev.	0.761	0.785	0.480	0.527	0.249	0.479	0.796
Skewness	0.403	-0.012	0.160	0.584	-0.800	-0.335	-0.319
Kurtosis	2.1114	2.029	2.329	2.172	3.417	1.804	1.613
J.B.	16.149a	10.554a	4.811c	22.991a	30.674a	20.911a	26.156a

Analyzed series are expressed in logarithmic form and denominated in US dollars, extracted from the Datastream and EMDB of IFC. a, b, c: significant at the 1%, 5%, and 10%, level respectively.

Table 1 presents descriptive statistics of stock returns. We note that average stock returns vary between -1.49 (Korea) and 14.58 (Argentina). The most volatile market is Argentina with a standard deviation equal to 1.84, but the less volatile market is Brazil, with a standard deviation equal to 0.039. The largest difference between a minimal return and a maximal return is observed on the Argentinean market. These differences in the characteristics of returns and volatility inform about the dispersion of risk classes and risk premium on international stock markets in the absence of the contribution of fundamental macroeconomic effects. The normality of statistical distributions is checked via the Jarque-Bera test. We note that the normality hypothesis is not rejected for the whole of considered stock markets except for Mexico. For the case of the German market, the hypothesis is rejected at the 10% level.

4.1. Unit root test

Results of ADF test, presented in Table 2, indicate that the null hypothesis of existence of unit root is not rejected for all countries. They are maintained for the three models of ADF test. Optimal lag length was given for each series using the usual information criteria, in particular, the AIC criterion, Final Prediction Error, Hannan-

[1]The major currencies index is a weighted average of the foreign exchange values of the US dollar against a subset of currencies in the broad index that circulate widely outside the country of issue, The weights are derived from those in the broad index.

Quinn Criterion, Schwarz Criterion. These results involve that the current series are nonstationary and are integrated of order one, I(1). Our findings corroborate the statistical properties of economic and financial series. Consequently, shocks on stock returns tend to be persistent on the whole markets.

Table 2. Unit root Test (Emerging markets & Developed markets)

Series/variables	Lag lenght	ADF	Series	Lag lenght	ADF
Argentina	1	1.8984	**Canada**	0	3.6020
Exchg	7	-2.2649	Exchg	2	0.7743
CPI	7	-0.0892	CPI	1	7.6687
Wtrade	1	-1.9502	Wtrade	5	-1.2440
Brasil	1	2.7995	**France**	0	3.2022
Exchg	2	-0.3068	Exchg	2	-0.7743
CPI	2	3.1859	CPI	6	4.4239
Wtrade	2	-1.9946	Wtrade	5	-0.9199
Chile	1	1,3447	**Germany**	0	2.2634
Exchg	1	0,9525	Exchg	2	-0.2433
CPI	5	3,0670	CPI	4	5.1689
Wtrade	5	0,4759	Wtrade	7	-0.7802
India	1	0.7471	**Italy**	0	1.7862
Exchg	1	2.2059	Exchg	2	-0.7743
CPI	1	5.2816	CPI	8	2.2387
Wtrade	3	-1.8509	Wtrade	7	-1.9535
Korea	1	-1.1735	**Japan**	0	0.5010
Exchg	2	0.3481	Exchg	0	-1.2302
CPI	3	4.6373	CPI	3	2.7057
Wtrade	6	-2.5033	Wtrade	2	-1.3275
Malaysia	2	-1,0865	**UK**	0	1.7974
Exchg	8	0,2309	Exchg	1	0.1618
CPI	0	11,8660	CPI	6	3.2879
Wtrade	2	-1,6951	Wtrade	8	0.1089
Mexico	0	2.0305	**USA**	0	3.2493
Exchg	4	1.6612	Exchg	2	-0.7828
CPI	1	2.5294	CPI	2	8.4473
Wtrade	1	-1.8547	Wtrade	8	-0.4637
Thailand	0	0.1257	**Global var.**		
Exchg	9	-0.5368	MSCI	0	2.1278
CPI	1	0.4904	TBill	0	-1.0321
Wtrade	2	-2.1304	Oil	1	1.6900

Column ADF indicates computed values. Critical values of ADF statistics are equal to -1.94 (-2.56) at the 5% (1%) level. If observations number exceeds 250, critical value will be equal to -2.87 (-3.44) at the 5% (1%) level. If the computed value is higher than the critical value, then we will reject the null hypothesis of unit root.

4.2. Cointegration Test

ADF results confirm properties of non-stationary macroeconomic variables. In such a situation, Engle and Granger (1987, 251) show that the use of a VAR model of first difference, risks leading to a miss-specified data and that a VECM modelling will be more relevant. In that direction, we have to verify the number of cointegration relations between variables of the system. An approach based on the trace test of Johansen (1991, 1551), generates the results presented in Table 3. The letter p, in the second column of the Table, indicates the number of common lag of the variables in level for each market in line, which was determined by the information criteria (AIC, FPE, HQ and SC). Other columns of the Table indicate computed values of the statistic λ_{trace} according to different null hypothesis of r cointegration relation ($r = 0, \cdots, 6$) for each market. Critical values are presented in

the last two lines at the 5% and 1%, level for a model with a constant term. Results show that the null hypothesis of absence of cointegration relations is rejected for all markets, seeing that the computed value $\lambda_{trace}(0)$ exceeds critical values at the 5% and 1% level. Consequently, the vector of macroeconomic variables forms a cointegrated system for each market. The statistics λ_{trace} allows detecting three cointegration relations, at the 5% level, for the majority of countries, such as Canada, Germany, Italy, Argentina, Brazil, Korea, Thailand, Mexico and Malaysia. The number of cointegration relations is equal to 2 for the other markets, at the 5% level.

Table 3. Trace test

Country	p	0	1	2	3	4	5	6
Argentina	3	234.45	150.17	96.80	46.18	25.28	13.39	3.30
Brazil	1	467.46	259.22	127.27	42.13	24.17	11.18	2.65
Chile	2	196.24	131.73	63.97	36.44	21.03	10.89	3.18
India	2	171.11	115.58	76.47	42.87	22.01	10.49	3.53
Korea	3	220.08	125.55	82.67	51.20	28.47	14.37	4.04
Malaysia	1	312.10	168.97	93.91	37.38	10.85	4.71	1.56
Mexico	2	173.54	123.71	78.00	47.37	25.71	9.72	3.53
Thailand	2	166.21	109.35	76.82	50.43	29.43	29.43	3.18
Canada	2	236.28	148.74	89.46	52.92	19.57	10.00	4.02
France	2	293.35	171.09	71.93	30.70	17.51	7.88	2.69
Germany	2	246.52	157.80	86.16	38.10	23.14	10.77	4.54
Italy	2	305.11	135.91	80.79	40.60	20.00	10.06	2.63
Japan	3	152.73	105.48	70.79	42.36	22.67	10.92	4.49
UK	2	227.72	135.43	60.02	32.37	16.14	6.98	3.21
USA	2	219.54	122.39	71.25	39.30	21.72	10.55	4.07
	95%	134.54	103.68	76.81	53.94	35.07	20.16	9.14
	99%	144.91	112.88	84.84	60.81	40.78	24.69	12.53

The absence of cointegration relations, third column, is represented by the test of $H_0 : r = 0, vs. H_a : r > 0$. Null hypothesis of this test is rejected for all markets. The presence of at maximum three cointegration relations, sixth column, is represented by the following test $H_0 : r \leq 3, vs. H_a : r > 3$. H_0, is not rejected for the majority of countries, because computed value $\lambda_{trace}(3)$ is less than critical value at the 5% level. (e.g., for Germany $\lambda_{trace}(3) = 38.10 < 53.94(5\%)$). Accordingly, the number of cointegration relations varies between two and three, at the 5% level. Critical values are tabulated by Osterwald-Lenum (1992, 461).

Results of cointegration test show that all markets belong to cointegrated systems. Within this framework, a VECM representation would be interesting to study interactions of each market with the selected variables. Such a task requires determination of the optimal number of common lag of the variables of first difference. Results of the application of information criteria are summarized in Table 4. The last column presents the final choice of the lag length for each market selected via the common number indicated by the maximum of criteria.

Table 4. Optimal endogenous lags from information criteria

Countries	Akaike Info Criterion	Final Prediction Error	Hannan-Quinn Criterion	Schwarz Criterion	Selected Lag length
Argentina	2	3	3	2	2
Brazil	1	1	1	1	1
Chile	1	1	1	0	1
India	1	1	1	0	1
Korea	2	2	1	0	2
Malaysia	1	1	0	0	1
Mexico	1	3	1	1	1
Thailand	1	0	0	0	0
Canada	1	1	1	1	1
France	1	1	1	0	1
Germany	1	1	0	0	1
Italy	1	1	1	0	1
Japan	3	3	3	1	3
UK	1	3	0	1	1
USA	1	1	1	0	1

5. Interpretation and discussion of results

5.1. The impulse response functions

The impulse response functions allow characterizing the impact of a shock or an innovation of a variable on the current and future values of other variables.

Plots 1, in appendix, provides a description of these response functions of each series of stock return to an innovation on each macroeconomic variable in the system. The confidence intervals allow measuring the significance of each impulse response function. The first inference to cite is that stock returns react positively and significantly to their own shocks. This reaction persists sufficiently in time for the majority of markets.

Generally, the results show that shocks on exchange rate involves dynamism on stock markets. For instance, depreciation of the exchange rate leads to a decline of stock returns at least for the perspective of an international investor who considers the exchange gain in his asset portfolio (e.g. Bilson *et al.* 2001, 401; Abugri 2008, 396). In the majority of cases, the response of stock returns to exchange rates shock reaches a maximal value in short term (example, Argentina 0.926, Korea 0,0356, UK 0,0341). These reactions exhibit a sure stability during the future periods (example, Chile, India, Korea, Thailand, France, Germany ...). Innovation on the consumer price index affects negatively stock return (example, Argentina, Brazil, Chile, India, Italy, and USA). On the other hand, reaction is positive for Mexico, Malaysia, Thailand, Canada, France, and UK. However, the reaction of stock return is stabilized, also, over the future periods (example, Argentina, Chile, Mexico, Canada, Germany, Italy, Japan, and UK). This stabilization of reactions can be explained by the effect of regulating actions considered by investors conditionally to the vector of information acquired during the following periods. Reactions to impulses on the trade openness are often positive but they stabilize and/or amortize through time. Negative sign of the response, for some of stock markets, can be explained by the presence of rational anticipations inherent to joined effects of nominal interest rates and inflation. The significant response to local factors confirms the sensitivity of equity markets to domestic economic and financial circumstances.

As for global risk factors, response to innovations on MSCI world is positive. The positive sign involves that stock markets has become sufficiently integrated in the world market. Moreover, lessons of portfolio theory contend that in a context of international financial integration, international asset pricing is defined by world market risk prices. World interest rate seems to produce a positive response by developed markets and emerging markets (example, Brazil, Chile, Korea, Canada, Germany, Italy ...). However, a negative reaction is observed on American, British, Thai and Indian markets. The positive response can be explained by investor's anticipations over the future periods. The functions of negative reaction to interest rate shocks observed on certain markets are explained by the fact that the increase in the US interest rates, lead capital flows towards the United-States and bring to a reduction in stock returns on domestic markets (e.g. Bekaert *et al.* 2002, 203). Reaction functions to shocks on oil prices take a negative sign (example, Argentina, Brazil, Chile, Korea, Thailand, Canada, France, Germany, Japan, U.K., and USA). We contend that the current result is far from being surprising considering oil is a strategic commodity which leads, world production, firms performance and the behaviour of investors on international stock markets. On Indian and Mexican markets, the functions of reaction are associated to positive sign. Generally, oil price affects positively the dynamics of equity returns. Jones and Kaul (1996, 463), employed quarterly data and noticed that the nature of the reaction of stock returns to oil prices can be explained by the impact of shocks on firms cash-flows. However, economic theory suggests that the long-run sensitivity of stock return to chocks on oil prices should be positive. The observation of a negative relation can be explained by the presence of intrinsic feature of assets (Lanza *et al.* 2005, 1423).

The examination of results allows surveying a number of inferences which can be distinguished on several shutters: First, the behaviour of stock markets returns cannot be predetermined in a final way in relation to macroeconomic fundamentals. Thus, stock prices vary according to economic and financial industry of each country as well as according to the logic of business cycles and the nature of listed firms. We can affirm, in this framework, that the heterogeneity of reactions to shocks on local factors can be attributed to effects of economic policies developed by governments to ensure the development and the stability of their national financial markets. Second, global factors seem to be more determining of stock return dynamics. Indeed, they imply a significant but such a common reaction for overall stock markets. In other words, impulse response functions to global variables do not show significant differences in terms of size and sign. Our findings corroborate the financial theory and are in conformity with those obtained by recent literature, such as Abugri (2008, 396), Henriques and Sadorsky (2008, 998), Aloui and Jammazi (2009, 31).

We specify that the significance of a response impulse function is of capital importance in so far as it mirrors relevant effects on stock prices and leads investor's anticipations and their investment strategies through time. Similarly, modification of the sign of reaction makes difficult the establishment of prediction process for equity returns on a long horizon. Being the prediction of returns for a given forecast horizon, the forecast error variance decomposition allows assessing the relative contributions of each variable.

5.2. The forecast error variance decomposition

Table 3, (Panel A and panel B) provides results of the forecast error variance decomposition. Five horizons of forecast are selected (3 months, 6 months, 12 months, 18 months and 20 months).

Table 3. The Forecast Error variance Decomposition (FEVD)
Panel A. Eight major Emerging Markets

Country explained	Horizon (months)	Return index	Local Factors				Global Factors	
			Exchg	CPI	Wtrade	MSCI	TBill	Oil
Argentina	3	0.78	0.14	0.04	0.03	0.01	0.00	0.00
	6	0.73	0.15	0.06	0.05	0.00	0.00	0.01
	12	0.73	0.14	0.05	0.05	0.00	0.00	0.02
	18	0.70	0.12	0.05	0.05	0.00	0.00	0.07
	20	0.69	0.11	0.05	0.05	0.00	0.00	0.09
Brazil	3	0.89	0.04	0.02	0.01	0.00	0.03	0.01
	6	0.79	0.11	0.03	0.01	0.01	0.05	0.02
	12	0.59	0.20	0.07	0.00	0.04	0.03	0.06
	18	0.43	0.25	0.11	0.00	0.06	0.02	0.13
	20	0.39	0.26	0.12	0.00	0.07	0.01	0.15
Chile	3	0.98	0.00	0.00	0.00	0.00	0.01	0.00
	6	0.95	0.00	0.00	0.00	0.00	0.03	0.00
	12	0.90	0.02	0.01	0.00	0.01	0.06	0.00
	18	0.87	0.03	0.01	0.00	0.02	0.08	0.00

Country explained	Horizon (months)	Return index	Local Factors				Global Factors	
			Exchg	CPI	Wtrade	MSCI	TBill	Oil
	20	0.86	0.03	0.01	0.00	0.02	0.08	0.00
	3	0.99	0.00	0.00	0.00	0.01	0.00	0.00
	6	0.96	0.00	0.00	0.00	0.03	0.00	0.00
India	12	0.91	0.00	0.01	0.00	0.07	0.00	0.01
	18	0.86	0.00	0.01	0.00	0.11	0.00	0.01
	20	0.85	0.00	0.01	0.00	0.12	0.00	0.01
	3	0.88	0.05	0.00	0.02	0.01	0.02	0.01
	6	0.76	0.08	0.00	0.05	0.04	0.07	0.01
Korea	12	0.64	0.07	0.00	0.09	0.06	0.11	0.01
	18	0.58	0.07	0.00	0.12	0.08	0.14	0.01
	20	0.56	0.07	0.00	0.12	0.09	0.14	0.12
	3	0.99	0.00	0.00	0.00	0.00	0.00	0.00
	6	0.97	0.01	0.01	0.00	0.00	0.00	0.00
Malaysia	12	0.92	0.05	0.01	0.00	0.01	0.01	0.00
	18	0.87	0.08	0.01	0.00	0.03	0.01	0.00
	20	0.86	0.08	0.02	0.00	0.04	0.01	0.00
	3	0.78	0.17	0.00	0.01	0.04	0.00	0.00
	6	0.77	0.19	0.01	0.01	0.03	0.00	0.00
Mexico	12	0.77	0.18	0.01	0.00	0.02	0.00	0.00
	18	0.79	0.17	0.01	0.00	0.02	0.01	0.01
	20	0.79	0.16	0.01	0.00	0.01	0.01	0.01
	3	0.99	0.00	0.00	0.00	0.00	0.00	0.00
	6	0.96	0.01	0.00	0.00	0.01	0.00	0.02
Thailand	12	0.90	0.02	0.01	0.00	0.02	0.00	0.05
	18	0.84	0.02	0.02	0.00	0.04	0.01	0.08
	20	0.82	0.01	0.02	0.00	0.04	0.01	0.09

The first inference to rise is that the forecast error variance of stock returns is explained mainly by the effect of their proper last shocks. The effect of this proper shock persists on a longer horizon. It is a direct link between the return and his history. As for the selected macroeconomic factors, they exhibit a considerable contribution to explain the forecast error variance. The effect of these factors is present at the overall forecast horizons considered. However, by distinguishing relative contributions from these macroeconomic variables, we can note that, on emerging markets, local risk factors tend to have an instantaneous effect but global risk factors produce an effect on a longer horizon. We must note that the variable 'Exchg' persists on the whole forecast periods.

This evidence can be explained by the fact that exchange rate checks at the same time a local feature and a global feature. To move forward the analysis, influences of exchange rate risk increases while advancing in the forecast horizon. We note this influence in the case of Brazil, Argentina, Chile, Korea and Malaysia. By transition from a forecast horizon of 3 months to 24 months, contribution of the exchange rate risk goes from 4% to 26% for Brazil, from 0% to 3% for Chile, from 5% to 7% for Korea and from 0% to 8% for Malaysia. The effect of 'wtrade' persists through time only for Argentina and Korea. We explain this evidence by the importance of bilateral trade. However, global variables display a contribution on a longer horizon. Indeed, MSCI world and Oil prices provide a marginal contribution to the explanation of the forecast error variance. For example, on a 24 months horizon, the effect of MSCI world is 7% for Brazil, 12% for India, 9% for Korea and 4% for Thailand. For oil prices, it is equal to 9% for Argentina, 15% for Brazil, 12% for Korea and 9% for Thailand. As for the world interest rate, it seems to be very relevant for the Korean stock market. The Korean market seems, either, to be very sensitive to global risk factors. Accordingly, the Korean market seems to be more integrated in the world market, as well as, the presence of the international investors on this market increases its sensitivity to the common factors.

For the developed markets, the contribution effects is similar for the global factors but with the presence of an instantaneous effect. MSCI world verify the hypothesis of perfect integration. As for oil prices, it exerts an instantaneous effect but which persists over the following horizons. From our findings, we can contend that oil prices constitute a determining factor on stock market. This evidence corroborate Chen *et al.* (1986, 383), and recently, Aloui and Jammazi (2009, 31).

Panel B. Developed markets

Country explained	Horizon (months)	Return index	Local Factors				Global Factors	
			Exchg.	CPI	Wtrade	MSCI	Tbill	Oil
Canada	3	0.99	0.00	0.00	0.00	0.00	0.00	0.00
	6	0.97	0.00	0.00	0.01	0.00	0.01	0.00
	12	0.94	0.00	0.00	0.01	0.00	0.03	0.01
	18	0.92	0.01	0.00	0.00	0.00	0.04	0.03
	20	0.92	0.01	0.00	0.00	0.00	0.04	0.03
France	3	0.98	0.00	0.00	0.01	0.00	0.00	0.01
	6	0.97	0.01	0.00	0.01	0.00	0.00	0.01
	12	0.96	0.02	0.01	0.01	0.00	0.00	0.00
	18	0.95	0.02	0.01	0.00	0.01	0.00	0.00
	20	0.95	0.03	0.01	0.00	0.01	0.00	0.00
Germany	3	0.98	0.00	0.00	0.00	0.00	0.00	0.01
	6	0.97	0.01	0.00	0.00	0.00	0.00	0.02
	12	0.94	0.02	0.00	0.00	0.01	0.00	0.03
	18	0.92	0.02	0.00	0.00	0.01	0.00	0.04
	20	0.92	0.03	0.00	0.00	0.01	0.00	0.04
Italy	3	0.93	0.00	0.00	0.01	0.02	0.01	0.03
	6	0.89	0.01	0.00	0.01	0.04	0.01	0.04
	12	0.84	0.02	0.00	0.01	0.06	0.01	0.06
	18	0.80	0.03	0.00	0.01	0.07	0.01	0.08
	20	0.79	0.04	0.00	0.01	0.07	0.01	0.08
Japan	3	0.98	0.00	0.00	0.01	0.00	0.00	0.00
	6	0.94	0.00	0.00	0.03	0.00	0.02	0.01
	12	0.83	0.00	0.00	0.08	0.00	0.06	0.03
	18	0.71	0.01	0.00	0.13	0.00	0.10	0.05
	20	0.68	0.02	0.00	0.14	0.00	0.10	0.06
UK	3	0.97	0.00	0.00	0.00	0.01	0.00	0.02
	6	0.93	0.00	0.00	0.02	0.02	0.00	0.03
	12	0.87	0.00	0.01	0.03	0.04	0.00	0.04
	18	0.83	0.01	0.01	0.03	0.06	0.00	0.06
	20	0.82	0.01	0.01	0.03	0.07	0.00	0.06
USA	3	0.99	0.00	0.00	0.00	0.00	0.00	0.01
	6	0.97	0.00	0.00	0.00	0.01	0.00	0.02
	12	0.94	0.00	0.00	0.01	0.02	0.01	0.02
	18	0.92	0.00	0.00	0.02	0.02	0.01	0.02
	20	0.91	0.00	0.00	0.03	0.02	0.01	0.02

What remains interesting in our results is that stock markets exhibit a considerable sensitivity to macroeconomic volatility. This sensitivity changes according to whether it is a local variable or a global variable. Likewise, response to the global factors is related to the financial integration level. Being of a developing market or a developed market, the response to local shocks is instantaneous on emerging markets but it is not very significant on developed markets. However, the response to global factors persists over future periods on emerging markets but it is immediate and persistent on developed markets.

The observation which deserves to be evoked is that, for a given level of integration, the influence of common factors stresses the importance of external shocks. From where, analysts, decision makers and international investment managers should see beyond domestic macroeconomic volatility as well as control such factors behaviour over time.

6. Conclusion

In this paper, the relation between macroeconomic volatility and stock returns is examined under several shutters. We employed local and global macroeconomic risk factors and stock returns of both developed and emerging markets. In parallel, we used an ECM methodology and studied the impulses response functions and the forecast error variance decomposition.

We must state, that our intention is not to judge if a reaction is positive or negative but we are interested in the changes of that reaction's sign through time. Significance of the reactions is of capital importance seeing that it affects stock returns and modifies investor's anticipations and investment strategies. The forecast error variance

decomposition allows us to rise that local factors contribute increasingly to the explanation of the forecast error variance. Global factors contribute instantaneously but persist through time on developed markets.

Interpretation of our findings allows noting that the behaviour of stock markets cannot be identified *a priori* in the presence of macroeconomic volatility. Thus, it varies according to the economic and financial structure of each country as well as according to the logic of the business cycles synchronisation and to the idiosyncratic specificities of stocks' value. Thus, we can affirm that the heterogeneity of response functions on local factors can be attributed to the effect of economic policies developed by governments to ensure development and stability of their national financial markets. Also, we note that global factors seem to be more determining the stock return dynamics. Consequently, we confirm the relevance of such factors.

Our results seem to be more relevant for the decision-making, in particular for analysts, portfolio managers and for domestic governors. Thus, assembling a better planning as well as a better forecast horizon makes it possible to stabilize shocks and to ensure an immunization of exposure to risk.

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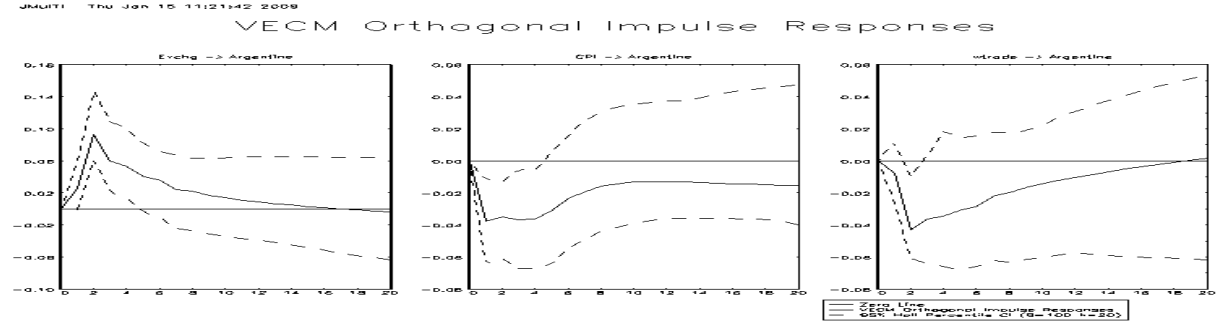
APPENDIX

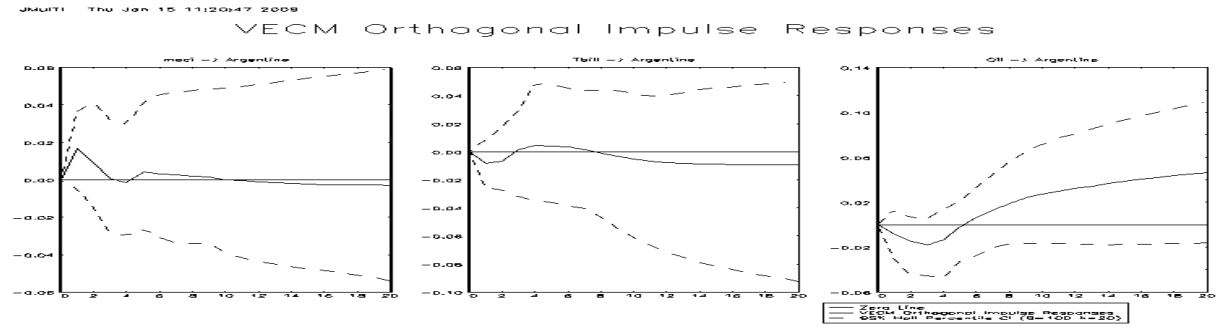
Figure 1. The impulse ofresponse functions

Argentina

Local Factors

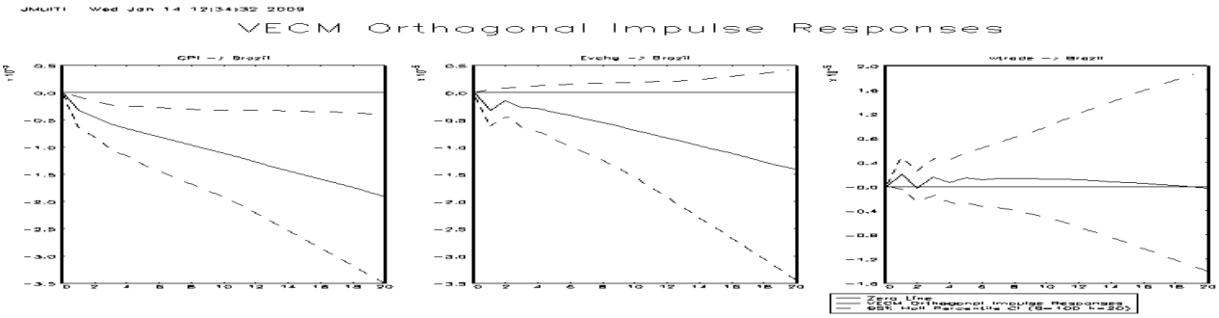


Global Factors

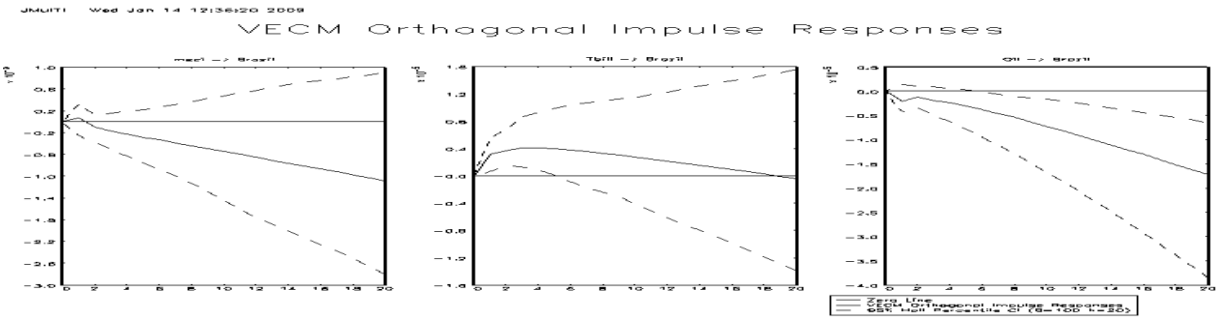


Brazil

Local Factors

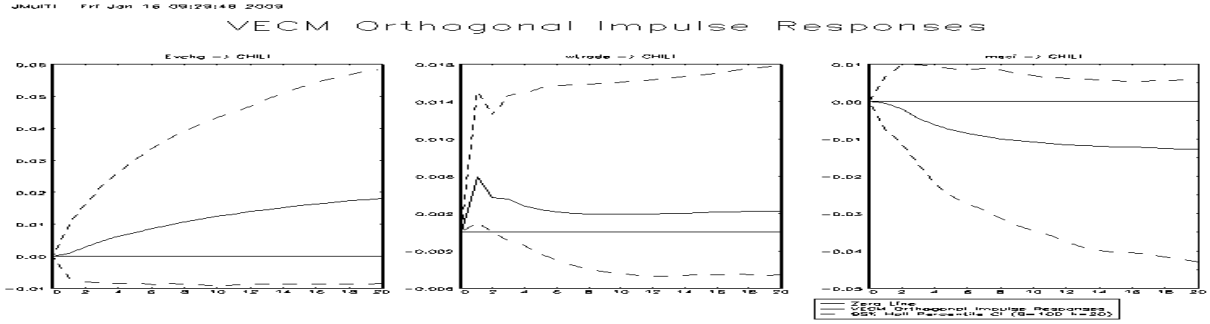


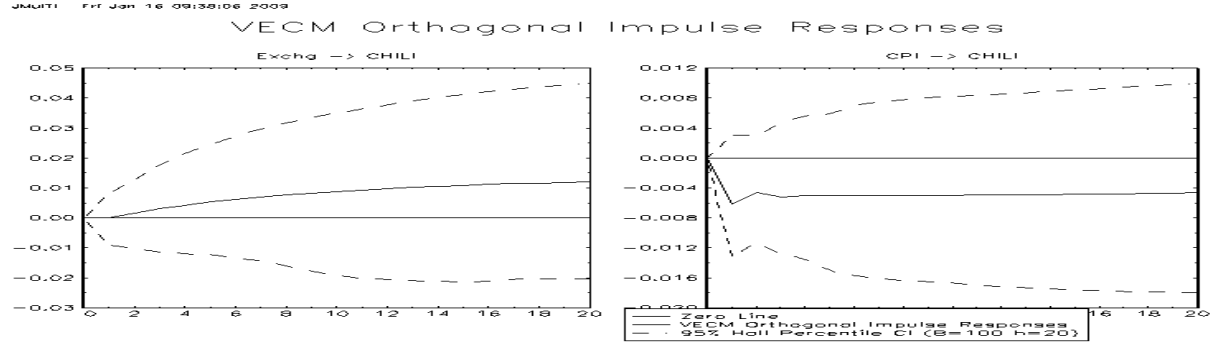
Global Factors



Chile

Local Factors





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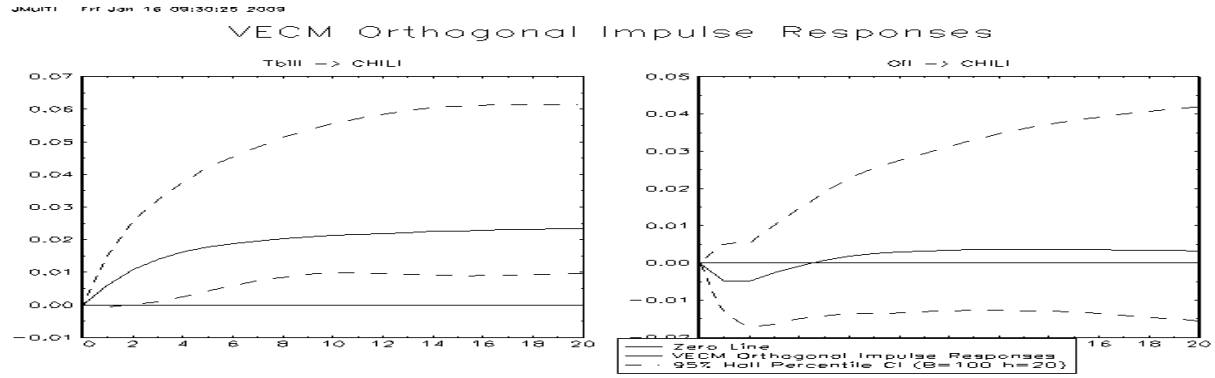
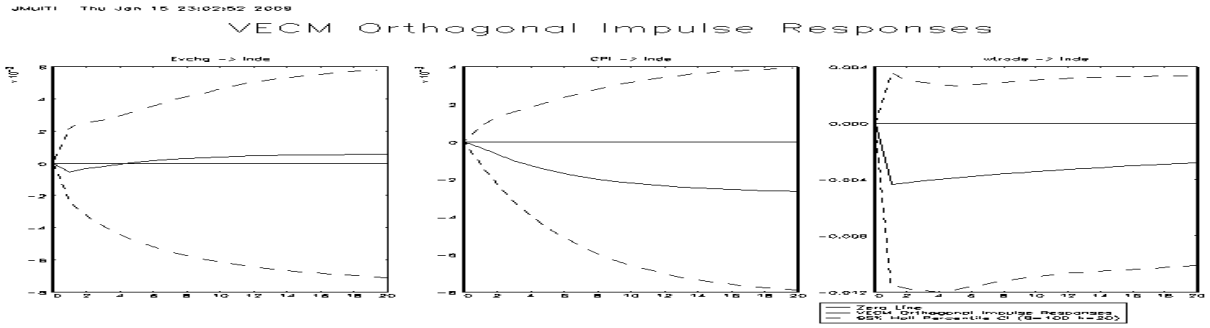


India

Local Factors



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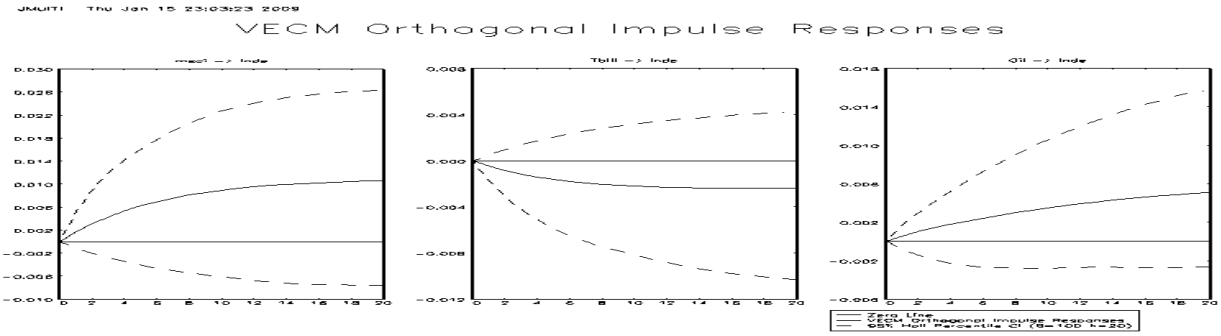
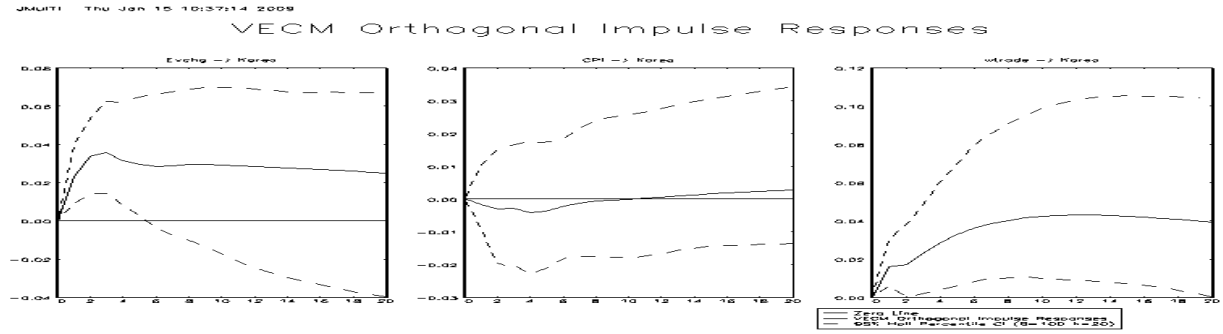


Korea

Local Factors



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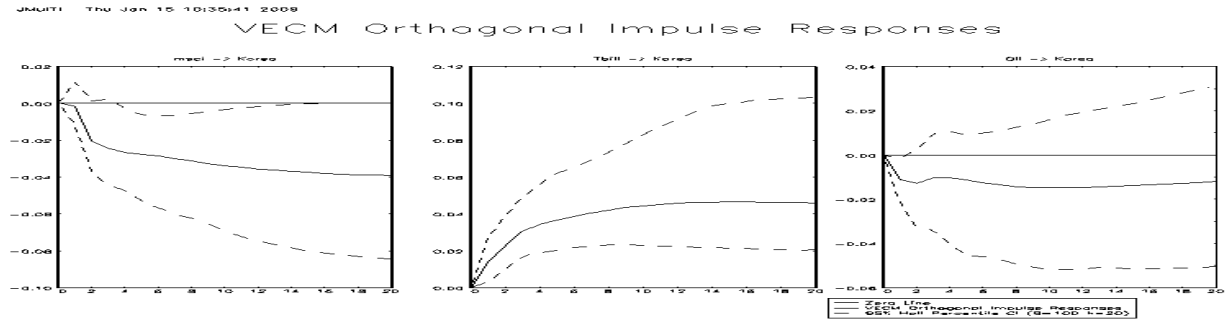
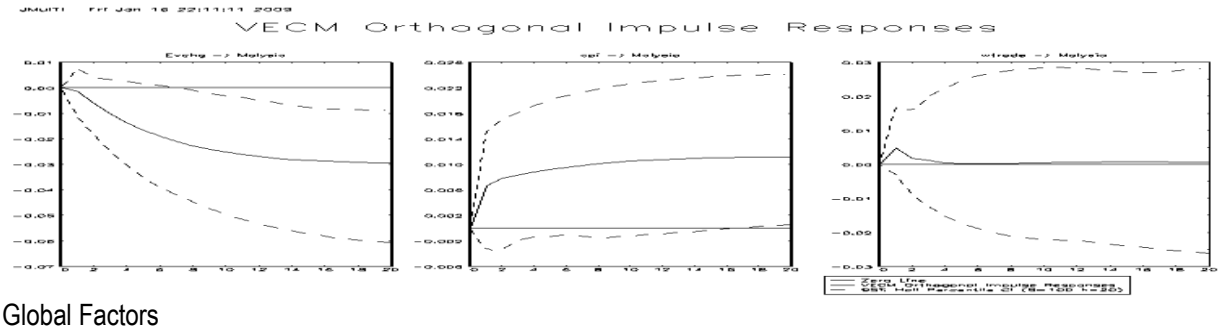


Malaysia

Local Factors



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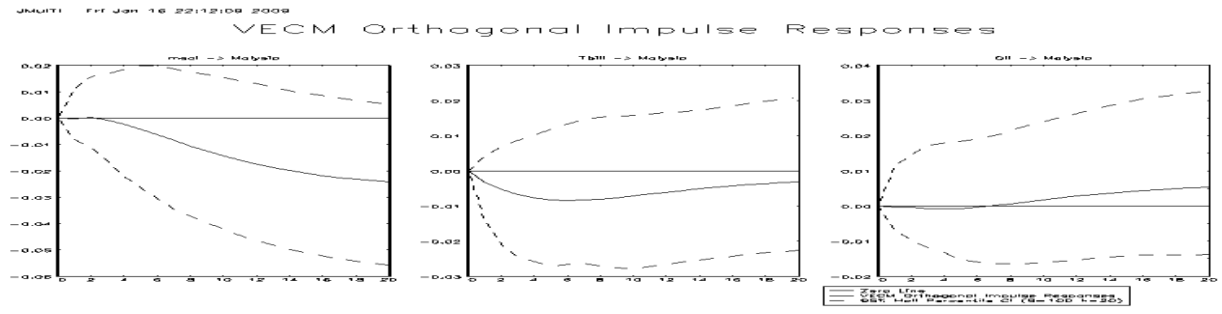
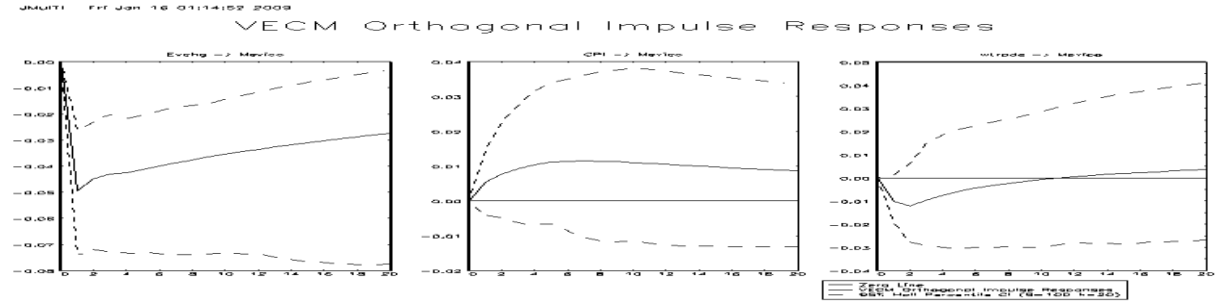
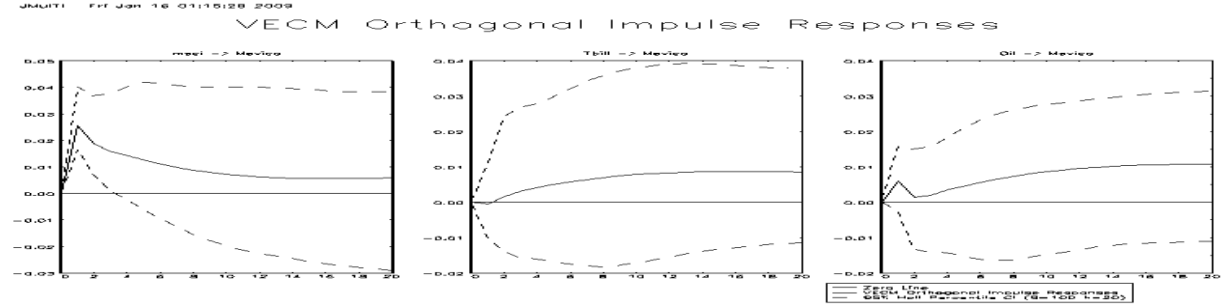


Mexico

Local Factors

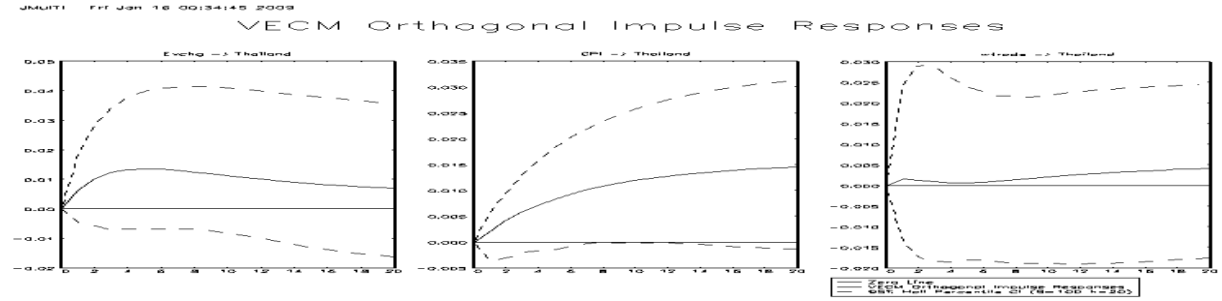


Global Factors

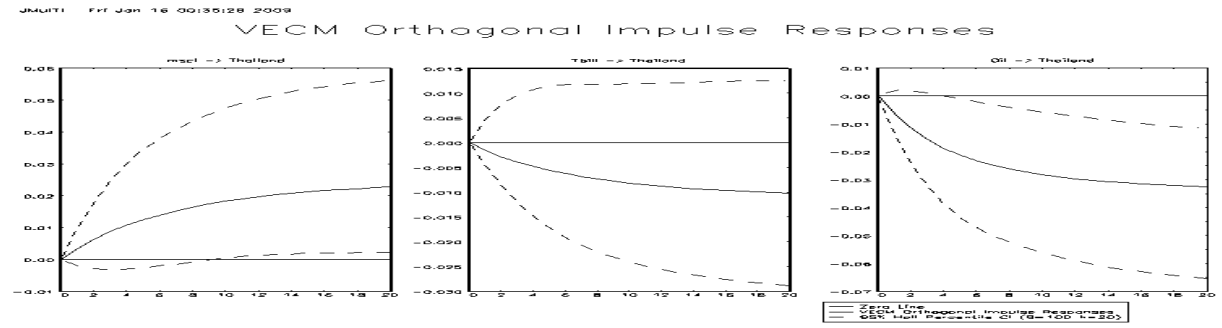


Thailand

Local Factors

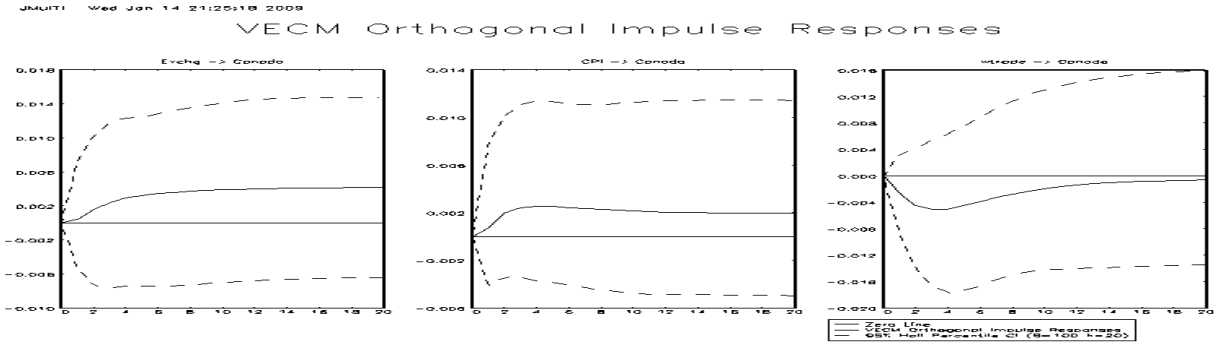


Global Factors

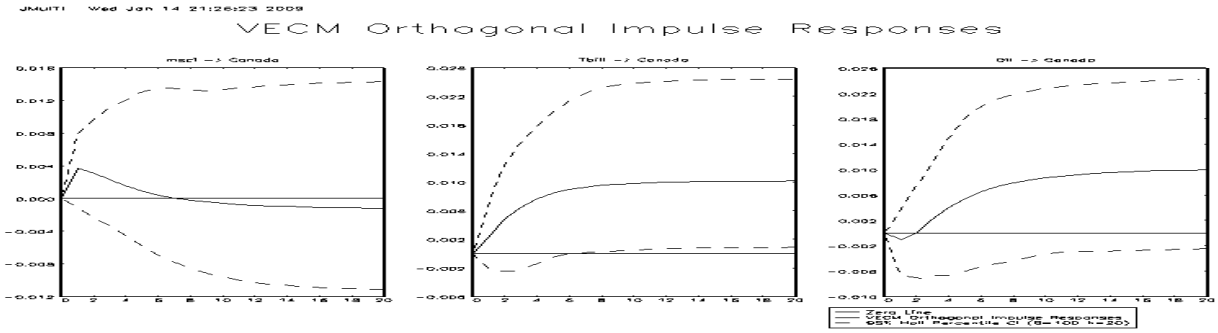


Canada

Local Factors

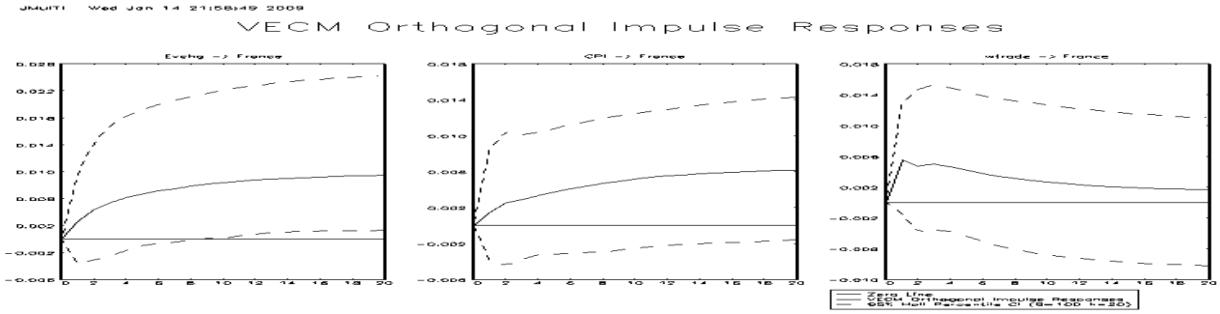


Global Factors

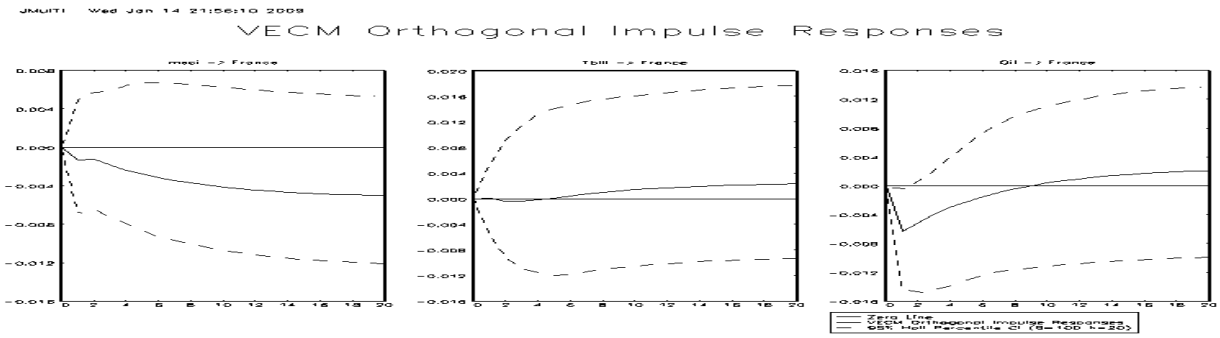


France

Local Factors

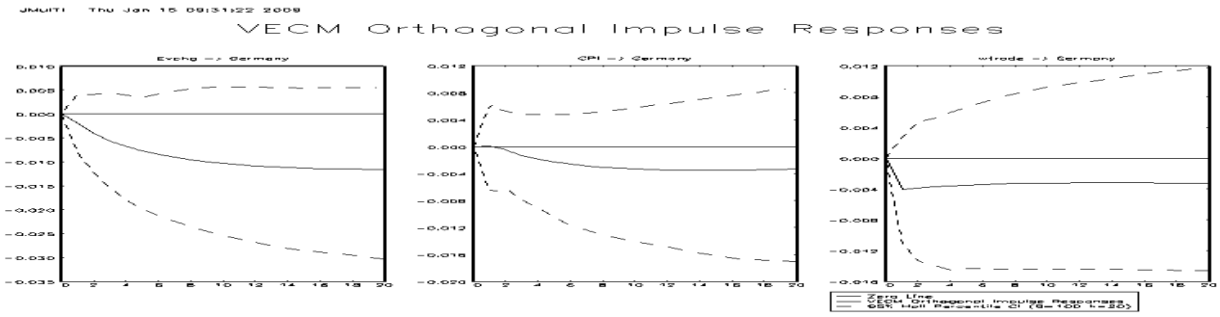


Global Factors



Germany

Local Factors



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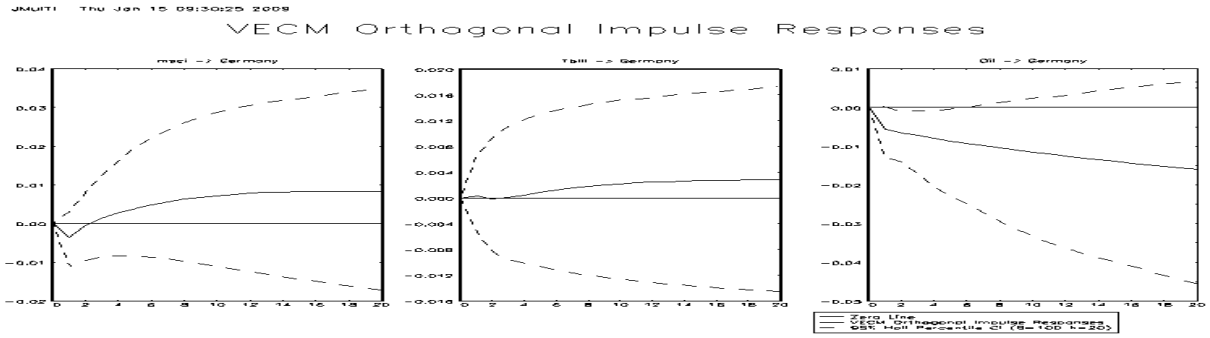
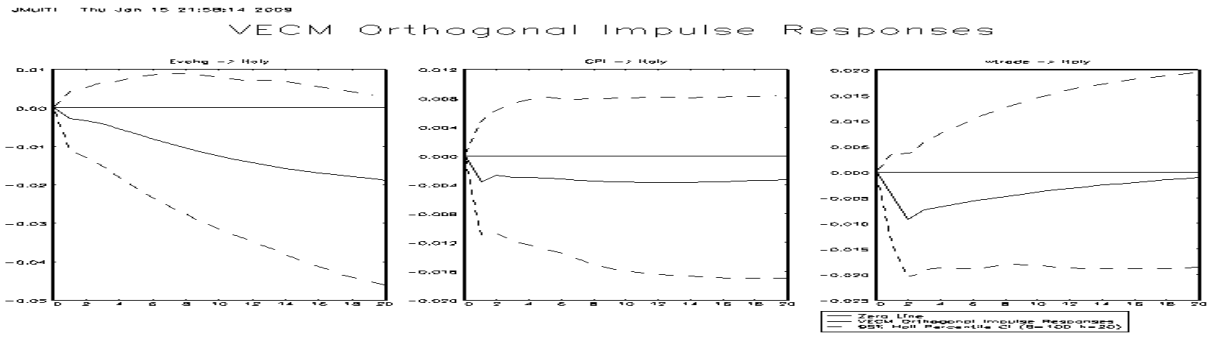


Italy

Local Factors



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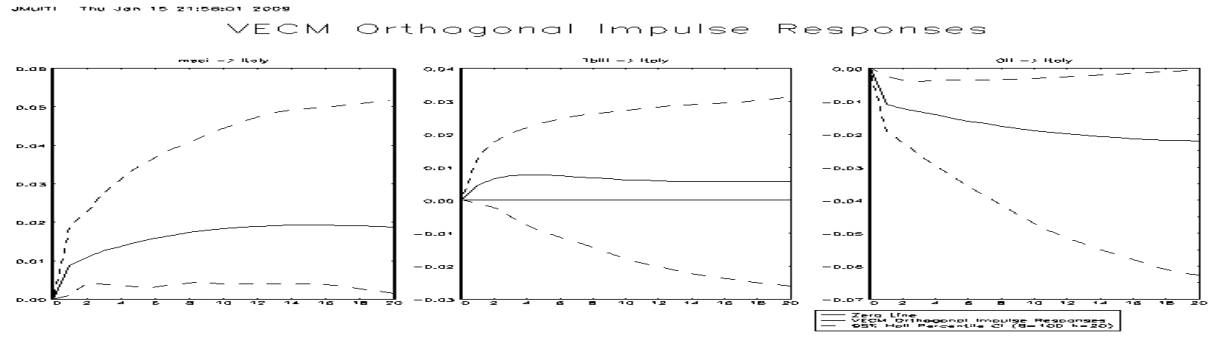
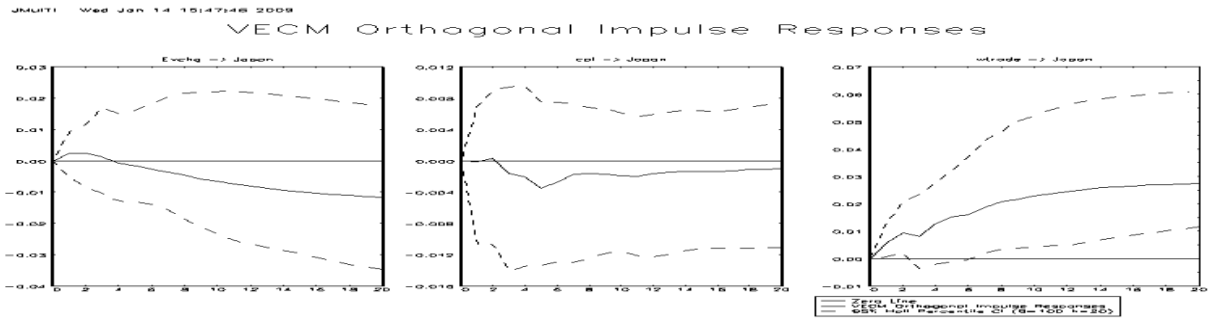


Japan

Local Factors



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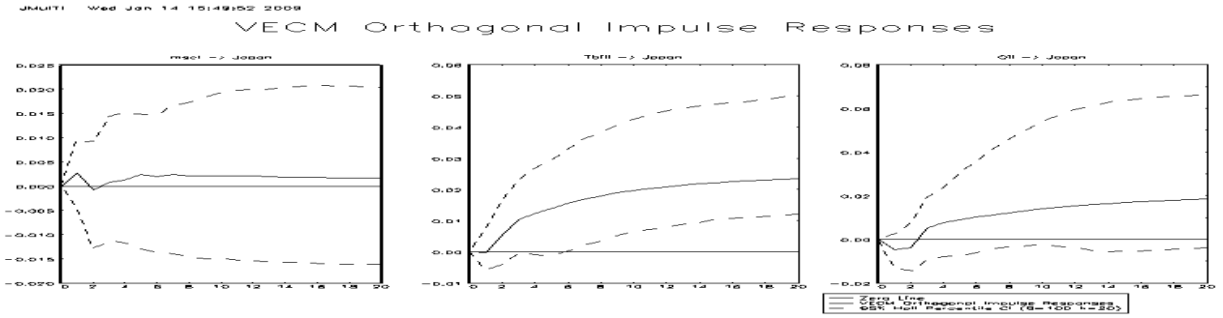
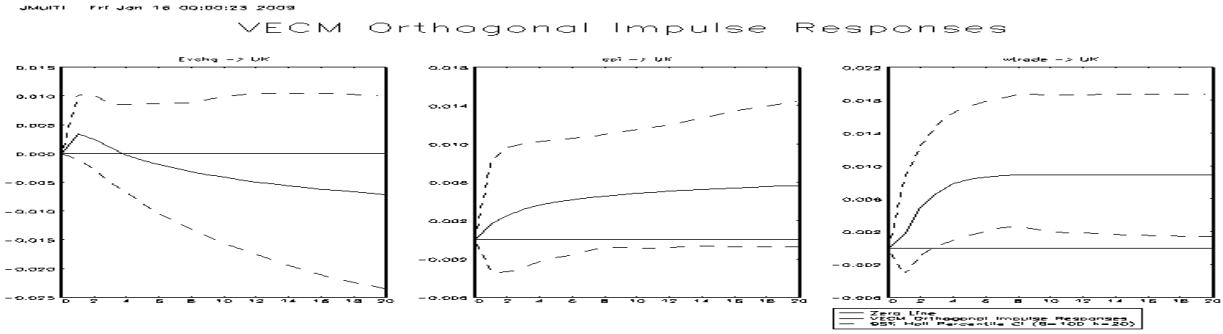


UK

Local Factors



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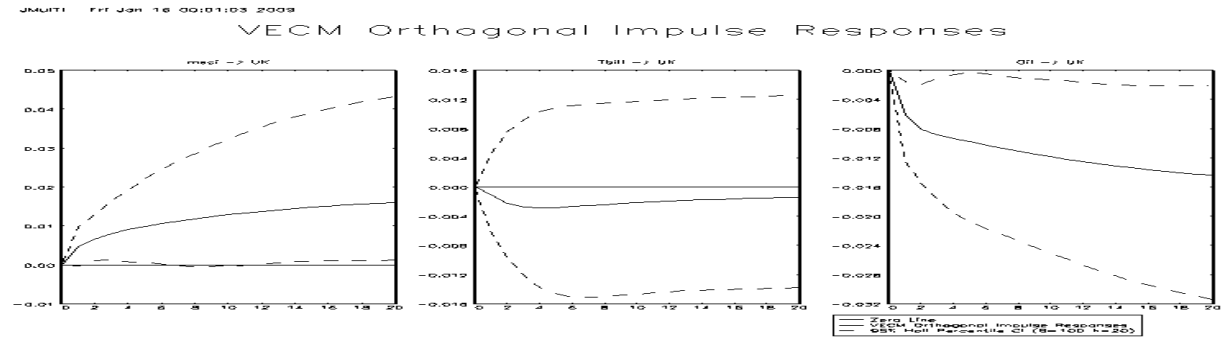
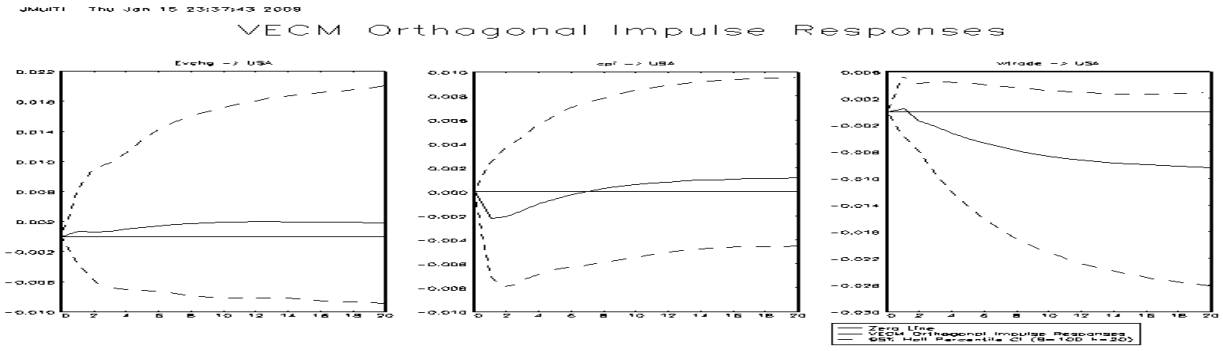


USA

Local Factors



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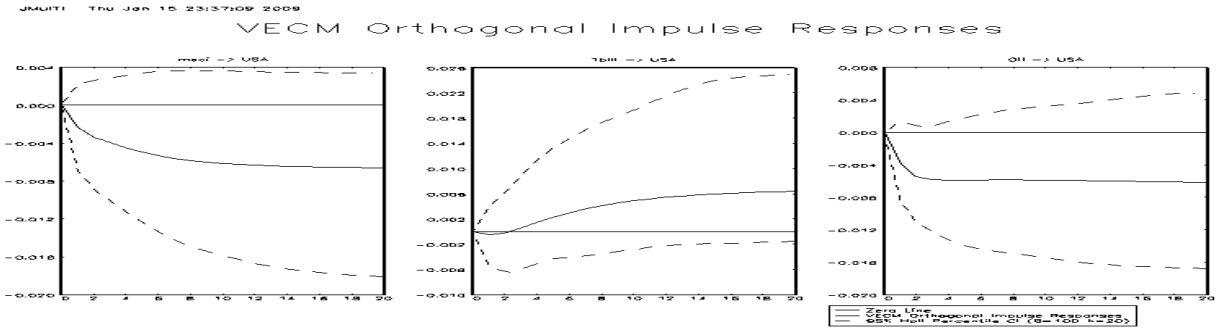
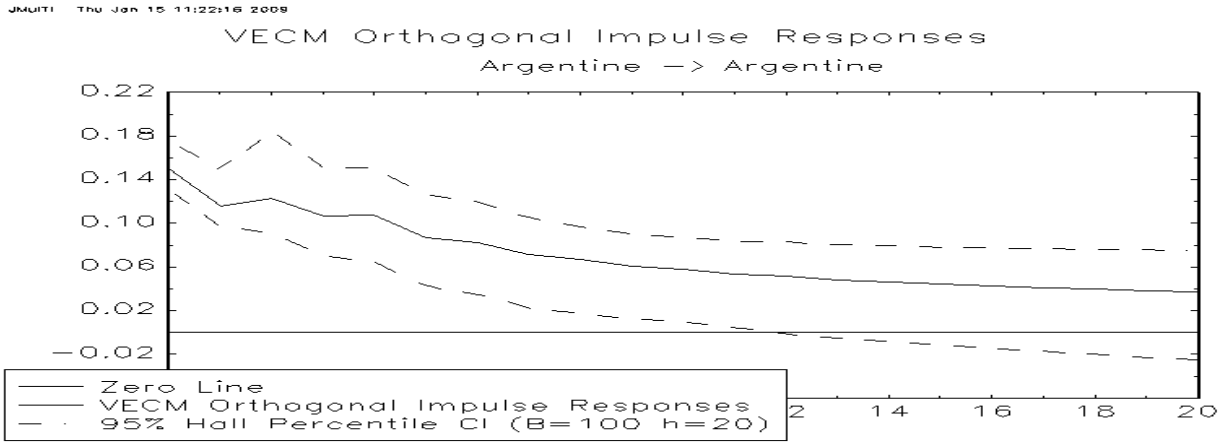


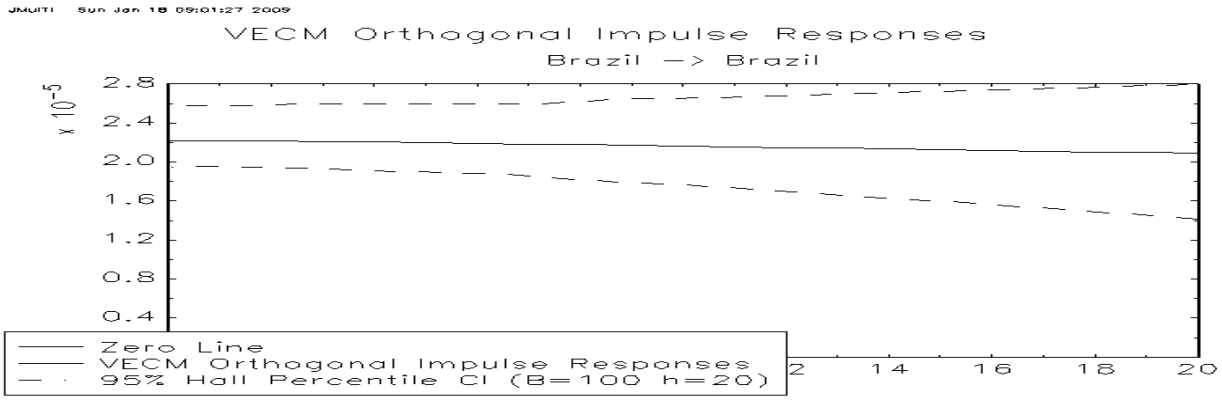
Appendix

Plots 2. IRF

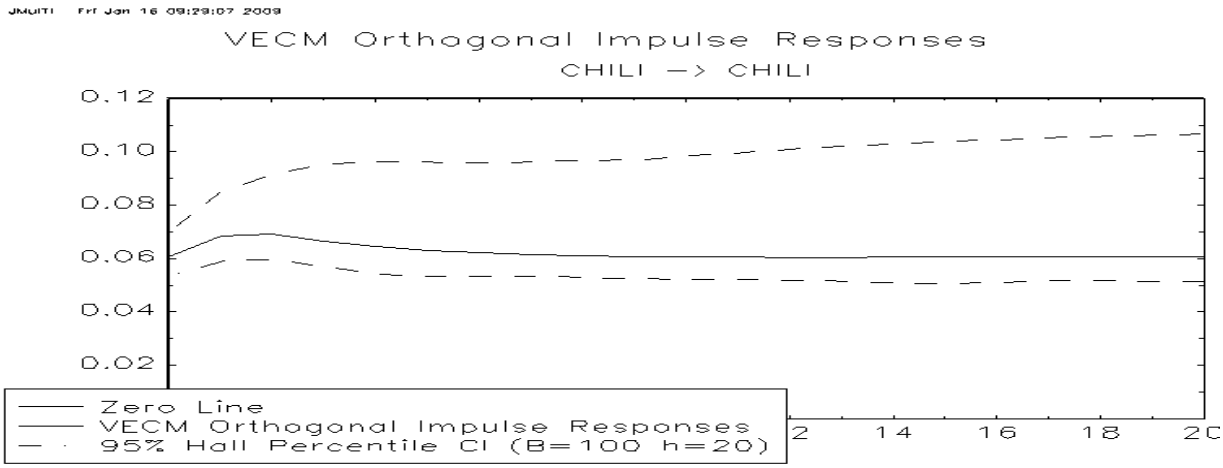
Argentina



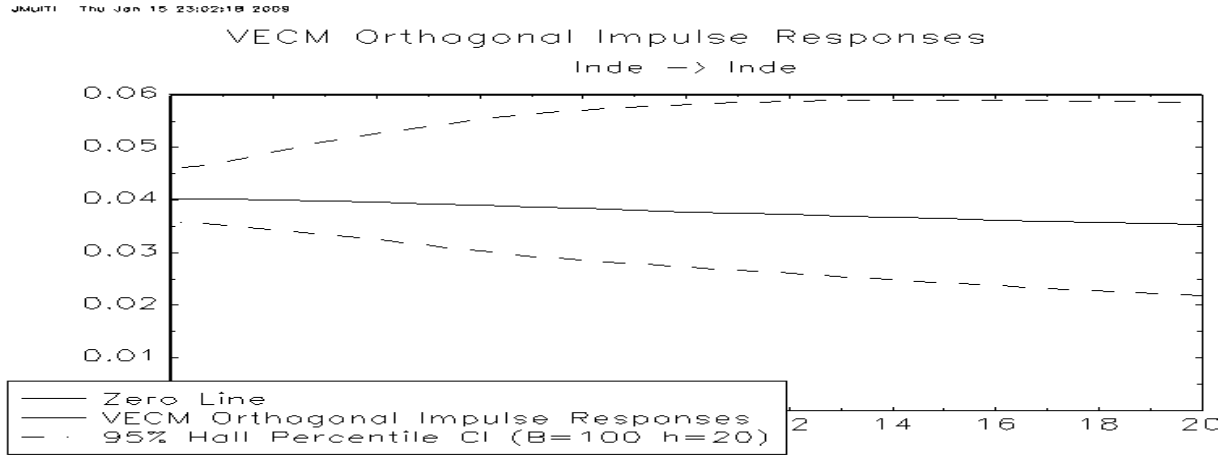
Brazil



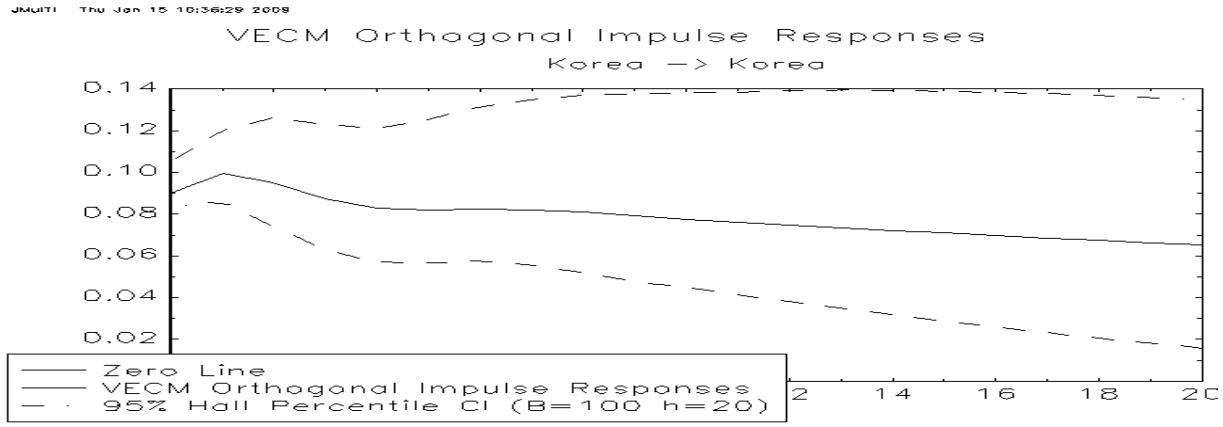
Chile



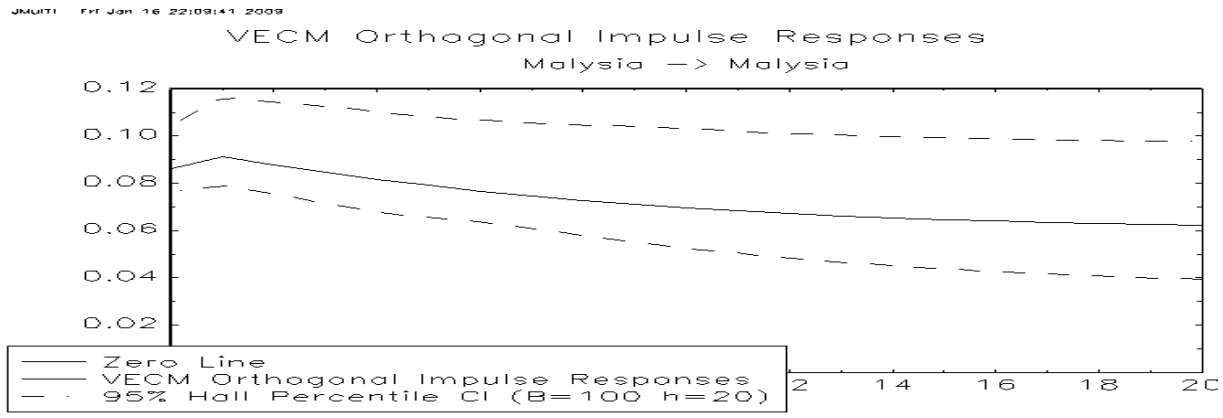
India



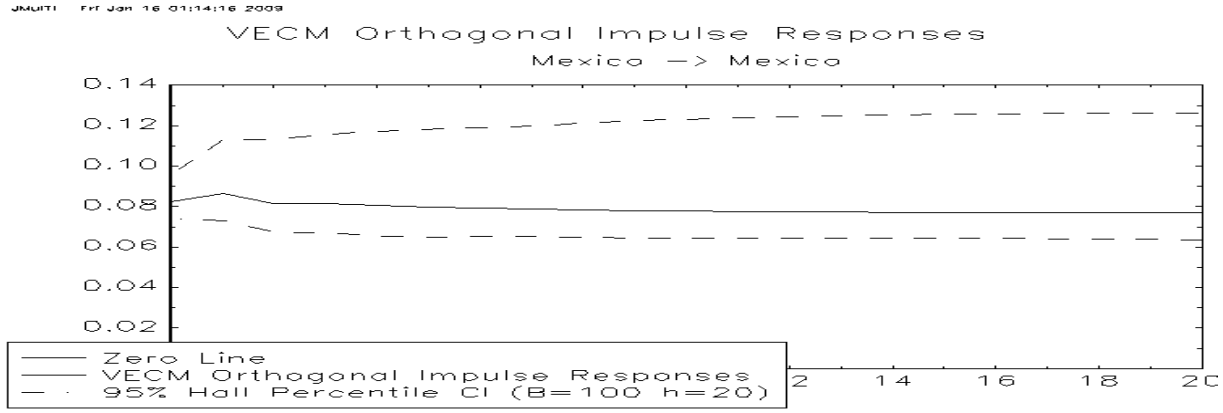
Korea



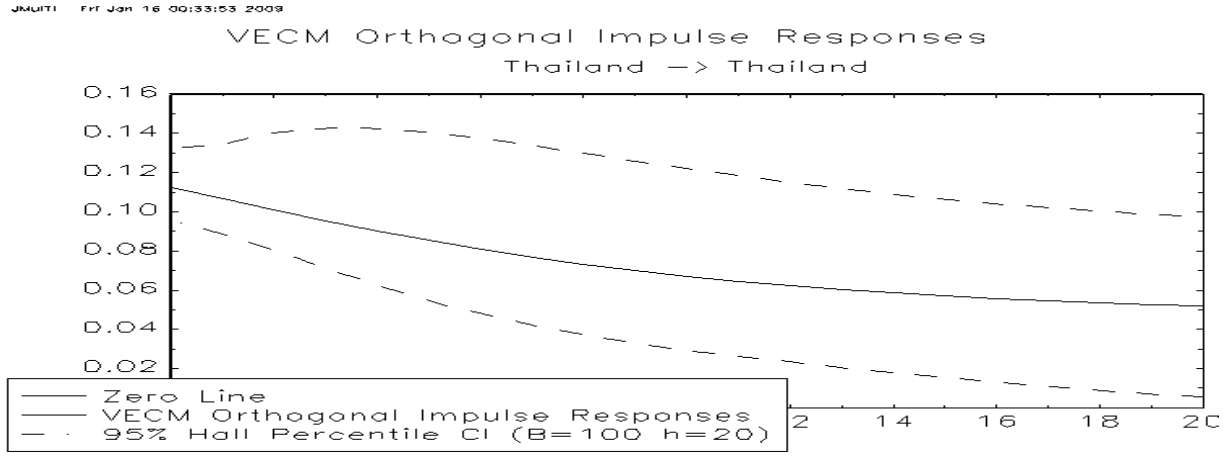
Malaysia



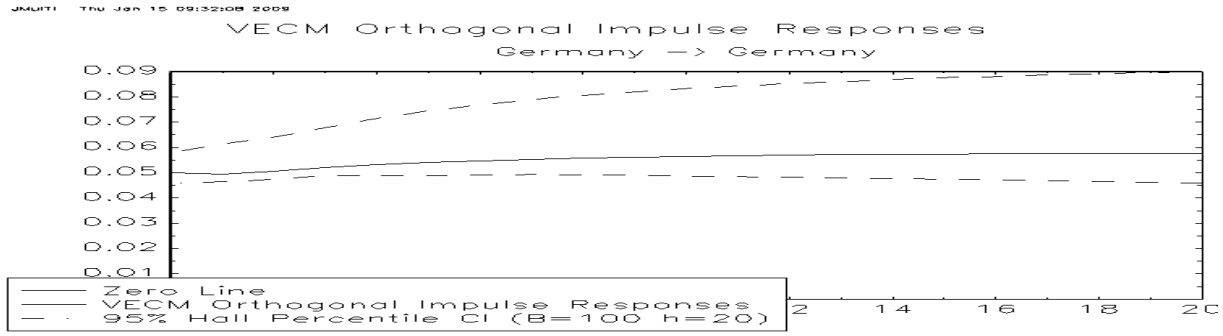
Mexico



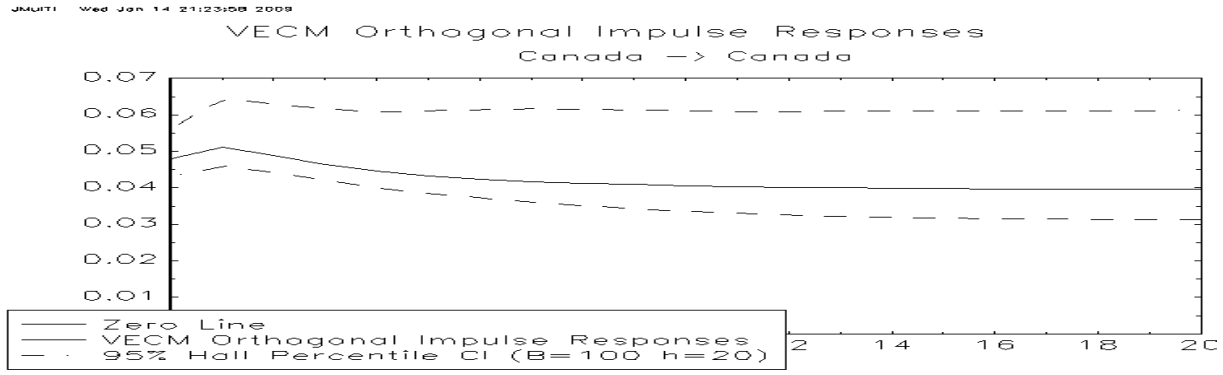
Thaïland



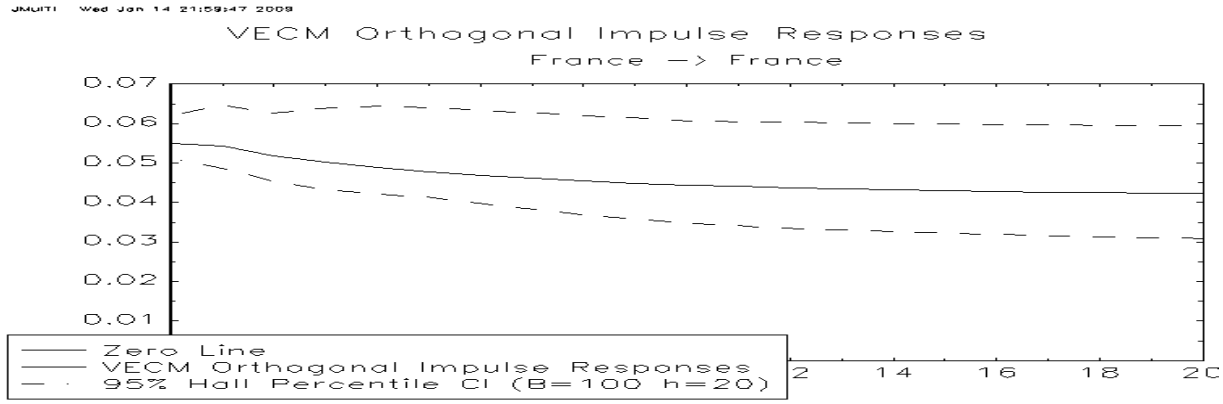
Germany



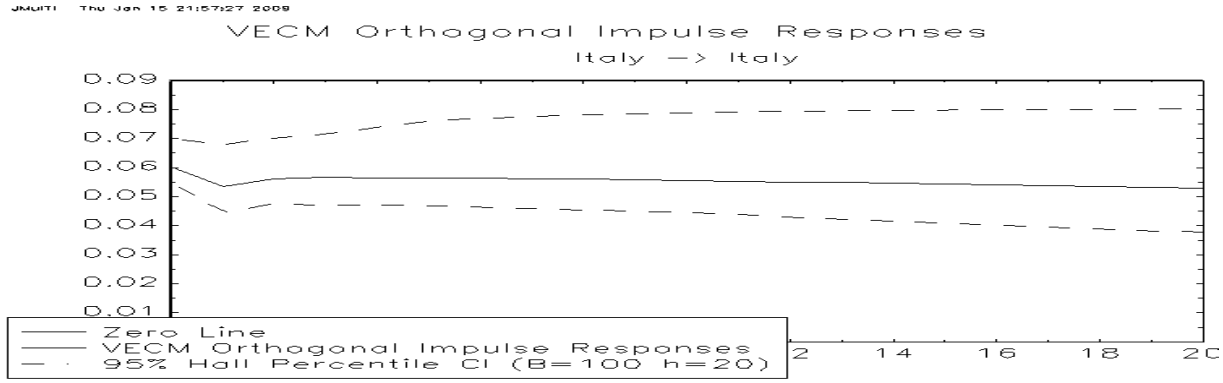
Canada



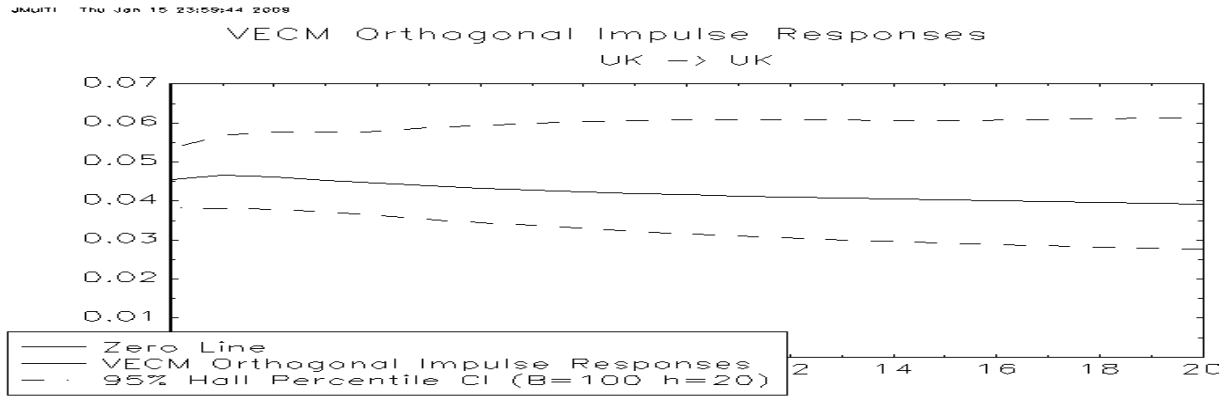
France



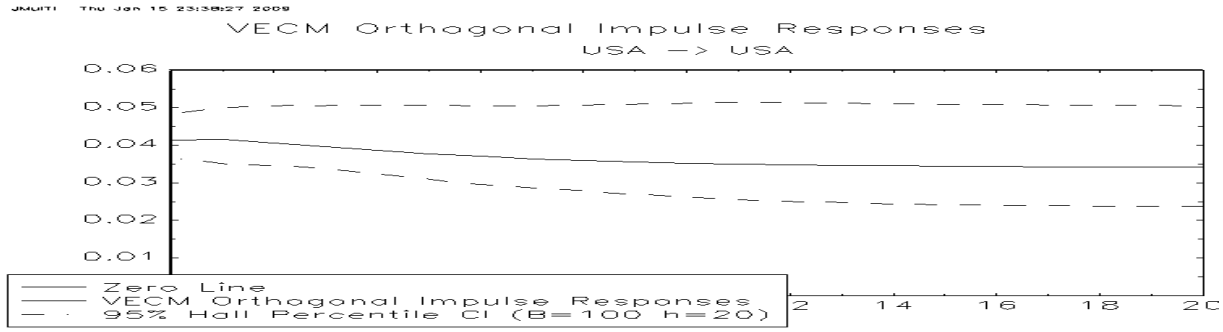
Italy



United-Kingdom



United States of America



FINANCIAL INTEGRATION IN THE FOUR BASINS: A QUANTITATIVE COMPARISON

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Abstract

The intention of the following paper is to present some stylized features of the financial integration of the four basin regions composed by the Baltic Sea, Black Sea, Caspian Sea and Mediterranean Sea regions. It discusses the developments, trends and features of the International Investment Position (IIP) in the regions. Using volume based indicators we compare and identify the gaps in them, whilst distinguishing between the EU e non-EU members and providing an overview of the asymmetries and the convergence as a result of the integration in the different financial markets. After reviewing the trends, the final chapter points to those areas that need further efforts to achieve greater regional integration.

Keywords: international financial integration, convergence, asymmetries, current account openness, FDI, financial development, portfolio investment

JEL Classification: F15, F21, F33

1. Introduction[2]

Starting from the 1990s, the European Union undertook a set of reforms addressed to complete the full liberalization of the capital transactions between the member states and the third parties. The purpose of the agreement was to accomplish the full financial integration of the European capital markets alongside the same principles of the common market for good and services[3]. In 2004, the Wider Europe and the European Neighbourhood Policy (ENP) projects proposed a '*comprehensive prudential regulatory framework for the financial services area*'[4], aimed to reinforce the undergoing benefits of the capital account liberalization in the partner countries.

The original conceptual framework suggests, in combination with the achievement of the internal market and the implementation of the Economic and Monetary Union (EMU), that over time more financial integration will promote the stability of financial markets. Furthermore the new asset will enhance the overall economic performance with financial innovations and organizational improvements.

Moreover, the main benefit of the financial integration consists in the development of the financial sector, promoting deeper and more sophisticated domestic financial markets. Thus, banks and financial institutions may increase the financial alternatives for borrowers and investors[5].

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[2] This paper falls within EU4SEAS, *The EU and sub-regional multilateralism in Europe's four sea basins: Neighbourhood, Enlargement and Multilateral Cooperation,* research project funded by the European Union's Seventh Framework Programme (FP7/2007-2013) under Grant Agreement no.225382 (visit www.eu4seas.eu for further information)

[3] European Commission, *Capital Market Liberalization*: *The Single Market Review Series, Subseries III, Dismantling of Barriers*, (August 1996).

[4] European Commission, *Communication from the Commission, European Neighbourhood Policy, Strategy Paper.* (2004), 15-16. "It will be key to the creation of business and the promotion of investments that these countries ensure that companies are able to operate on a level playing field. In combination with the above measures, access to European financial markets should, over time, add to the stability of partners' financial markets and help enhance their overall economic performance. The further liberalising of capital movements will provide new opportunities."

[5] For a critical analysis of the benefits of capital liberalisation see Stiglitz, Josef E. 2004. Capital-market Liberalization, Globalization, and the IMF. *Oxford Review of Economic Policy,* Vol. 20, No. 1: 57, in particular the different impact between FDI and short-term capital flows.

2. Two questions

The following paper attempts to compare the patterns of the international financial integration, it addresses some specific theoretical issues and aims to benchmark the four basin regions. The four sea basin regions are composed by groups of countries with different institutional and economic characteristics.
The four sea regions are the following:

- **The Baltic Sea region:**
  EU: Estonia, Latvia, Lithuania, Denmark, Finland, Sweden, Germany, Poland;
  Non EU: Russia, Belarus.

- **The Black Sea region:**
  EU: Bulgaria, Greece, Romania;
  Non EU: Turkey, Georgia, Russia, Ukraine, Moldova, Armenia, Azerbaijan.

- **The Caspian Sea region:**
  EU: none;
  Non EU: Iran, Azerbaijan, Russia, Kazakhstan, Turkmenistan, Georgia, Armenia, Turkey, Uzbekistan.

- **The Mediterranean Sea region:**
  EU: France, Greece, Italy, Slovenia, Spain, Malta, Cyprus;
  Non EU: Turkey, Lebanon, Syria, Israel, Egypt, Jordan, Libya, Tunisia, Algeria, Morocco, Bosnia and Herzegovina, Croatia, Montenegro, Albania, Serbia, Macedonia.

Some countries are overlapping among the groups: Russia and Turkey have borders in three basins, whilst Azerbaijan, Armenia, Georgia and Greece belong to two basins.

Once defined the purpose of the study, it is significant to answer the following two main questions. The first one relates to the theoretical models of financial integration.

The standard economic theory suggests that the liberalization of capital flows, in particular long-term capital flows, and financial development are important policy instruments; as a matter of facts, they provide a favourable support for the integration of neighbouring countries on a regional scale. In this regard, capital flows play a crucial role, in terms of fostering accelerated growth, technical innovation and enterprise restructuring[6]. In recognition of these potential benefits, governments undertook widespread capital account liberalization over the past quarter-century.

In the 1990's, capital account liberalization played an important role in the market reforms introduced by governments in the transition economies[7]. The countries that adopted policies of capital account liberalization attracted a large amount of foreign capital; their financial system developed enhancing more complete, deeper and better-regulated financial markets. Additionally these nations gained credit to foster the transition and the economic growth.

There are two main channels through which financial integration promotes financial development. First, financial integration implies that a new type of capital is available from neighbouring countries. In addition, new and more capital inflows allow these countries to smooth consumption, to deepen financial markets, and to increase the degree of market discipline.

Second, financial integration leads to a better financial infrastructure, which mitigates information asymmetries and, as a consequence, reduces problems such as adverse selection and moral hazard[8]. Financial

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[6] *See* Prasad, Eswar S., Rogoff, K., Wel, S., and Kose, M. Ayhan. 2003. Effects of Financial Globalization on Developing Countries: Some Empirical Evidence, *IMF Occasional Paper No. 220,* Washington: International Monetary Fund (2003). and Edwards, Sebastian. "Thirty years of current account imbalances, current account reversals, and sudden stops". *IMF Staff Papers* (2004): 51 (Special Issue), 1.

[7] Capital account liberalization is considered an important precursor to financial integration. See Kose et al. "Financial Globalization: A Reappraisal". *IMF Staff Papers* (2009): Vol. 56, No. 1, 8.

[8] *See* Schmukler, Sergio L. "Financial Globalization: Gain and Pain for Developing Countries". *Federal Reserve Bank of Atlanta Economic Review, Second Quarter* (2004), and the criticism of Stiglitz, Josef E. "Capital-market Liberalization, Globalization, and the IMF". *Oxford Review of Economic Policy* (2004): Vol. 20, No. 1, 57. See also Massad, Carlos. *Capital Flows in Chile: Changes and Policies in the 1990's in Financial Globalization and the Emerging Economies*, (J. A. Ocampo, S. Zamagni, R. Davis and C. Pietrobelli ed., 2000), 219-233.

integration is a market driven process. According to this aim, the legislative and regulatory framework has been adapted and addressed at lowering legal regulatory impediments and at reducing the transaction costs of the domestic financial markets[9].

The second question is addressed to the empirical measurement of the financial integration. The enquiry requires a quantitative analysis to understand the openness of the capital markets and the evolution of the financial integration among the basins.

The definition of 'financial integration' considers two broad categories of indicators: quantity or volume-based indicators and price-based indicators. The former set is used to investigate the extent to which investors have internationalised their portfolios. In financially integrated markets investors increase their holdings of non-domestic assets in order to benefit from the international diversification.

Price-based indicators measure discrepancies in asset prices on the basis of their geographical origin. In a perfectly integrated market, prices of assets with similar characteristics should be the same or at least largely influenced by common area factors.

In this paper we approach the comparison using volume-based indicators.

3. Financial integration in the four basins

3.1 The evidence and the practices

The liberalization of capital flows is a general feature in almost all countries of the four basins, even though its degree of openness and its timing has been the subject of specific policy decisions. Most neighbouring countries undertook a series of market reforms and adjusted their monetary policies to enable a higher openness of the capital account over the decade. Only seven countries decided to lift all capital controls according to the *acquis communaitaire* and became full members of the European Union (EU).

The non-EU partners adopted a broad variety of different exchange rate regimes and capital liberalisation policies, even though the integration policies of the EU had the explicit aim of removing legal barriers on capital cross-border transactions[10] and promoting the financial integration in the single currency area.

Only four partner countries opted for pegging the euro with currency board arrangements (Bulgaria, Bosnia) or conventional fixed peg arrangements (Macedonia, Croatia). The large majority of partners opted for a fixed peg agreement anchored to the US dollar (Belarus, Jordan, Kazakhstan, Lebanon, Morocco, Russia, Tunisia, and Turkmenistan) or to the SDR as Libya. Other countries decided to pursue a more flexible approach and introduced a crawling peg system with a composite basket of currencies, such as Iran. Others managed a float system as Turkey, Ukraine, Algeria, Egypt, Moldova and Romania. See the annex for a further detailed analysis of the foreign exchange regimes.

The capital account liberalisation policies have been also mixed: the Baltic States proceeded towards the accession to the EU, whilst the Caspian and Mediterranean countries lagged behind.

This paper adopts the annual data published by the IMF's Annual Reports on Exchange Rate Arrangements and Exchange Restrictions (AREAER)[11] in order to obtain a comparable measure of capital account restrictions for the 17 EU members and 29 non-EU countries. The AREAER data are suggested by the majority of studies on capital account liberalization, due to the several advantages from an institutional point of view, or a de jure measure. They provide a consistent measure of restrictions on capital account transactions as well as foreign exchange arrangements and they are available on an annual basis across a wide range of countries. Their main disadvantage is that such 'rule based' data generates a simple 'on-off' indicator, which indicates neither the relative degree of capital restrictions, capital mobility nor the degree of legal restrictions enforced.

However, the recent empirical research tried to overcome these shortcomings. For example, Chinn and Ito[12] proposed a composite index (KAOPEN) that incorporates information either about restrictions on capital account transactions or on current account transactions and exchange rate arrangements. The index highlights positive values when the level of restrictions is low, whilst negative values are displayed when the countries have a higher intensity of capital controls.

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[9] Nevertheless, evidence in Europe has demonstrated that in a context of perfect financial integration, frictions are likely to persist. See European Central Bank, *Financial Integration in Europe*. (European Central Bank, April 2009), 12.

[10] The EU Banking Directives (1977, 1988), the Financial Services Action Plan (1999), the White Paper (2005).

[11] Among others, de-jure measures based on information on the AREAER have been developed by Quinn 1997, Johnston and Tamirisa 1998, Miniane 2004, Chinn And Ito 2002, 2008.

[12] Chinn, D. Menzie *et al*., *Capital Account Liberalization, Institutions and Financial Development: Cross Country Evidence*. (NBER Working Paper No. 8967, 2002)

Figure 1 shows the performances of the countries which adopted the Euro or pegged their currencies to Euro during the period of observation that lasted from year 2000 to year 2007. The diagram illustrates that these nations had the best growth of financial integration (KAOPEN index higher than 1,50) if compared to those that opted for other policies. Instead those countries that pegged their currencies to US dollar or SDR or other composite baskets (in particular the Black Sea and the Caspian Sea regions) had a lowest growth of financial integration, with negative KAOPEN indices. Not surprisingly, countries with pegged their rates to the EU had considerably higher financial integration, confirming the conventional discipline. When the national rules converge to EU norms, regional financial integration improves substantially with greater participation of domestic banks and private investors.

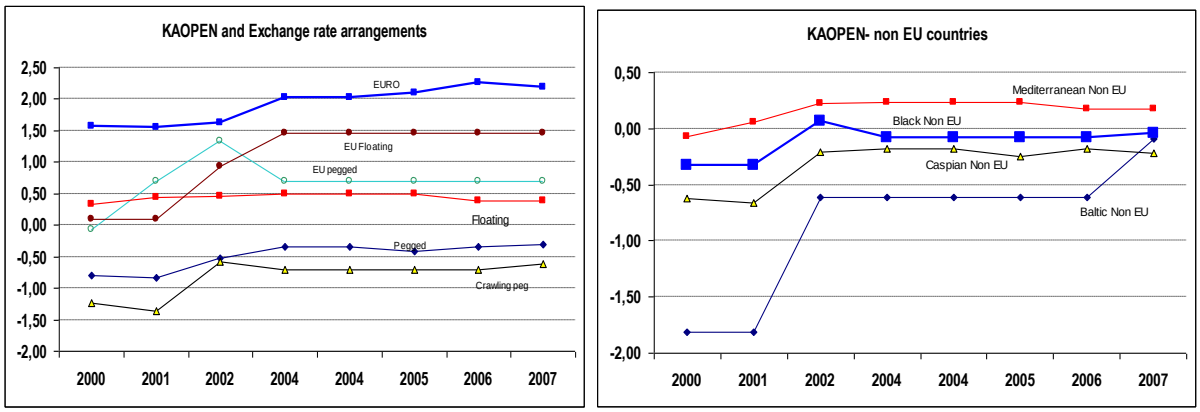


Figure 1. Capital Account Openness (KAOPEN) and Foreign Exchange Regime

These are, of course, simple observations. However, it is possible to suggest how much financial integration was due to the introduction of euro (the highest level) or the pegging to euro. In particular the Baltic Sea region shows the best experience, not only for the large concentration of EU members, but also for the 'Russian factor', which has been supported by the institutional liberalization of the capital accounts in the most recent years and the consequent convergence, as shown in the right side of Figure 1. Also in the Mediterranean countries, as capital controls have been progressively eased in recent years, the financial integration has increased significantly with positive values of the index[13].

The history of the European Union and of some individual countries has recognized the importance of financial cooperation, which has been institutionalized in three regions: the EIB, FEMIP for the Mediterranean (the oldest and the largest), the Nordic Investment Bank (with the extension to the three accession countries in 2005), the Black Sea Trade and Development Bank (the smallest). Only the Caspian Region has not yet received due attention. The level of regional cooperation has increased over time, adding new projects on the portfolio and increasing the resources to the planned needs.

However, the financial resources are limited and the total asset exposure is only a small fraction of the entire capital flows in the regions. Consequently, over time the resources have been properly addressed on selected projects of mutual interest, from energy, to transport, to environment, to SMEs. Additional factors have contributed to the increasing flows of funds to the bordering regions: in particular the capital liberalization combined with the market deregulation. As a result, the savings of the EU economies had the possibility to finance investments in the neighbouring partners, to differentiate the risk and attain a more efficient allocation of capital. However, capital outflows have also less desirable side-effects. In a context of incomplete structural reforms, as in the Mediterranean and Caspian Sea regions, the international capital flows carry considerable risks which could magnify the underlying macroeconomic and structural weaknesses.

To sum up, the empirical evidence shows that capital flows are influenced by many factors, some of them belong to a general scale, whilst others involves only specific countries. A few examples of factors that affect the capital flow are: the liberalisation of international capital transactions; regulatory reforms of capital markets;

[13] Müller-Jentsch, Daniel, *Deeper Integration and Trade in Services in the Euro-Mediterranean Region: Southern Dimensions of the European Neighbourhood Policy*. (Washington, D.C., World Bank and European Commission, 2004); Lagoarde-Segot, *et al.* "The Capital Markets of the Middle East and North African Region. Situation and Characteristics", *Emerging Markets Finance & Trade* (September–October 2008): Vol. 44, No. 5, 68.

improvements in the macroeconomic performance of countries; rapid progress in communication technologies, and privatisation and structural economic policies.

3.2 The domestic perspective

The financial market integration plays a special role in neighbouring emerging or transition countries. It is widely known that the financial market is one of the most important elements of the transition, as it is the central institution for transforming savings into investments and thus generating long-term economic growth.

Previous studies have shown that the financial integration can be analysed from two different perspectives.

The first one, the domestic perspective, financial markets in neighbouring countries still remain underdeveloped and rudimentary; an example of this trend is clearly shown in Table 1.

Table 1. Domestic financial integration

	GNI per capita PPP		Market capitalisation of listed companies (% of GDP)			Domestic credit to private sector (% of GDP)	
	2000	2009	2000	2007	2008	2000	2008
EU Baltic	16.790	27.051	72,6	69,0	27,0	55,6	105,2
Non EU Baltic	5.615	13.790	7,5	58,0	39,4	11,1	34,9
EU Black Sea	9.357	17.683	32,0	55,5	17,7	22,2	68,8
Non EU Black Sea	3.510	8.337	11,2	36,2	16,0	11,4	35,9
EU Caspian Sea	0	0	0,0	0,0	0,0	0,0	0,0
Non EU Caspian Sea	3.758	8.582	6,3	25,6	13,6	10,9	21,2
EU Mediterranean Sea	19.297	27.990	66,6	91,7	30,4	94,3	138,5
Non EU Mediterranean Sea	5.524	11.144	12,3	53,9	27,7	35,9	48,9
Euro Area	23.275	33.193	86,9	85,0	37,9	97,9	126,4

The Baltic Sea basin has the highest average level of GNI per capita compared with the other regions, followed by the Mediterranean Sea basin. The difference between EU and Non EU member states, measured by the standard deviation, is also lower in the Baltic Sea basin then in the Mediterranean, with the highest differences in the Black Sea basin. The ranking remains essentially the same if we look at the two other indicators of financial development: the Market capitalisation of the listed companies and the Share of lending to private sector.

The indicators show two different aspects of the financial divide between EU and non-EU members, and between regions. Where the process of financial liberalization is more advanced, as for the stock exchange, the gap is much smaller. But where national restrictions prevail on the harmonization to international rules, as in the commercial banking system, the gap is much wider and more resistant over the decade.

The share of private claims on GDP can help to access the degree of financial liberalization and financial deepening. Table 1 indicates that the gap in financial deepening has been reduced during the decade, but it still

remains considerably high, one third in average of the euro area. Moreover, the differences among the countries or region are also very important: a low 20-35% in the Caspian and Baltic region, with the predominant presence of Russia, compared to a 50% in the Mediterranean region which has a relatively well developed commercial banking system.

Instead, for the market capitalisation index, the differences disappeared during the decade as a result of the improvements of the corporate governance of the listed companies and the government policies. Financial activities have been boosted by increased listings of companies, mostly made possible through privatization of state-owned enterprises. In addition, the growth of their economies has been higher than the EU, and the attractiveness of these new stock markets has grown considerably in size and volume. For example, the Egyptian equity market is one of the most developed in the Mediterranean region with 306 listed companies in 2009 (down from 1148 in 2002).

The data is very respectable compared to the listed companies in the Stock exchanges of Turkey and Russia, which performed 315 and 333 respectively. The cumulative result is that the average capitalisation index in the four regions increased to 50-60% in 2007 from 10-15% in the Nineties, compared to the high 80% of the Eurozone. Therefore, considering the good performance of their markets, some of these countries have been included in the MSCI composite index[14]. According to the classification of markets and the accessibility measures that reflect the international investors' experience and excluding the Eurozone countries, twelve countries are defined as frontier markets[15]; other four as emerging countries, and one, Israel, as developed market.

In a context of large differences in volume and in scale, the international financial integration has provided additional resource to supplement domestic savings and has increased the competition in domestic financial systems. On the way to adapt their rules and regulations to the new environment, all countries had to face several pressing problems and resistances that may concern the economy in general and the development of a national financial intermediation system.

Some of these problems have an institutional nature, as the low profitability of the economy and its industries, the lack of a common corporate and economic culture or the inadequate protection of the minority shareholder rights during the privatisation phase. And on more than one occasion, the monopolisation of some sectors of the economy had a significant and negative influence in the financial markets.

3.3 The international perspective

The second outlook is called the international perspective. According to the international perspective the main contribution of integration is the source of financing, with the traditional tripartition of international capital flows: (1) Foreign direct investment (FDI) which are flows between firms and their foreign subsidiaries or foreign partners and may be the result of earnings of the same foreign subsidiary that are retained abroad; (2) Portfolio investments, which are private transaction in equity securities and debt securities between banks and financial intermediaries; (3) Debt instruments, which are financial flows between financial intermediaries and firms and governments which supports trade and investment activities.

All indicators of cross-border transactions from the IMF of the BIS suggest an ever increasing interdependence within the countries of the four basins and the EU.

For the analysis we use the database of Lane and Milesi-Ferretti (2000-2007)[16] last updated on 2008. According to the authors' methodology, international financial transactions are divided into broad categories: portfolio equity investment, FDI, foreign exchange reserves, and debt. The debt category includes portfolio debt securities and other instruments, such as loans, deposits, and trade credits.

The following analysis took in consideration stocks, which is typical for such kind of structural analysis, instead of flows. The net external position, given by the difference between total external assets and total external liabilities, measures the net creditor or debtor position of the four regions vis-à-vis the rest of the world. Therefore, the net external position is similar to the IMF definition of 'Net International Investment Position', which is the measure of the cross-border financial net flows (over time) plus the changes in the value of the holdings of these

[14] MSCI, *MSCI Global Market Accessibility Review*, June 2010.

[15] Frontier markets: Estonia, Lithuania; Kazakhstan; Romania, Bulgaria, Ukraine; Croatia, Lebanon, Jordan; Serbia, Slovenia, Tunisia. Emerging markets: Russia, Turkey, Egypt, Morocco; Developed markets: Israel and the Eurozone countries.

[16] The database *"External Wealth of Nations" Dataset, 1970-2007* is available on line at http://www.philiplane.org/EWN.html.

assets. We used the Lane Milesi-Ferretti database because the IIP statistics diffused by the IMF do not yet cover all neighbouring countries of the four basins.

From the elaboration of data we can derive a number of broad trends or stylized facts.

3.4 Two big trends

The pattern of international financial integration has changed significantly over the decade. It seems that the direction of capital flows is no longer a one-way, top-down element of the European pyramid of external relations. There are some partner countries with the highest level of assets close to the highest liabilities' level, resulting in almost flat net position. On the other side, there are other partner countries with increasing unbalances, positive or negative. The traditional characterization of capital-rich and capital-poor no longer follows the EU's external borders, so as to emphasize the traditional separation between the North and the South that has governed the debate during the Seventies.

Today the role of financial intermediation will hold for both: not only supplementing the domestic savings as proposed by the traditional European institutional literature, but mobilizing the accumulated financial resources in some countries or 'swapping' assets and liabilities in order to diversify the risk.

In presenting the data, we divide countries into four basins. In addition in order to identify the EU members within each group, we subdivide the Four Seas groups in EU e non EU. The separation is necessary in order to remark the different institutional character of the country and its association with the foreign exchange regime.

The indicators follow the definition proposed by Lane and Milesi-Ferretti (2003)[17] for measuring the International Financial Integration as a stock to GDP ratio:

Eq. (1) IFI = (FA + FL) / GDP

where FA (FL) denotes the stock of external assets (liabilities). This ratio is a volume-based measure of international financial integration.

The indicator can also be expressed as a difference between gross foreign assets and foreign, as defined by the net external position, and GDP.

Eq.(2) NEP = (FA - FL) / GDP

Figure 2 plots the IFI ratio, as a weighted average, for each of the four groups of countries over the period 2000-2008. Since most of the adjustment of the liberalization of the capital accounts were implemented rather quickly in the Nineties, the share of capital flows has finally stabilized at a ratio between 1,0 and 1,5, while continuing to increase in the euro area.

For the non-EU economies, we notice a deceleration of the financial integration that stops in 2004 with a resumption of bilateral flows that led these countries to overcome the initial levels of integration. The financial crisis of 2008 has dissolved the progress achieved in a decade. The development is however not comparable to the strength and the speed of financial integration within the European Union, with a ratio three time higher than the GDP.

This is, of course, consistent with the theory of financial harmonisation pursued by the European Union since the end of the seventies: no doubts that the international financial integration has increased markedly, particularly among the EU economies. While the trend towards increased international asset trade has been visible since the early 1970s, it has accelerated in the mid-1990s with the implementation of the three stages of the EMU (Economic Monetary Union). Total assets of the Euro Area increased from 6.590 billion USD to 19.239 billions in 2008. The IFI ratio increased from 210 to 300% of GDP. In the EU, the increase in cross-border asset holdings has been strong for both debt and equity instruments (the latter including FDI and portfolio equity) and in other debt instruments.

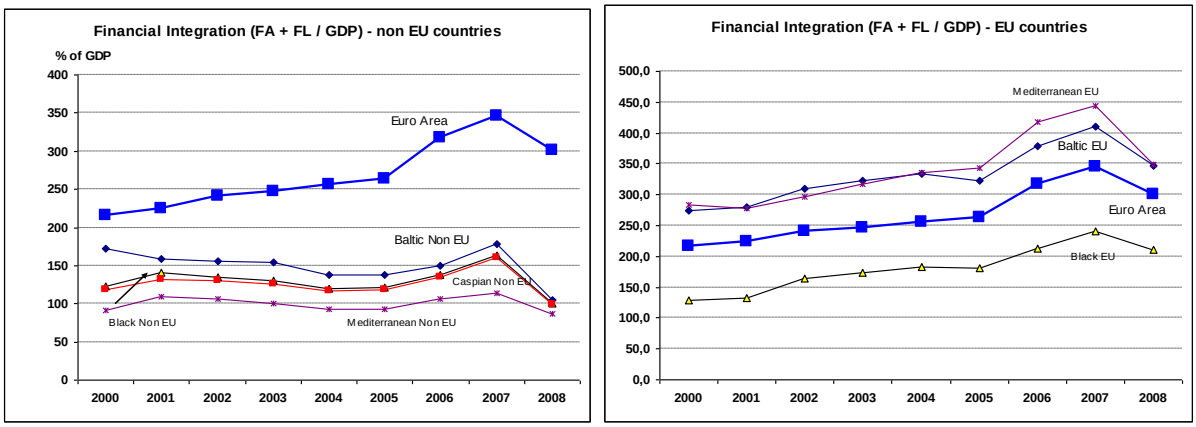
The situation is completely different in the non-EU countries. We observe a general increase in cross-border equity holdings, particularly FDI, but the overall stock of debt instruments on GDP (debt assets and debt liabilities) has decreased over the decade. The pattern appears similar for the four basins, even though we notice

[17] Lane, Philip R., and Milesi-Ferretti Gian Maria, "The External Wealth of Nations: Measures of Foreign Assets and Liabilities for Industrial and Developing Countries". *Journal of International Economics* (2001): Vol. 55, 263.

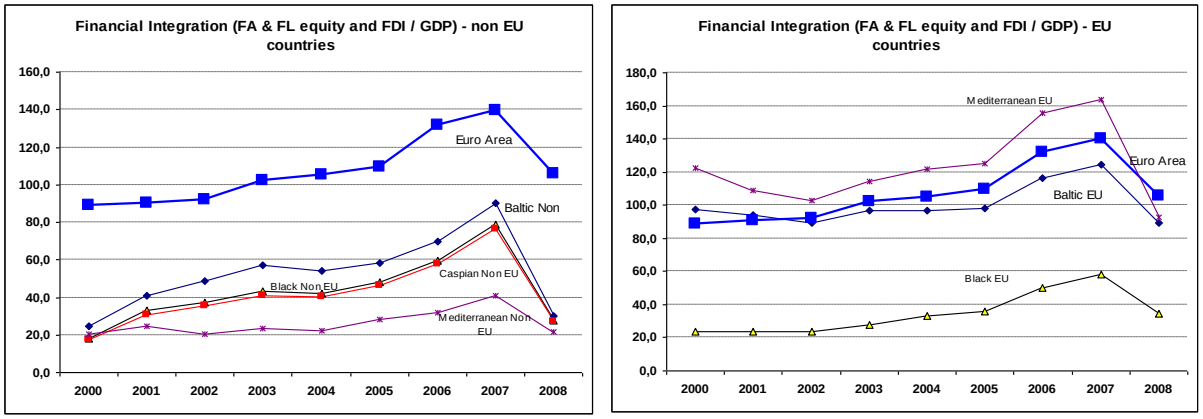
Lane, Philip R., and Milesi-Ferretti Gian Maria, "International Financial Integration". *IMF Staff Papers, Washington: International Monetary Fund* (2003): Vol. 50, Special Issue, 82.

important differences in term of intensity. The non EU Baltic economies have the highest IFI index for FDI and Portfolio equity instruments, 90% of GDP in 2007, while the lowest 50% is reported by non EU Mediterranean countries. Furthermore, all four Neighbouring regions show a common trend towards a smaller share of debt instruments, which is also converging to 50% of GDP.

a. Gross capital flows



b. Gross Portfolio Equity and Foreign Direct Investment



c. Gross Other Investment (Portfolio Securities Debt and Other Investment)

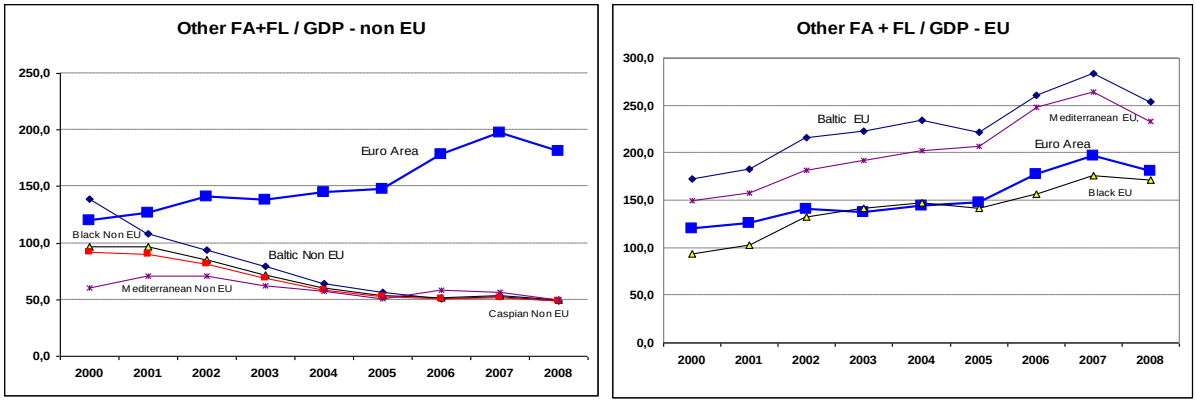


Figure 2. International Integration Index (Gross position)

Clearly, factors such as the increase in trade linkages, the reduction in capital controls, the foreign exchange regime, advances in telecommunications, and the increased availability of information are important in driving the acceleration of international financial integration in the four regions, but the trends (in particular those

referring to other investments) underscore the deep difference that separates the European economy and that of neighbouring countries.

However, the structure and the quality of capital stocks has improved, in the sense that FDI has become the most dynamic source of net capital flows in all regions. The 'Russian factor' is relevant here. In fact, the non-EU Baltic countries double their advantage on the Mediterranean region, while considering the relative size to GDP, and they are also more integrated than the EU Black Sea countries. During the decade FDI seems the most desirable type of flows, in that it tends to be more long-term and less easily reversible, as well as often incorporating new technology and other know-how. Additionally we can notice that the announcement of the ENP project in 2004 has contributed positively in accelerating the FDI inflows in all regions.

Moreover, there is another fundamental trend concerning the convergence effect of a deeper integration. The EU imbalances, displayed in Figure 3 as Net External Position (NEP), have increased during the decade after the accession of the Eastern and Nordic countries, while for the non EU partners the convergence was the main effect of the European integration project until the disruption caused by the financial crisis in 2008. The Euro Area consolidated its position of net exporter of capital, with a net negative position near to 20% of GDP. Non EU Mediterranean decreased their net debt position from 35% to 19% of GDP, while the non EU Baltic region (Russia, for clarity) shifted from a net positive position to a negative one since 2004.

These trends confirm that the evolution of the neighbouring countries may be different from the other emerging market economies, which on the contrary, suffered the contraction of external capital flows during the same period. In this perspective the favourable expectations of the international lenders to the Baltic region, and Russia in particular, differ from the relative contraction of external financing (in particular bank loans) affecting the Southern Mediterranean region. These convergence patterns were interrupted by the financial crisis of the summer 2008. In fact, the net creditor position in 2008 in the three regions (Baltic, Caspian and Black sea) is essentially due to the contraction of portfolio liabilities of Russia.

Instead, for the EU economies the imbalances increased, with a positive net position for the Baltic region (net position of Germany) and a deterioration of the Black Sea region (Greece) and Mediterranean Region (Spain).

Which are the largest creditors and debtors, relative to their GDP levels? Even though richer countries tend to be creditors (Germany, with a net position of 25% of GDP in 2007 from a - 7% in 2001 and France, with a net creditor position of 10% of GDP), the correlation is less evident. Russia has been net creditor before 2004 and becomes net creditor again in 2008. Syria, Iran and Libya are creditor with net foreign credits higher than 30% of GDP (230% for Libya). In the Caspian region the foreign assets accumulated by the governments during the decade of high oil and gas prices now exceed the total foreign debt and inward FDI in countries like Azerbaijan, Turkmenistan and Uzbekistan, with an average net external position higher than 30%. Iran too, has a net positive position.

Several neighbouring countries have successfully build up foreign assets and funds that help mitigate the impact of the economic setback in the industrial countries, even though the longer-term goal of economic diversification remain elusive. This is partly because the countries in the Mediterranean and Caspian basin depend on wealth from natural resources. Furthermore, they lack of the sound institutional framework that would support the creation of a more diversified and sustainable economy.

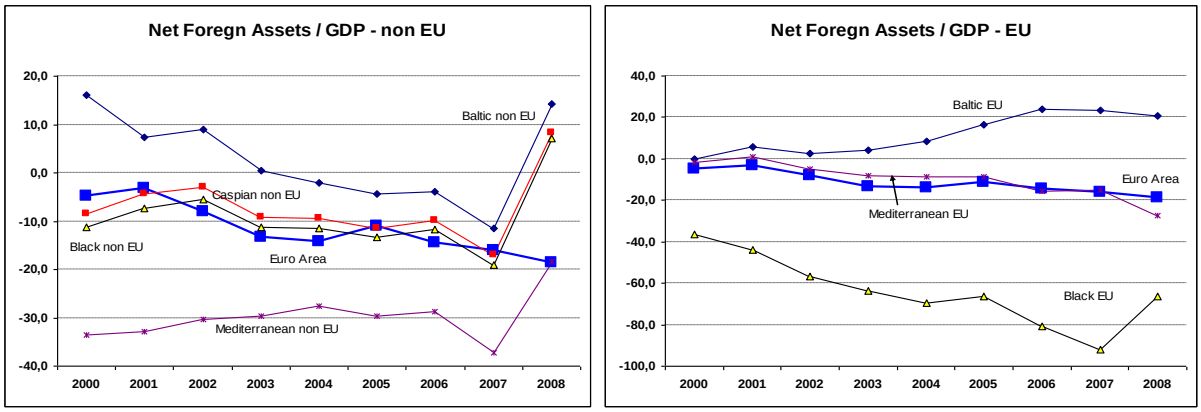
France became net debtor in 2008, with a remarkable contraction of the value of FDI. The EU largest net debtors are Spain, with a NEP index higher than 80% (from a 24% in 2000), Greece (more than 100%), while Italy remains more or less stable at 21% of its GDP. Indeed, in addition to the level of development (measured by the GNI), several other factors—including demography, the size of public debt and FDI flows, and natural resources endowment—influence significantly the net external position of the four basins.

From the perspective of private capital flows the asymmetries between EU and non-EU have increased during the decade, with a negative net external position higher than 35% of GDP in all regions and with only five capital exporting EU countries (Denmark, Germany and Sweden) in the Baltic Sea, Italy and France in the Mediterranean Sea. Among the neighbouring countries only Libya is a net investor (Portfolio Investments). For the non-EU Mediterranean countries and Baltic region, the downward trend in their external position was reversed in 2008, primary because of a deterioration of Russian Federation (contraction of inward FDI) and the stability of the Caspian ad Black sea. For the Baltic the improvement in 2008 is due to the contraction of foreign investments in the same year.

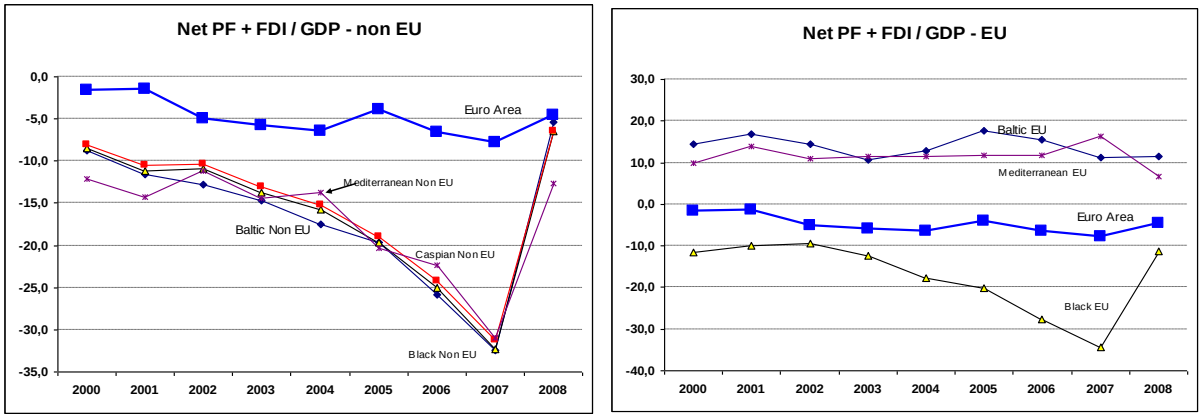
The comparative look for the net debt position (debt assets less debt liabilities, Figure 3 c) shows the common convergence to lower level of external exposure, around 10% of GDP, while in 2000 the non EU Mediterranean countries were exposed by more than 30% of their GDP. Here, the shift from indebtedness to FDI

has been made possible by the instruments of the first pillar of the Euro-Mediterranean partnership within the Barcelona Process. Instead, the financial integration within the EU has encouraged a credit boom and over-borrowing which have increased the unbalances in the Black sea basin (Greece in particular and Romania), the Mediterranean (again Greece and Spain), in contrast with the Baltic Sea basin that is near the balance or in net creditor position.

a. Gross capital flows



b. Gross Portfolio Equity and Foreign Direct Investment



c. Gross Other Investment (Portfolio Securities Debt and Other Investment)

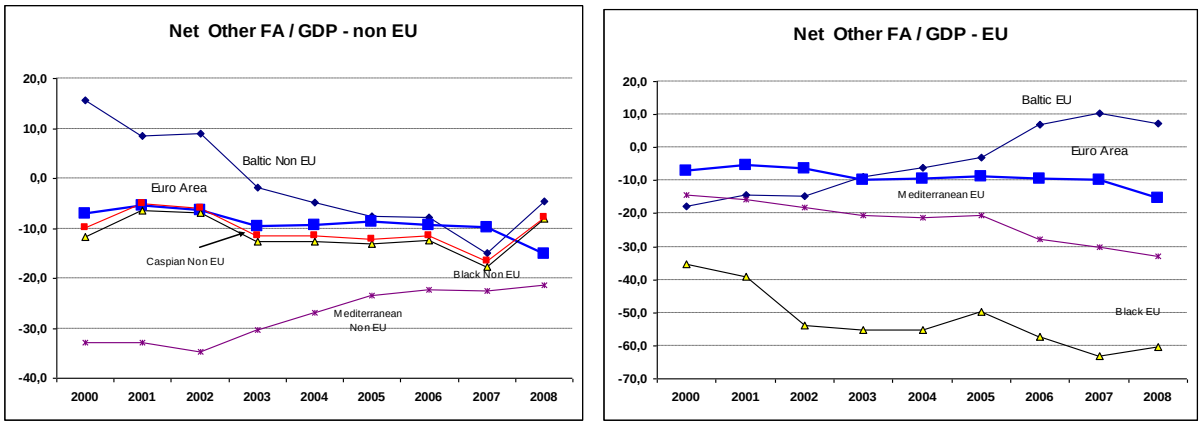


Figure 3. Net External Position Index

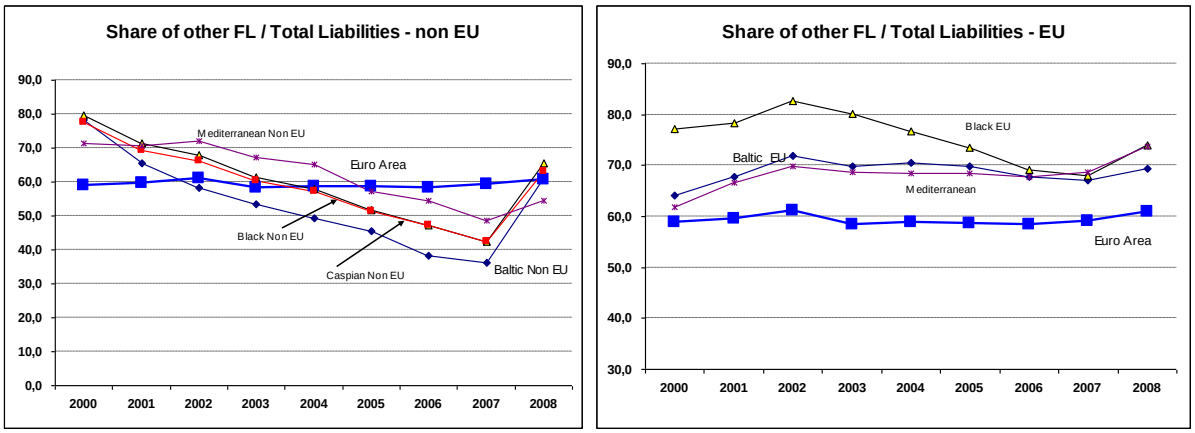
3.5 Opportunities and risks for neighbouring countries

The large increase in cross-border equity, direct investment holdings, in the shifting patterns in international borrowing and lending in the non EU partners can be viewed positively, as factors reducing the vulnerability of the neighbouring markets to external shocks. Equity liabilities (including FDI) now account for about 40% of total external liabilities as a whole, compared to 20% of EU countries. Only the non-EU Mediterranean countries, while showing a gradual growth of private capital inflows, remained below 33%, offsetting the difference with a greater share of financial loans.

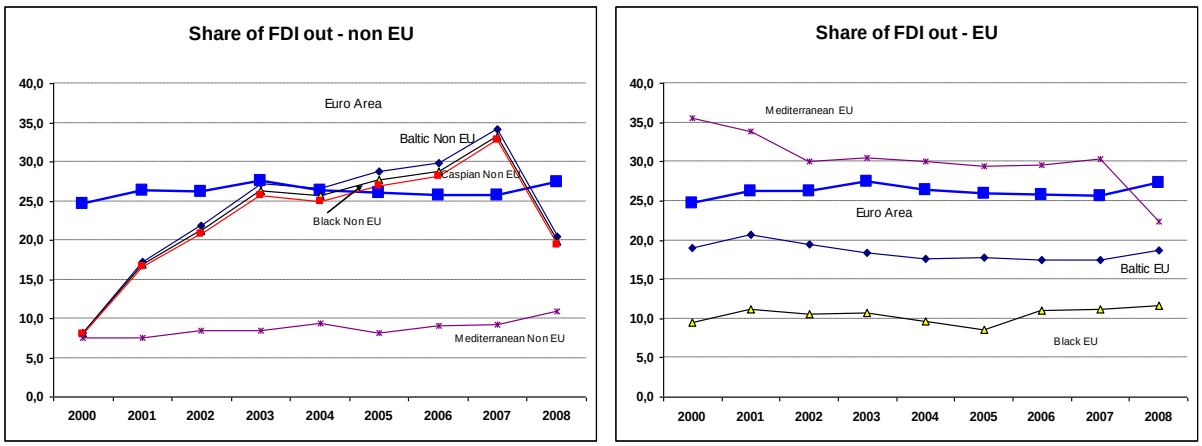
Financial integration also relates to the foreign assets. From this point of view, it appears an important systemic innovation, i.e. the growth of the outward FDI (Figure 4 b), which is enhanced by the removal of legal restrictions and the increased integration of the economies. This aspect concerns in particular two basins: the Baltic and Black Sea, which are interconnected by the foreign investment activities of the Russian firms. The critical aspect in these financial relations is the lack of dynamism of the Mediterranean countries, with a share of direct investment of less than 10% of their foreign assets.

Consequently, all neighbouring economies have dramatically reduced the share of debt to their external liabilities to level well below the EU average, thus clearly reducing the risks of financial crises by linking more closely the return on external liabilities to domestic economic performance. However, as shown in Figure 4, the financial crisis of 2008 reversed the good performance of the previous years.

a. Share of Other Foreign Investment over total Foreign liabilities



b. Share of outward FDI over total Foreign Assets



c. Share of inward FDI over total Foreign Liabilities

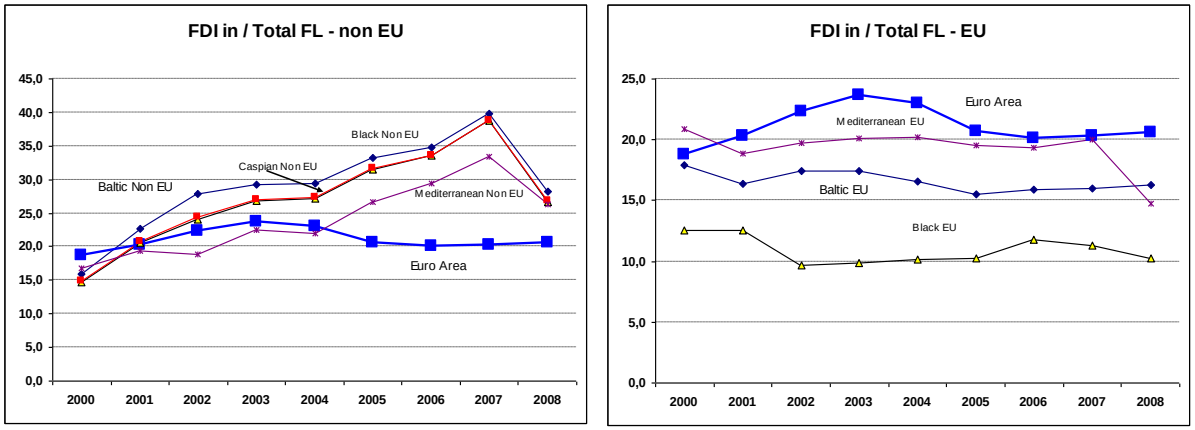


Figure 4. Share of FDI and Indebtedness

3.6 Stock market capitalisation

In terms of their stock market capitalisation, the Mediterranean and Baltic Sea Regions are in a better position compared with the other two regions. Particularly, Egypt, Jordan, Morocco, Croatia, in the Mediterranean basin and Russian Federation in the North show a clear upward trend between 2003 and 2007 (Figure 5).

Nevertheless, the stock market capitalisation still remains considerably below the relevant values of developed economies in Tunisia, Algeria, Turkey, Syria, Belarus and in the Caspian basin. Because the stock market is of relevance in financing enterprises, further efforts especially to attract foreign investors can be very important.

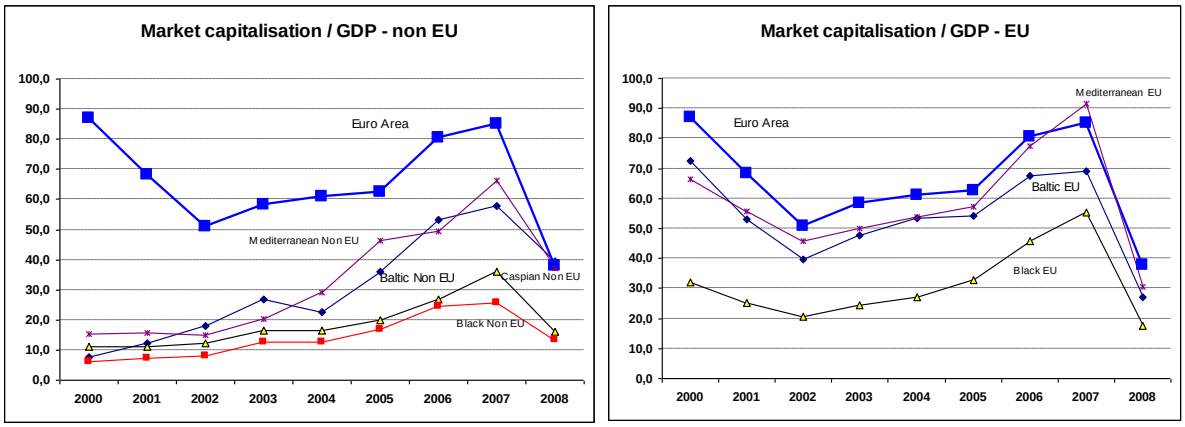


Figure 5. Stock Market Capitalisation in the 4 Seas 2000-2008, in percentage of GDP

3.7 Reserves

To conclude, this paper deepens the topic of International reserves, which are the liquid external assets under the control of the central bank. In this case we notice a great asymmetry between the EU and the non EU regions. Not only the reserves-GDP ratios are ten time larger in non EU countries but the ratios increased substantially during the decade, 30% of GDP in the Mediterranean basis and 35% in the Baltic region (Russia in particular).

In a period of greater flexibility of the exchange rates, it is debatable this huge accumulation of reserves in line with the predictions of the buffer stock models, such as the adjustment costs, the volatility of foreign trade, the exposure to volatile short-term inflows of capital[18].

[15] Calvo, Guillermo. *Capital flows and capital-market crises: the simple economics of sudden stops*. (Journal of Applied Economics, 1998) 1: 35–54.

The 'social cost' of these reserve was estimated by Rodrik (2006)[19] through the spread between the private sector's cost of short-term borrowing abroad and the yield that the Central Bank earns on its liquid foreign assets. The estimated spread is between 3 to 7 percent, undoubtedly very high especially for capital scarce economies. Therefore, it can be suggested that the central bank either curtail the size of reserves accumulation or invest the excess reserves for more profitable returns in term of employment (Mediterranean basin) and growth (Baltic basin).

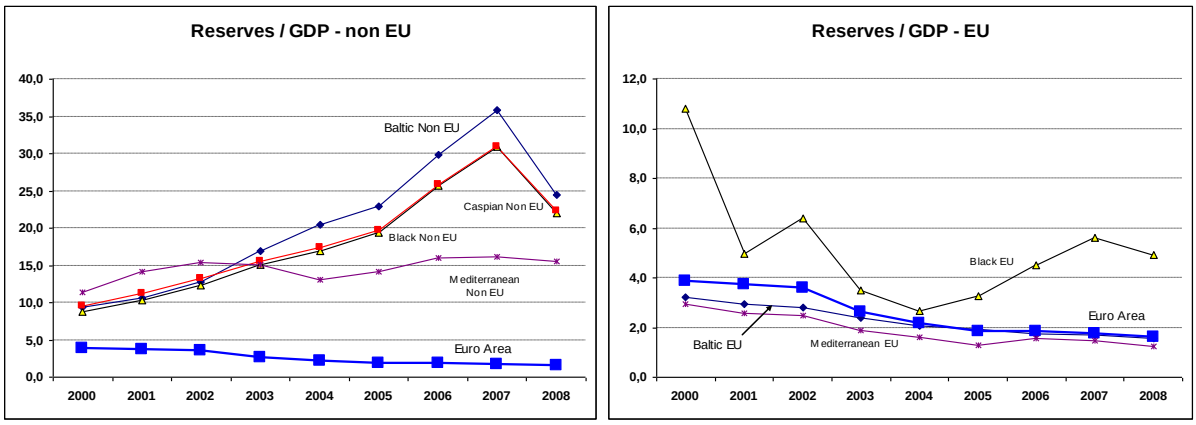


Figure 6. Stock of International Reserves in the 4 Seas 2000-2008, in percentage of GDP

4. Conclusions

The experience of the South Mediterranean countries suggest that, despite the improvements in the FDI inflows and in deeper financial integration to some countries (Morocco, Tunisia, Egypt, Jordan), its sectorial destination does not always correspond to the real needs of the recipient economies. Excluding privatizations and investments in oil and gas concessions, foreign promoters invested only 1% of GPD. These results are disappointing when confronted with the 'ritual' declarations to stimulate local production capacity and to create additional employment and revenue.

Therefore the essential policy issue is not simply to deepen the financial integration of the neighbouring countries into the global market. Rather, it refers to other specific objectives that can be achieved by competitive and dynamic sectors or industries. In this regard, financial integration becomes the instrument, as well as the incentive, to diversify the composition of export. Moreover it improves the performance along the competitive advantages, which are more likely to benefit from investment and innovation.

Despite the weaknesses of the domestic financial markets, foreign investors could increase the chances of domestic enterprises to realize trade and investment opportunities through partnership, networking and exchange of information on best practices.

To understand the factors behind the financial integration and the necessary policy measures, we need to look at the role represented by the institutions in setting the legal environment and the regulations which promote the financial market development. The increased information costs, which reduce the overall levels of business investment, are an effect of the weak performances of the financial institutions. The benefits, as well as the incentives, from the integration cannot be limited to the markets for goods and services, which are the main goals of all FTA project.

Financial cooperation, rather than financial integration, is still seen as a tool for targeted assistance to partner countries. The financial resources that are allocated by the EU in supporting the financial Institutions are still marginal compared to the overall external financial flows towards the partner countries. In three basins the financial cooperation is assisted and promoted by regional Financial Institutions supported by EU member states: FEMIP in the Mediterranean, the IEB, the Black Sea Trade and Development Bank, the Nordic Investment Bank. It is obvious that the institutionalization of financial cooperation is in itself an incentive, but at the same time is not the only condition for the success of economic integration with the neighbouring countries.

Financial integration needs the presence of foreign banks which are expected to strengthen the economic relationships among the EU and the partner countries or among the partner countries. Financial integration needs

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also a more open attitude from the central authorities, which include also the reconsideration of the exchange rate regime, since recent experience shows that countries that anchored their currencies to the Euro at the end they obtain better results in term of growth and stability.

ANNEX
FOREIGN EXCHANGE REGIMES IN THE FOUR SEA BASINS

THE BALTIC SEA REGION

EU: Estonia, Latvia, Lithuania, Denmark, Finland, Sweden, Germany, Poland;
NON EU: Russia, Belarus.

Estonia joined the IMF on the 26th of May 1992 and it was included in the ERM II on the 28th of June 2004 pegging its kroon to the euro tightly to the central rate. The euro will replace the kroon on the 1st of January 2011.

Lithuania joined the IMF on the 29th of April 1992 and it was included in the ERM II on the 28th of June 2004. Currently the litas is pegged to the euro at the rate of 3.4528 to 1. Euro was expected to replace the litas by January 1, 2010, but due to the current rate of inflation and the economic crisis, this date will be delayed for another three years until 1 January 2013.

Latvia joined the IMF on the 19th of May 1992 and it was included in ERM II on the 2nd of May 2005. The lats are so pegged to euro and they float within 1% of the central rate, Ls 0.702804 = €1. Latvia had originally planned to adopt the euro as its official currency on 1 January 2008. It is now expected that Latvia will introduce the euro in 2012 at the earliest, although the head of the National Bank of Latvia has suggested that 2013 may be a more realistic date.

Denmark joined the IMF on the 30th March 1946 and it has been included in ERM since 13 March 1979. Denmark negotiated special 'opt-outs' of the Maastricht Treaty that allowed the country to preserve the krone while most other members of the European Union adopted the euro in 1999. The krone is now pegged to the euro via the ERM II and the Denmark Nationalbank keeps the exchange rate within a range of ± 2.25% against the central rate of EUR 1 = DKK 7.460 38, a narrower one of that provided by the ERM II of ±15%.

Finland joined the IMF on the 14th of January 1948, the European Union in 1995 and the Eurozone in 1999. The Finnish Markka was replaced by the euro in 2002. The euro has a floating exchange rate. However, since central banks frequently intervene to avoid excessive appreciation or depreciation, this regime can be also called managed or dirty float.

Sweden joined the IMF on the 31st of August 1951. The exchange rate of the Swedish krona against other currencies has historically been dependent on the monetary policy pursued by Sweden at the time. Since November 1992 a managed float regime has been upheld. By simply choosing to stay outside the ERM II, the Swedish government is provided a formal loophole avoiding the theoretical requirement of adopting the euro.

Germany joined the IMF on the 14th of August 1952. It adopted the euro in 1999.

Poland joined the IMF on the 12th of June 1986 and it became a full member of European Union on the 1st of May 2004, which means that Poland is obliged to

introduce the euro, which will replace its current currency, the zloty, though not at any specific date and only after Poland would be able to meet the necessary stability Maastricht criteria. Poland at the moment is not able to join the ERM II and it still uses a floating regime even if more flexible.

Russia joined the IMF on the 1st June 1992. It adopted a floating exchange rate with no predetermined path: ruble has no explicitly stated nominal anchor; Russian monetary policy is conducted monitoring various indicators.

Belarus joined the IMF on 10th of July 1992. In 2008 Belarus claimed it would have abandoned pegging the Belarusian ruble to the Russian ruble saying goodbye to currency integration after renewed tension with Russia caused by another pricing dispute over Russia's gas supplies to Belarus.
The National Bank of Belarus decided to maintain the Belarusian ruble's stable exchange rate against the U.S. dollar as the sole monetary policy benchmark.

THE BLACK SEA REGION

EU: Bulgaria, Greece, Romania;
NON EU: Turkey, Georgia, Russia, Ukraine, Moldova, Armenia, Azerbaijan.

Bulgaria joined the IMF on the 25th of September 1990. It signed the EU accession treaty on the 25th of April 2005. Bulgaria meets three and fails on two criteria in order to join the eurozone. It derogates on the price stability criterion, which envisages that its inflation does not exceed that of the three EU member states with the lowest inflation (Malta, the Netherlands and Denmark) by 1.5%. Bulgaria's inflation in the 12 months to March 2008 reached 9.4%, well above the reference value of 3.2%, the report said. Bulgaria has not yet joined ERM II. As the current lev was fixed to the Deutsche Mark in par, the lev's peg effectively switched to the euro, at the rate of 1.95583 leva = 1 euro, which is the Deutsche Mark's fixed exchange rate to euro.

Greece joined the IMF on the 27th of December 1945. It acceded the European Union on the 1st January 1981, the ERM II in 1999 and it adopted the euro in 2002.

Romania joined the IMF on the 15th of December 1972. It acceded the European Union on the 1st of January 2007. Currently, the leu is not yet part of ERM II but plans to join in 2010-2012. The Romanian monetary authority are now managing a floating exchange rate regime influencing the movements of the exchange rate through active intervention in the foreign exchange market in order to create the condition to meet the ERM II as soon as possible.

Turkey joined the IMF on the 11th March 1947. As it has been negotiating EU membership since 2005, it adopted a loosely floating exchange rate regime for its lira managed with the support of EU and it introduced inflation targeting.

Georgia joined the IMF on the 5th May 1992. The country has been IMF supported since after the August military conflict with Russia in 2008. The IMF programme determined the immediate monetary tasks as securing sufficient banking-sector liquidity, exchange-rate stability and adequate level of foreign-currency reserves. The Fund now states that the monetary authorities remain committed to implementing a flexible exchange rate regime for the lari, as advocated by the IMF as a longer term strategy. This reduces the need to intervene in the foreign currency markets, even if moderate intervention to stabilise the exchange rate can be defended.

Ukraine joined the IMF on the 3rd September 1992. Hryvnya has been the national currency of Ukraine since 1996. Initially, the foreign exchange rate was UAH 1.76 =

USD 1.00. Following the Asian financial crisis in 1998 the currency devaluated to UAH 5.6 = USD 1.00 in February 2000. Later, the exchange rate remained relatively stable at around 5.4 hryvnias for 1 US dollar and was fixed to 5.05 hryvnias for 1 US dollar from 21 April 2005 until 21 May 2008. In mid-October 2008 rapid devaluation began with the hryvnia dropping 38.4 % from UAH 4.85 for USD 1 on 23 September 2008 to UAH 7.88 for USD 1 on 19 December 2008.

Moldova joined the IMF on the 12th of August 1992. Moldova currently aspires to join the EU and has implemented the first three-year Action Plan within the framework of the European Neighbourhood Policy (ENP). The Moldovan leu was established on 29 November 1993, following the collapse of the Soviet Union and the creation of the independent republic. The National Bank of Moldova (NBM) maintains a floating exchange rate regime of the Moldovan leu. The rate is calculated by the NBM as the arithmetical mean of the weighted average of buying and selling exchange rates of deals contracted on the Moldovan foreign exchange market between 12:30 of the previous day and 12:30 of the reporting day.

Armenia joined the IMF on the 28th May of 1992. The modern dram came into effect on 22 November 1993, at a rate of 200 rubles = 1 dram (1 USD: 14.5 AMD). The dram is not pegged to any other currency and it flows independently on the market.

Azerbaijan joined the IMF on the 18th of September 1992. In 2007 the National Bank appreciated the exchange rate against the US dollar along smooth path. Starting March 2008, the authorities fixed the value of the manta vis-à-vis to euro/US dollar composite. The weights of the manat currencies in the composite are regularly changed to increase the weight of the euro. Thus, effective March 2008, the classification of de facto exchange rate arrangements has been changed from a crawling peg to a crawling band arrangement.

THE CASPIAN SEA REGION

EU: none;
NON EU: Iran, Azerbaijan, Russia, Kazakhstan, Turkmenistan, Georgia, Armenia, Turkey, Uzbekistan.

Iran joined the IMF on the 29th December 1945. Starting November 2007, the rial gradually depreciated against a composite of currencies, including the euro, the US dollar and the yen. Thus, effective January 2008, the classification of the facto exchange rate arrangement has been changed from conventional pegged arrangement to a crawling peg.

Kazakhstan joined the IMF on the 15th of July 1992. The tenge has remained within a 2% band as result of official actions. Thus, effective October 2007, the classification of the facto exchange rate arrangement has been changed from managed floating with no predetermined path to a conventional US dollar pegged arrangement.

Turkmenistan joined the IMF on the 22nd of September 1992. The redenomination of the manat currency was completed in January 2009 and the central bank remains committed and has intervened regularly on the foreign exchange market to support the new exchange rate and satisfy the increased demand for foreign exchange from commercial banks.

Uzbekistan joined the IMF on the 21st of September 1992. Since April 2007, the sum has been depreciating vis-à-vis the US dollar within a 2% crawling band, while the Central Bank of Uzbekistan's one-sided interventions have resulted in steady

reserve accumulation. As a result, the exchange rate arrangement has been reclassified, effective April 2007, from a conventional pegged arrangement to a crawling peg.

THE MEDITERRANEAN SEA REGION

EU: France, Greece, Italy, Slovenia, Spain, Malta, Cyprus;
NON EU: Turkey, Lebanon, Syria, Israel, Egypt, Jordan, Libya, Tunisia, Algeria, Morocco, Bosnia and Herzegovina, Croatia, Montenegro, Albania, Serbia, Macedonia.

France joined the IMF on the 27th of December 1945. It is a founding member state of the EU and it adopted euro in 2002.

Italy joined the IMF on the 27th of March 1947. It is a founding member state of the EU and it adopted euro in 2002.

Spain joined the IMF in the 1958. On the 1st of January 1986 Spain joined the European Communities and later in 2002 it adopted the euro.

Slovenia joined the IMF on the 14th December 1992. Slovenian tolar was included in ERM II on the 28th June 2004. On 1 January 2007, the tolar was supplanted by the euro.

Malta joined the IMF on the 11th of September 1968 and the ERM II on 2nd of May 2005. The euro replaced the Maltese lira as the official currency of Malta on 1 January 2008 at the irrevocable fixed exchange rate of 0.429300 MTL per 1 euro.

Cyprus joined the IMF on the 21st of December 1961and the ERM II on the 2nd of May 2005. The Cyprus pound was replaced by the euro as official currency on 1 January 2008 at the irrevocable fixed exchange rate of CYP 0.585274 per EUR 1.00.

Lebanon joined the IMF on the 14th of April 1947. The exchange rate peg to US dollar provides a strong nominal anchor and remains the lynchpin of financial stability. Maintenance of the peg is essential in light of the government's high debt and debt service obligations in foreign currency, and the substantial currency mismatches of corporations and households, owing to widespread loan dollarization. Under the IMF's exchange rate arrangement classification system, Lebanon falls under the category 'stabilized arrangement' since its *de facto* peg has not been formally announced. The recent increase in the real exchange rate reflects both a strengthening of the U.S. dollar and sustained domestic inflation.

Syria joined the IMF on the 10th of April 1947. Since August 2007 the official rate has been pegged to the SDR (Special Drawing Rights), a reserve currency created by the IMF to reduce the pressure on gold and the U.S. dollar in international transactions, with a wide margin. The currencies pegged to SDR derive their value from a currency basket consisting of the U.S. dollar, the Japanese yen, the British pound, and the euro. Thus, the classification of the de facto exchange rate arrangement has been changed, effective September 2007, from a conventional pegged arrangement to a pegged exchange rate with horizontal bands.

Israel joined the IMF on the 12th of July 1954. The new sheqel was introduced, replacing the old sheqel on January 1, 1986 at a rate of 1,000 old sheqalim = 1 new sheqel. Since January 1, 2003, the sheqel has been a freely convertible currency. This makes the sheqel one of only twenty or so world currencies for which there are

widely available currency future contracts in the foreign exchange market. It is also a currency that can be exchanged by consumers in many parts of the world.

Egypt joined the IMF on the 27th of December 1945. The pound has appreciated by about 4% vis-à-vis the US dollar since August 2007. As a result, the de facto exchange rate arrangement has been reclassified, effective August 2007, from a conventional pegged arrangement to managed floating with no predetermined path for exchange rate.

Jordan joined the IMF on the 29th of August 1952. Since October 23, 1995, the dinar has been officially pegged to the IMF's Special Drawing Rights (SDR). In practice, it is fixed at 1 US dollar= 0.709 dinar most of the time, which translates to approximately 1 dinar = 1.41044 dollars. The Central Bank buys U.S. dollars at 0.708 dinar, and sells U.S. dollars at 0.710 dinar.

Libya joined the IMF on the 17th of September 1958. From February 1999 to December 2001, Libya maintained a dual exchange rate, with the official rate pegged to a Special Drawing Right (SDR) at the rate of 1LD=.608 SDRs. State import agencies effected transactions using the official rate. Since 2001, the Libyan Dinar has been unofficially pegged to the U.S. Dollar (allowed to float within a specified band). With a 50% devaluation of the official rate in 2002, the two rates were effectively unified. A further 15% devaluation took place in June of 2003. In June of the same year, Libya agreed to the terms of IMF Article IV consultations, which called for, among other things, advanced import requirements and an end to the 15% exchange tax and subsidy.

Tunisia joined the IMF on the 14th of April 1958. The dinar has been very stable against a euro/US dollar composite. Thus, effective May 2006, the classification of the de facto exchange rate arrangement has been changed from managed floating with no predetermined path to a conventional pegged arrangement.

Algeria joined the IMF on the 26th of September 1963. Algeria's current exchange rate regime is a managed float, of which the IMF approves. Algeria does not subscribe to the IMF's Special Data Dissemination Standard but began participation in the less stringent General Data Dissemination System in April 2009.

Morocco joined the IMF on the 25th of April 1958. The exchange rate regime, under which the dirham is pegged to a basket of currencies composed essentially of the Euro, has served Morocco well, contributing to macroeconomic stability, and particularly to price stability.

Bosnia and Herzegovina joined the IMF on the 14th of December 1992. The convertible mark was established by the 1995 Dayton Agreement and replaced the Bosnia and Herzegovina dinar, Croatian kuna and Republika Srpska dinar as the currency of Bosnia and Herzegovina in 1998. *Mark* refers to the German mark, the currency to which it was pegged at par. Since the replacement of the German mark by the euro in 2002, the Bosnian convertible mark uses the same fixed exchange rate to euro that the German mark has (that is, 1 EUR = 1.95583 BAM).

Croatia joined the IMF on the 14th of December 1992. The country is a candidate for the EU membership. The main reference currency for kuna was the German mark, and later the euro. A long-time policy of the Croatian National Bank has been to keep the fluctuations of the kuna exchange rate with the euro in a relatively stable range. The country has been on the path of accession of the EU and it plans to join the European Monetary System.

Montenegro joined the IMF on the 18th of January 2007. Montenegro is a potential candidate for membership in the EU. The country presented its official application in 2008, hoping to gain EU candidate status in 2010, though it has already adopted the euro as sole currency.

Albania joined the IMF on the 15th of October 1991. It formally applied for EU membership on 28 April 2009. The cautious monetary policy has proved to be successful in keeping inflation low in recent years, well within the informal 3 ± 1% inflation target range. Albania's exchange rate regime is an independent float, although the Bank of Albania occasionally intervenes in the foreign exchange market with the aim of smoothing temporary fluctuations and accumulating the necessary reserves.

Serbia joined the IMF on the 14th of December 1992. The dinar exchange rate is under a managed floating regime with no pre-determined path and the Central Bank has taken preliminary steps towards inflation targeting preparing the transition to full-fledged inflation targeting.

Macedonia joined the IMF on the 14th of December 1992. As an EU candidate country, the Former Yugoslav Republic of Macedonia is taking part in the instruments of the pre-accession strategy, such as a Stabilisation and Association Agreement and the accession partnership, which defines specific priorities for which progress is to be made in view of further EU integration. An economic dialogue is held annually. In the context of the pre-accession fiscal surveillance procedure, each year the country notifies the Commission of key data on public finances and submits annually a pre-accession economic programme. This, together with an assessment prepared by Commission staff, is the basis for the multilateral dialogue between EU Member States and candidate countries. The Commission's annual Progress Report, usually published in the autumn, assesses progress in meeting the Copenhagen accession criteria.

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THE LAW OF ONE PRICE: SURVEY OF A FAILURE

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Abstract

This paper aims to survey the literature about the Law of One Price in order to document its failure in terms of actual application. After a brief theoretical overview, which starts from classical economists' thought, the reported literature has been classified on the basis of three main streams: pricing-to-market (also considering investigations about differences between domestic and export prices), national borders, and tradability of goods. Reviewed works have been selected in order to provide a dedicated survey for 'the Law', which is absent in previous works about this topic. Therefore, the investigation has been kept intentionally separate from PPP-related debate.

Keywords: Law of one price, purchasing power parity, relative prices, exchange rate

JEL Classification: E30, F15, F31, F40, F41

1. Introduction

The Law of One Price (LoOP), is usually presented as the 'one good version' of the well-known concept of Purchasing Power Parity (PPP). Conceptually, LoOP implies PPP whilst the contrary is not true. PPP theory was first developed in XVI century at the University of Salamanca in Spain, and proposed in its contemporary fashion by Gustav Cassel (1918, 1922) between the two World Wars. This contribution was mainly founded on the debate about the restoration of the world financial system after the World War I, given that many countries which adopted the gold standard system before the war had to abandon gold convertibility of their currencies afterwards. Thus, the problem to evaluate correct exchange rates arose, as relative gold values could not be used anymore.

The basic idea behind PPP is that the nominal exchange rate between two currencies should be equal to the ratio of aggregate price indices between the two countries. In this way, PPP implies that a unit of currency of the first country would have the same purchasing power in terms of the second country's currency. This theory encountered enormous consensus. Parsley-Wei (1996) held that almost all of the theories for the determination of exchange rate and open-economy macroeconomic models use LoOP and PPP concepts. This opinion is widely accepted. For example, Dornbusch-Krugman (1976) wrote: 'under the skin of any international economist lies a deep-seated belief in some variant of PPP'; Rogoff (1996) said: 'most [economists] instinctively believe in some variant of PPP as an anchor for long-run real exchange rates', and explained that, today, PPP has a key role in relevant macroeconomic matters such as, for example, fixing the correct exchange rate for a newly-created currency, or forecasting medium and long-term exchange rate movements, or analysing the price differential in income comparisons among countries.

In its purest version, the Law on One Price states that the same good must have the same price wherever it is sold, including in different countries, once its price is expressed in terms of the same currency. In the event of different prices for the same good, arbitrage would immediately operate: agents would buy it where the price is lower in order to resell it where the price is higher, until the difference disappears. The presence of trasportation costs implies a more general condition for LoOP to work: whether transportation is possible, the price paid for a good can differ among places.

In sight of a dedicated survey for 'the Law', which is absent in previous works about this topic, this paper will try to document that LoOP does not survive the move from theory to practice. This result will be shown through a review of the relevant literature, trying to show how LoOP is depicted as a failure in many studies.

The main difficulty was to isolate contributions that effectively have impact on the LoOP debate. Many streams of literature have seen the light since the first papers in the 1970s, as explained in Goldberg-Knetter (1997): many of them deal with LoOP indirectly, referring to market power of firms, to PPP, or to other aspects.

The review will be presented avoiding literature focused on the dynamics of exchange rate as a mean to reach LoOP, within PPP debate. However, also PPP is generically rejected in dedicated studies, at least in the short-run; most of the times, this rejection is based exactly upon the failure of the LoOP, as it is explained for example in Engel (1993), Rogers-Jenkins (1995), and Engel-Rogers (1995).

In what follows, the literature review will show that this theoretically fascinating law fails for several reasons. Section two will present a brief theoretical overview of LoOP's roots in classical economists' thought; the subsequent Sections deal with the different reasons why LoOP may fail: Section three will review literature about *pricing-to-market* theory (referring to empirical investigations about differences between domestic and export prices); Section four will deal with national borders' effect; Section five will focus on the tradability of goods; Section six will present the conclusive question.

2. The Law of One Price: a theoretical introduction

A good point to start is probably the most famous empirical investigation about the 'Law': Big Mac price comparison all over the world first published by the Economist in 1986. Big Mac prices (quoted in dollars) varied widely from country to country, with a maximum difference between the lowest and the highest price (China and Switzerland, respectively) of more than four dollars. The choice of the Big Mac can be explained considering that it is a highly traded good (at least its ingredients are) and it is very well-known and recognized as a 'standardized' good. Standardization is important at this stage of the analysis because it can 'mimic' prefect knowledge and perfect information, typical of the Walrasian competitive equilibrium. Dispersion in Big Mac price is evidently due to both different taxation systems, and to another important topic: differentiation. True, the Big Mac is not sold identically everywhere, because geographical location influences ingredients and their prices, but the point is that the McDonald's hamburger could satisfy consumers in different ways moving around the world. This occurs because people in different places have different tastes and different habits, firms have different degrees of power.

LoOP, which has been defined by Lamont and Thaler (2003) as the 'Second Law of Economics', is basically a logical consequence of the perfect competitive equilibrium, where perfectly informed agents, in a world built upon certainty, buy and sell identical goods. Then, international arbitrage would ensure the strong applicability of LoOP, apart from transportation cost, as the famous analogy that Hume (1752) wrote, saying that all water, whatever it communicates, always remains at one level.

The idea that the *same* commodities should be sold at the *same* price is traceable in Cournot (1838) who, referring to the market mechanism, wrote that buyers and sellers 'are so united by the relations of unrestricted commerce that prices take the same level throughout [the market] with ease and rapidity' (p. 51). Still before Cournot, Smith (1776, p. 376) wrote: 'the corn which grows within a mile of the town, sells there for the same price as that which comes from twenty miles distance. But the price of the latter must generally not only pay the expenses of raising and bringing it to the market, but afford too the ordinary profits of agriculture to the farmer'. Jevon's Law of Indifference is similar in content, (quoted in Edgeworth, 1896, p. 786): 'in the same open market, at any one moment, there cannot be two prices for the same kind of article'. Menger (1871) stated that the more the market is organized, the easier the determination of the 'economic price' is. This hypothetical view of the market was slightly adjusted in the words of Marshall (1920, p.325), who underlined that 'the more nearly perfect a market is, the stronger the tendency for the same price to be paid for the same thing […] in all parts of the market'. It must be noted that Marshall speaks about a tendency, which is different from an 'easy and rapid' unique price. In these words, there is an allowance for whatever can influence the price determination process, such as expenses of delivery, taxes/tariffs, and information costs. These are crucial steps in defining validity for the law. Recalling the famous metaphor of scissors, however, the author sees the price as a result of interaction between cost and utility. However, price differences for even identical products were considered, as in Jevons (1871, p. 137) who underlined that those differences can 'arise from extraneous circumstances, such as defective credit of the purchasers, their imperfect knowledge of the market, and so on'.

3. Firms' behavior and Pricing-to-Market: differences between domestic and export prices

Papers reported in this Section mainly describe data supporting differences in prices between different places. The reason for this difference is explained as a result of price discrimination policies (also known as *pricing to market* approach, originally introduced by Krugman, 1987), chosen by firms on the basis of geographical location. Pricing to market (PTM) theory does not support LoOP. It has been analysed with reference to either contesTable markets, (as in Baldwin 1988, Dixit 1989, Baldwin-Krugman 1989, and Shiha-Chavas 1995), and menu costs (as in Delgado 1991), and imperfect competition (as in Dornbusch 1987). There are numerous other contributions dealing with this theory, such as: Alexius (1996), Adolfson (1999), Feenstra (1989), Feenstra-Kendall (1997), Gagnon-Knetter (1995), Hooper-Mann (1989), Kichian-Khalaf (2000), Marston (1990).

Isard (1977) is most probably the first reference to LoOP failure. In the first part of his contribution, the author finds that the ratio of the American wholesale price index to the German export price index (monthly data referring to industrial sectors, values expressed in dollars), is stably correlated to the nominal exchange rate. This result is confirmed by the second part of his work, where the same analysis is replicated using annual data on export prices (for US and Germany). In the third part, he presents two regressions: firstly he regress the ratio of US import unit value by country of origin relative to US export unit value on the exchange rate, a dummy variable, and lagged errors; and secondly he considers again the same regression, but this time he regress the variation of the dependent variable on the variation of the independent ones. This analysis confirmed results obtained in previous two Sections of his work, leading him (p. 942) to hold that 'in reality the law of one price is flagrantly and systematically violated by empirical data'.

Kravis-Lipsey-Kalter (1977), analyzed the relationship between exchange rate changes, export and domestic prices. They start out from the conditions necessary for LoOP to hold: the existence of identical internationally-traded goods, and either the existence of a unique source of supply or the absence of transportation costs (alternatively, the equality of delivery from all origins to every destination). Thus, they consider a number of reasons, both static and dynamic, for expecting deviations from LoOP. Static reasons are the oligopolistic power of firms, which face different demand schedules with diverse elasticity in each market; profit-maximising behaviour, which induces different mark-up approaches; product differentiation (before and after sale); credit terms and delivery conditions (coherently with Kravis-Lipsey, 1971). Dynamic reasons are market share allocation and price-competition strategies; uncertainty and informative asymmetries; customer-seller partnerships and purchasing habits. All of these reasons explain why price cannot be identical in diverse locations and unavoidably push price out from LoOP predictions. Comparing then German and American export price for machinery and equipment sector, authors found very little evidence of correlation in export-price changes in these two countries when prices are expressed in American dollars. In order to analyze price discrimination operated by firms, Kravis-Lipsey-Kalter highlighted divergences between export and wholesale prices, looking for small ranges of variation in the export/domestic price ratio for US and Germany (because a very small range of variation would imply that prices in home and foreign markets move identically). Results are unequivocal: there is neither equality in export and domestic prices, nor in their movements. Investigating the pass-through grade, then, they found that it is complete and that only gradually exporters tend to reduce it.

The existence of empirically relevant deviations from LoOP suggest that arbitrage is not present as it should be, Elzinga-Hogarty (1978) made a significant contribution to LoOP debate, because they showed an important deviation in the 1975 f.o.b. price of bituminous coal between Eastern and Western Kentucky: 27.03 dollars against 13.75 dollars respectively. Considering that the nationwide average shipping cost for one ton of coal was just 5 dollars in the same year, this result underlines very clearly the failure of the law.

On the presence and the extent of arbitrage, Richardson (1978) tried to summarize results from a disaggregated commodity arbitrage between US and Canada. His results show that arbitrage does not operate significantly for every commodity group, and that even when it does, it is not perfect. Differentiating his contribution from previous results obtained by Isard (1977) and by Kravis-Lipsey-Kalter (1977), Richardson underlines that only in rare cases Canadian commodity prices respond to American commodity prices. In order to explain his point of view, the author proceeded with an econometric evaluation of an approximation of the law of one price which expresses the Canadian price of a good as a function of the exchange rate, of the US price of the same good, of transportation costs, and of a set of residuals. This approach allows him to focus on two extremes: the perfect arbitrage between Canadian and American markets and the complete absence of any form of arbitrage. It is worth underlining two aspects. Firstly, such a specification would also represent a test for absolute PPP, and, secondly, investigations about arbitrage could give some information about the *tradability* of commodities. There is some scepticism about this point in Curtis (1971), Dunn (1970, 1972), and Rosenberg (1976). Richardson tried to readdress his analysis to avoid serial correlation and the lack of data for transport costs through a monotonic transformation of the period to period inflation rate. The result is a uniform failure of LoOP. Parameters representing elasticity of the Canadian price to the exchange rate and to the US price are shown to be significantly different from 1: this implies the absence of parity conditions in the price of commodities, suggesting that it can be much more descriptive to treat goods from different countries as differentiated with respect to domestic products, despite their conventional classification under similar headings.

Comparison between two imaginary extremes (LoOP and the absence of any arbitrage) is also used to depict the adjustment of relative prices to the exchange rate in Dornbusch (1987), who found that product substitutability, relative to the number of firms, and market structure actually drive price levels. This author defines an alternative to the law of one price, named Keynesian, where goods are neither fully homogeneous nor

substituTable, wages are fixed (or sticky) in national currencies, and therefore exchange rate movements alter relative prices. Evidently, this affects the world distribution of demand and employment, revising also the idea of a constant mark-up in cross-border market strategies of firms. Then, after a theoretical Section where he traced the implications of diverse equilibrium price models (the Cournot equilibrium, the Dixit-Stiglitz model, and the Salop circle-competitive model), he pursued his analysis through an empirical investigation, comparing US export prices in dollars with those of Germany and Japan, finding great variability. The main conclusion addresses the question whether a small country should open its frontiers to take advantage of the world market due to price reductions caused by tariffs abatement: the answer is negative, in the case of less than perfectly competitive market structure. This is consistent with the idea that price determination in different countries does not depend only on tariffs, transaction and transportation costs.

Giovannini (1988) investigated the pricing policy of firms selling in domestic and foreign markets. He also explained the correlation between the exchange rate and the domestic and export prices, underlying deviations from LoOP. Compared to other contributions about international discriminating monopolistic models, such as, for example, Gottfries (1986), Giovannini considered that firms have to commit themselves to given prices at the beginning of each period; furthermore, differently from other papers where price fixation policies of firms are described as local currency based (as for example in Aizenman, 1985), Giovannini hypothesized that, when prices are predetermined, currency used for denomination of exports is a crucial issue in deviating from LoOP. One important finding is that exchange rate dynamics (and its uncertainty) affect firm's profit expectations and therefore price policies. Following this approach, the author proves that exchange rate appreciations/depreciations influence prices: it is shown that deviations from LoOP, when export prices are denominated in foreign currency, include both *ex-ante* price discrimination and exchange rate surprise effect. After a theoretical demonstration, an empirical test is conducted to show actual correspondence to formal derivations: collected data refer to monthly domestic and export prices for ball bearings, screws, nuts and bolts produced by Japanese firms. Two criteria have been used in choosing presented data: the first is that price should be taken from a narrowly defined sector; the second is that geographical dispersion of exports should be minimal. Results further confirm the idea of failure of LoOP. With his analysis, Giovannini tried to achieve two further conclusions: isolate the *ex-ante* price discrimination policies effect, and determine whether failures of LoOP are forecasTable or not. The first objective is gained through a model which assumes a geometric distribution of prices, used in Calvo (1983), summing up contributions from Phelps (1978) and Taylor (1980): drawn conclusions are based on the strong rejection of the hypothesis that *ex-ante* discrimination does not exist. The second objective is pursued following Hansen (1982) and Cumby-Huizinga-Obstfeld (1983): using an estimator of the covariance matrix of parameters which allows us to account for autocorrelation and heteroskedasticity for the disturbance term. After running four regressions, Giovannini demonstrated that deviations from LoOP are forecasTable, but the lag is not always the same. In fact, for ball bearings and screws, tests indicated a longer lag than for nuts and bolts (12 months against 3).

A similar result is obtained by Knetter (1989). He dealt with mark-up determination strategy for international exporters in relation to the exchange rate dynamics. Knetter underlines that incomplete pass-through is consistent with two alternative theoretical frameworks: the competitive equilibrium (which implies LoOP), and an imperfectly competitive model where exporters can discriminate prices across destination markets. The author pursues his analysis through an econometric model which studies the effects of time and country-specific term on prices. He considered that exporters maximize profit in their own home currency terms, whilst import demand function depends on the local price in the destination market (and therefore expressed in local currency units). For any given price in the exporter's currency, a depreciation of the importer's currency pulls up the price effectively paid by the importer in his own home market. Therefore, demand function elasticity ultimately determines the strength of the linkage between prices and exchange rates, no matter which market model is hypothesized. The optimal mark-up is unchanged for the exporter only when demand has constant elasticity with respect to price. Even in this case, however, nothing implies that mark-up determination leads to the same price in different locations. Thus, Knetter found that when demand function, as perceived by the firm, appears to be more elastic as price increases, then the mark-up charged by the exporter must fall consequently as the buyer's currency depreciates. The author then collected monthly data (from 1978 to 1986 for American market, and from 1977 to 1985 for the German market) to investigate differences in price discrimination policies. He found that German enterprises adjusted export prices to nominal exchange rates more than American firms did. In a successive paper, Knetter (1993) found the same results with reference to export prices for goods from US, UK, Japan and Germany to selected countries.

Using the empirical framework proposed by Knetter, Gil-Pareja (2002), studied the pricing to market (PTM) behaviour of firms on European Union exports to OECD countries. Starting from the idea that exchange rate movements affect costs and mark-ups of firms selling in different international markets, Gil-Pareja estimated a fixed-effects model whose main advantage is basically that it allows to account for two very relevant effects: firstly, it considers the effect of marginal costs changes on export prices through the time dummy variables, and secondly, it captures destination-specific price movements caused by exchange rate variations through β_i coefficients. Positive values of β_i represent circumstances when mark-up variations are associated with stabilization in local buyer's currency (this kind of 'local currency pricing' will also be referred to by, among others, Engel and Rogers 1999, as reported below), whilst negative β_i represent situations when the effect of bilateral exchange rate variation on destination price of exports is boosted by destination-specific mark-up adjustments. Finally, $\beta_i = 0$ would mean that mark-up determination in a destination is not influenced by the bilateral exchange rate fluctuations at all. Results derived by Gil-Pareja offer evidence of pricing-to-market strategies of many exporter countries in the European Union. Their behaviour is homogeneous everywhere, but in the UK. The hypothesis by Rangan-Lawrence (1993), about presence of multinational firms whose agreements could justify exports to their foreign affiliates at constant prices, does not seem to find empirical confirmation.

Aw-Batra-Roberts (1997) showed substantial differences between average domestic and export prices of Taiwanese electronic producers, accounting for the heterogeneity of firms' strategies, reporting domestic prices which were always higher than the export prices. Their data, collected directly from firms, referred to the period 1986-1991 and have been measured at the production source without costs for transportation, insurance, and custom charges. Thus, authors can represent exactly the revenue actually received by the firm. The exposition of their data allowed them to underline the presence of strong differentials in prices between domestic and export markets. Considering that price differences between domestic and export prices can arise as a result of several factors, the authors proceeded to explain which reasons fit Taiwanese firms' behaviour: heterogeneity and differentiation explained strong domestic/export price differentials. Segmentation strategies are the core reason which can explain why the same good is not sold at the same conditions everywhere. Goldberg-Knetter (1997) define a market as integrated if geographical or national elements have no effects on prices. Therefore, the segmentation of a market relies on the ability to price discriminate: segmentation implies market power. This kind of approach has been deepened by Kasa (1992), who links with Krugman (1987), starting from the positive correlation between the value of a country's currency and the relative price of its imports: when a nation's currency appreciates, prices of its imports tend to raise (and respectively to fall in case of currency depreciation), compared to the price of same goods in other countries' markets. In his model, Kasa took into account both demand-side and supply-side previous contributions, like respectively Froot-Klemperer (1989, where dynamics is incorporated by assuming that in period 1 firm's demand depends on period 0 firm's market share), and Baldwin (1988, where dynamics is incorporated by linking different periods by sunk costs due to barriers to enter/exit a market). Then, Kasa built up a dynamic model of a German exporter, selling goods just abroad, in US and Canada; this model is useful to examine how a firm can use its profit margin to compensate temporary fluctuations in the exchange rate. As a first result, the model shows that systematic deviations from LoOP derive from adjustment costs caused by differences in marginal costs paid by the firm in the two markets; price differentiation is explained as pricing to market strategy, but the model highlights that a significant part of this strategy is generated by the transitory component of exchange rate movements. The second conclusion that Kasa presented is the construction of a data set which has been used to test the model, giving expected results in rejecting LoOP theory. Coherently with this rejection, see also Feenstra-Kendall (1997), Hooper-Mann (1989), and Gagnon-Knetter (1995).

4. National borders and the Law of One Price

Failures of LoOP have been also linked to the presence of a national border between two locations. In this literature stream, one of the most well-known contribution is Engel-Rogers (1996, ER1 henceforth), which tried to answer the question of the weight of the border on price differentials. The authors' work led to many other papers: one about relative price volatility (Engel-Rogers, 1998, ER2 henceforth), one about the welfare costs of deviations from LoOP (Engel-Rogers, 1999, ER3 henceforth) and one about price differentials of similar goods in different US cities, but from a composite point of view, investigating for several causes, such as nominal price stickiness, segmentation of markets, and tradability of goods (Engel-Rogers, 2001, henceforth ER4, reported in the next Section).

In ER1, authors demonstrate that the existence of a national border between two places widens the difference between prices. In order to obtain this result, they consider 14 disaggregated price indices from 23

North American cities referred to more than 16 years. Their choice of US and Canada for comparison, builds on the following reasons: first of all, they share a border; then, both countries are big enough (this aspect is particularly important to compare prices between distant places, to check whether cities in the same country reveal smaller price differentials than equally distant cities in different countries); thirdly, they have no trade restrictions between each other; and last but not least, they are both English-speaking countries and have similar context. Price volatility is expressed as function of distance between two places and a dummy variable for the presence of a national border is added. After reporting evidence that distance significantly affects price dispersion among cities in the same country, the authors find that the presence of the border influences differences in prices as well. This result is shown on the basis of the sign of coefficients on the dummy variable for the border, which are highly significant for all of the goods in the sample: distance does affect price dispersion, border widens it. The authors then tried several extensions to their basic investigations: they adjusted the sample, considering at first data from 1985 only, then splitting the sample at 1990 (in order to account for NAFTA effects); in all of these cases, results were still consistent with previously described conclusions. In the second part of their paper, Engel-Rogers tried to expound the economic significance of the border, once its relevance had been demonstrated: results highlighted that a border between cities has the same impact on price volatility as a distance of 1780 miles. They also highlighted that the 'size' of the border coefficient did not diminish after the trade agreement between USA and Canada was established.

These conclusions led Engel-Rogers (ER2) to deepen their analysis referring to market segmentation. They argue that if price differentials exist, then the reason might be that markets are not integrated. In fact, their main conclusion is that consumer markets are *national* markets, for several reasons: firstly, because the distribution network is nationally organized; secondly, because of barriers to movement of goods; finally, because tastes are differentiated across different countries. To analyze barriers to market integration, they updated their regression (done in ER1), accounting for distance, border, and different conditions in the labour market. Related literature deals with the definition of market integration based on the speed of convergence of prices (as in Parsley-Wei, 1996): within the US, it is lower the more distant the cities pairs, and in international cases of comparisons, in the presence of borders, still lower. Thus, as in ER1, the authors concluded again that the border matters significantly for at least two reasons: firstly, the segmentation of markets creates opportunities for pricing to market; secondly, hypothesizing nominal price stickiness, given that prices are set in customer's currencies, the nominal exchange rate may play a relevant role in creating divergence. Very interestingly, two further relevant reasons for prices inequality emerge: one is the level of mark-up that firms can exercise in markets; the other is that each commodity includes a 'non-tradable' part, whose price diverge across locations. In the next Section this aspect will help in distinction between tradable and non-tradable goods.

Borraz (2006) investigated the weight of the border ('the *width* of the border' in Engel and Rogers' words) between US and Mexico. Confirming expected results, also in keeping with findings by Rogers-Smith (2001), who conducted the analysis before him following ER1, Borraz demonstrated the existence of a large positive and significant border effect. He tried to pursue his analysis in an original fashion using disaggregated consumer price data, building indices in a different way (organizing similar categories of goods and not referring to the general consumer price index). Results which were still consistent with the above-depicted investigations. A further finding of this author is the reduction of the 'border effect' caused by the 'El Pacto Period' (May 1988 to Nov 1994).

Broda-Weinstein (2008) reported a strong border effect, referring to barcode data. According to them, borders give rise to flagrant violations of LoOp, distance affects these differences, and convergence to PPP is inconsistent with data, which report actual nominal price stickiness. LoOP is violated between cities in different countries, but it fails among cities within the same borders as well. Their analysis referred to micro datasets within and across 10 cities in USA and 6 regions in Canada, covering approximately 40 percent of all expenditure on goods in consumption. In order to support results by Engel-Rogers (1996), Broda and Weinstein investigated the 'width' of the border regressing a measure of the price dispersion on the log of distance and a dummy variable. The only difference, compared to Engel and Rogers, is that the authors here use two different measures of price dispersion, but their results are consistent with those presented earlier, even if the magnitude of the border itself is different.

In ER3, the main topic refers to the analysis of the importance of local currency pricing and flexible exchange rates in failure of LoOP. Under local currency pricing, nominal exchange rate volatility does not affect consumer prices directly in local markets (zero pass-through grade). If each firm's pricing policy is based on its own country's currency, this allows the nominal exchange rate variations to cause divergences in prices among countries. Inevitably, monetary unions are an instrument to reduce this volatility: this is the reason why Engel-

Rogers focused on an empirical exploration of LoOP in European cities, using consumer price data over the period 1981-1997. They find several conclusions. First of all, they identify that most of the border effects arise from local currency pricing within fluctuating exchange rate regimes. Secondly, they investigate the border effect that remains even if one accounts for nominal exchange rate variability, demonstrating that the border plays a significant role. Their opinion is that cross-country differences in national marketing and distribution systems may affect price structure. As a third result, they investigated welfare costs of LoOP failures. Under a floating exchange rate regime, if firms adopt local currency pricing policies, inefficiency arises because consumers pay different prices in different locations even when transport costs are zero. The adoption of a fixed exchange rate regime does not necessarily solve the inefficiency: in that case the welfare loss would arise from volatility in consumption, turning the focus on price stickiness, therefore reducing the relevance of the exchange rate regime in explaining the failure of LoOP.

Ascione (2003) evaluates two alternative explanations for incomplete pass-through. A first reason for the incomplete adjustment of import price to real exchange rate is the price discrimination policies of firms which decide retail prices on the basis of the destination market; the second reason for LoOP failure is based on the effect of distribution costs. Ascione shows that deviations from LoOP are greater under flexible exchange rate regimes than under fixed ones. A possible explanation for this conclusion is that under a fixed regime variations in the exchange rate are perceived by agents as more durable compared to a flexible context; in fact, if firms vary their prices only in the case of permanent exchange rates modifications, in a flexible exchange system elasticity of price with respect to the exchange rate will be lower and it will cause broader deviations from LoOP.

Earlier, Feenstra-Gagnon-Knetter (1996) studied the automobile industry to investigate the correlation between pass-through and market share of firms. They based their analysis on annual data from 1970 to 1988, looking cars from France, Germany, Sweden, and US, sold in twelve countries. The research showed that the pass-through behaved differently: inverse correlation to market share dynamic in cases of low market share; direct correlation to market share in cases of high market share.

LoOP validity is denied also by Asplund-Friberg (2001), who analyzed actual difference in prices of identical goods in a situation where none of the 'traditional' reasons of failure of the law can be invoked (transportation costs, trade barriers, imperfect information). These authors took their data sample from three Scandinavian duty-free outlets in two ferry boats companies between Sweden and Finland (data samples referred to years 1975 to 1998 for the first, and 1991 to 1997 for the second), and one airline company (data sample referred to years 1995 to 1998). Each good, in the same place, is priced in two currencies (at least), leaving the customer with the choice of paying in his preferred currency (thus choosing 'his' price). Percentage deviation from LoOP is calculated. Results of the analysis showed that relative price did not equal exchange rate (as it should do, if LoOP held). Persistence and magnitude of deviations from LoOP are insensible to product differentiation: the company maintained the same relative price for every product in every catalogue, and the reason is not due to the fixed cost to reprint catalogues, as the authors reported that between 1982 and 1988 five new catalogues were printed without changing relative prices. This indication is significant, because if LoOP were valid, catalogue updates should have occurred. On the basis of their statistically significant results, Asplund-Friberg concluded that LoOP validity must be rejected. Furthermore, they proceeded to test for a unit root in deviations from LoOP; this allowed them to conclude that relative price follows a random walk. Therefore, arbitrage did not exercise pressure to equalize prices, and this is consistent with the hypothesis that LoOP failures can also explain PPP deviations, (as in Engel, 1999, where rejection of the law of one price justifies a large part of exchange rate variability). Arbitrage takes place only after deviation from LoOP assumes significant magnitude: data showed that for minor deviations printing of a new catalogue is not necessary as arbitrage does not operate. A new catalogue is printed only when important variations in variables could justify arbitrage. Thus one can conclude, as in Obstfeld-Taylor (1997), that a sort of 'inaction band' operates.

5. Tradability of goods and LoOP

LoOP failures related to tradability of goods have been explored in literature. Tradability is usually linked to the relevance of transaction costs proportionally to the value of goods being sold. Following Heckscher (1916), some authors, for example Obstfeld-Taylor (1997) or Bec *et al.* (2004), considered the case in which arbitrage does not take place, when price differences between two places for the same good would be smaller than transaction costs (transport, taxes, tariffs, and so on).

These costs may then help distinguishing between tradable and non-tradable goods; as Dixon-Griffiths-Lawson (2004) point out, goods and services which enter international trade and satisfy the law of one price, or at an appropriate relative price that could satisfy the law of one price, can be defined as tradable. All other goods

and services will be defined as non-tradable. The most notable work done for the distinction between tradables and non-tradables was undertaken by Dwyer (1992) and elaborated further by Knight-Johnson (1997).

To the best of my knowledge, literature does not offer investigations which specifically test LoOP validity for non-tradable goods. Some relevant work has been instead released in order to study relationships among productivity, the Balassa-Samuelson effect, public expenditure, and the real exchange rate. Examples of this stream of literature can be found in Hsieh (1982), Marston (1990b), Froot-Rogoff (1991), Asea-Mendoza (1994a, 1994b), De Gregorio-Wolf (1994), De Gregorio, Giovannini-Wolf (1994), Micossi-Milesi-Ferretti (1994), Strauss (1996), Faruqee (1995), Chinn (1996), Chinn-Johnston (1997), Canzonieri *et al.* (1996), MacDonald (1997), and Alberola-Tyrväinen (1998). The Balassa-Samuelson effect-related literature has almost always been referred to the purchasing power parity debate, more that to LoOP validity, pointing mostly to debate about exchange rate dynamics. Exactly in this stream, the iceberg model by Sercu *et al.* (1995), tries to analyse the width of a band around the nominal PPP value, due to presence of transaction costs. Other examples are traceable in Dumas (1992), O'Connell-Wei (1997), Obstfeld-Rogoff (2000), Betts-Kehoe (2001), and Crucini-Lee (2004). This literature will not be surveyed here, as this review has been expressly dedicated to the debate about the Law of One Price, given the availability of well-recognized surveys of literature about PPP (see for example, Papell-Prodan, 2003, or Taylor-Taylor, 2004).

Engel-Rogers (2001, ER4), referring to the tradability of goods, proposed a test on a new version of LoOP, which is introduced as the 'proportional law of one price', using monthly price indices for 43 goods from 29 US cities, over the period 1986-1996. The difference between the normal LoOP (named the 'absolute law of one price') is that now they measured the standard deviation of changes in the log of the relative price index of goods across locations. Whether this deviation is low, it indicates that prices are either equal or proportional, and, perhaps surprisingly, they found that deviations are larger for traded goods. Such a result, appears to be in contrast with the traditional trade theory, which assumes that LoOP holds for tradable goods, but not for non-tradable ones.

This problem is considered in Koren (2004), giving support to the conclusion gained by Engel-Rogers (2001): hypothesizing costly trade as a transportation sector which uses resources with different factor intensities compared to the production sector, the author demonstrated that transport and distribution factors cause 10-20 per cent deviation from LoOP across US cities. This empirical investigation (using data set from Parsley-Wei 1996, ER4, and additional data which include pairwise driving distances between cities and the per-barrel price of oil) explains why if trading is costly, LoOP fails. This generates Koren's 'law of two prices'.

Parsley-Wei (1996) studied the speed of convergence to LoOP, with quarterly data, looking for the effect of transport costs. Using distance between cities as a proxy variable of transport costs, they also included in their analysis the impact of tariffs. Their results show unambiguously that distance can make prices differ very much; furthermore, the speed of convergence to LoOP is decreasing as the distance between two cities increases.

Local distribution services are the core of the paper written by Baba (2007), who considered that even whether LoOP held at producer/importer level, consumer prices could however differ for local firms' mark-ups associated to distribution costs, which heavily influence final good prices as also reported by Burnstein *et al.* (2003) and Campa-Goldberg (2004). In order to expound this idea, Baba analysed two addends of the final retail price of goods, named 'cost effect' and 'price discrimination effect'. These two effects interact in two ways: the first simply internalize into the final price the set of costs paid by the seller to produce the good being sold, whilst the second is decided by the seller accounting for tastes and demand function characteristics of the local market. The first effect has been analysed by MacDonald-Ricci (2003) for ten OECD countries using CPI data and by Goldberg-Verboven (2001) for European countries using car prices. Both of these contributions conclude that a significant role in differentiating prices is attributable to local wage difference, as in Alessandria-Kabosky (2004). The second effect has been studied by Goldberg-Verboven (2001) and Hellerstein (2004, for the beer industry) by modelling the impact of local inputs on retail prices of differentiated goods, thus explaining important source of differences in prices. In particular, both Goldberg-Verboven (2001) and Hellerstein (2004) are based on demand functions characterized by the Almost Ideal Demand System (AIDS), firstly proposed by Deaton-Muellenbauer (1980). Differently form other contributes, Baba conducted his analysis (dealing with monthly data for about 350 goods from 47 cities, referred to years 2000-2005) on price differentials only among Japanese cities: this allowed him to preserve his conclusion from problems which can affect all international price comparisons, such as, for example, sticky prices/wages, variations in nominal exchange rates. These analyses confirm LoOP failure.

Tradability is not always an exogenous characteristic of goods. Indeed, Bergin-Glick (2003) proposed a new way of thinking about non-tradedness, as an endogenous decision. Their model develops a simple method

for analysing a continuum of goods with heterogeneous trade costs, which explores whether and how a seller decides to trade a good internationally. Given this endogeneity, the good on the margin assumes a key-role in linking prices of traded and non traded goods, preventing the two price indices from moving too far apart. This point of view confirms that trade costs (tariffs, non-tariff barriers, shipping costs, and marketing and distribution costs) act dramatically in influencing trade decisions, as emphasized by Hummels (1999) in his empirical work. Collecting detailed data for individual goods, he finds that freight costs alone can range from more than 30 percent of value for raw materials down to 4 percent for some manufactures. The model by Bergin-Glick considers a small open economy with a continuum of home goods with a distribution of trade costs. The country tends to export those goods with low trade costs, once considered internal demand: this is the reason why the cut-off between traded and non-traded may shift over time. This is, in a sense, an extension of Obstfeld-Rogoff (2000), because they consider only one home good that switches between traded and non-traded status. Other empirical work found support for the idea that tradability of goods may change over time: Bernard and Jensen (2001) show that from a panel of US manufacturing plants from 1987 to 1997, on average, 13.9% of non-exporters begin to export in any given year during the sample, and 12.6% of exporters stop. Final results by Bergin and Glick report two surprising conclusions about the Balassa-Samuelson effect: the first is that there is little to no support for it as of the mid-20th century, contrary to the general conception; the second is that this effect has grown over time to rather large values in the most recent years. Productivity shocks that are heterogeneous among goods not only induce a response in relative prices, as usually conceived in the standard Balassa-Samuelson model, they also induce a response in the relative tradability of goods.

Naknoi (2008) developed a stochastic dynamic general equilibrium model to explain variance decompositions of real exchange rates. As empirical literature on real exchange rate has often found (see, among others, Engel 1999, Betts-Kehoe 2001, Chari *et al.* 2002), some real exchange rates are driven by the relative price of traded goods and some by the relative price of non-traded to traded goods. The way relative price dominates the real exchange rate is significant for implications about international shock transmissions. In order to investigate this topic, Naknoi focuses on trade costs, heterogeneous productivity, and sticky wages to underline how the dynamics of comparative advantage amplify expenditure switching. Thus, he presents an alternative theory with an emphasis on endogenous tradability and exchange rate regimes. This analysis is consistent with Mendoza (2000), who highlighted the role of exchange rate regimes, reporting that the contribution of relative price of non-traded to the variance of Mexico-US real exchange rate is over 30 percent higher in the period of fixed than in the period of flexible exchange rates. Naknoi analytically showed that the contribution of the relative price of traded goods is increasing in the covariance between terms of trade and productivity differentials in the non-traded and export sectors. If the covariance is large, it means that wage inflation is offset by productivity gain more in the non-traded than in the export sector. The covariance, therefore, measures the degree to which shocks are transmitted to prices in the export sector relative to those in the non-traded sector. The difference in the covariance across exchange rate regimes is essentially the expenditure-switching effect of exchange rates generated by endogenous tradability. The importance of endogenous tradability emerges as Naknoi shows that the correlation between the relative price of traded and non-traded goods is perfect in the absence of endogenous tradability, because shocks are transmitted only through terms of trade when the trade pattern is exogenous.

6. Conclusive remarks: is LoOP just a theoretical myth?

The reviewed literature builds upon the rejection of LoOP. This rejection is driven by the analysis of empirical aspects of its applicability.

Differences in prices may have several sources. A strongly different approach to explain differences in price between domestic- and export- destined goods is suggested by Ravn-Schmitt-Grohé-Uribe (2007), referring to deep habits. According to these authors, when habits are formed at the level of individual goods, firms can have the incentive to differentiate their mark-up (through price) accordingly with demand structure in each market they operate. This 'pricing to habit' formulation is inserted in the stream of literature about pricing to market referred to customer switching costs, as in Froot-Klemperer (1989), and allows the analysis to account for demand-shift-induced price variations. Demand shocks in markets can be the source of divergences in prices, which makes LoOP fail. In order to underline the impact of habits on the pricing policies of firms, Ravn, Schmitt-Grohé, and Uribe built a two-country dynamic general equilibrium model which focused on the presence of habits as a strong factor of influence for each variety of goods, exogenously determined, inside the inter-temporal utility function. This implies that demand structure for any individual variety of goods will be decreasing in the relative price, increasing in the level of habit-adjusted consumption, and increasing in the 'weight' of habit. The aggregate

demand function that each firm will face is depicted as the sum of private, public, domestic, and foreign components: the structure of this demand is constituted of a price-elastic component and a price-inelastic component. The latter is the deep-habits-influenced term. This leads the authors to conclude that given that, in principle, demand elasticity can differ domestically and abroad, and considering the possible difference in public expenditure decisions, price would differ internationally because demand functions would differ and thus firms can have the incentive to differentiate their mark-up accordingly.

At this stage, one can question whether LoOP ever failed in the past as it fails nowadays. This topic is the core of the paper by Froot-Kim-Rogoff (1995). They showed that deviations from LoOP have been remarkably present in time. They held furthermore that these deviations do not refer just to cross-country relative prices of individual goods, but to broad indices. They collected annual data of agricultural commodities from England and Holland: wheat, oats, barley, butter, eggs, cheese, peas, and silver. The first result obtained, is that volatility of LoOP deviations is very wide. The augmented Dickey-Fuller test showed that those deviations appear stationary, and after a Chow test on ARMA specifications, the estimation supported the conclusion that the rate of convergence during the XX century is not significantly different from the one referring to earlier centuries. Thus these authors demonstrated that deviations from LoOP have almost always been the same in both magnitude and persistence.

This survey tried to show evidence of empirical failure of LoOP. Results show the lack of actual support for the famous 'second law of economics'. Pippenger-Phillips (2006) tried to defend it, arguing that a common mistake in analyses rejecting LoOP is to ignore implications of arbitrage. LoOP does work correctly, in their opinion, and adverse ideas are, in their words, wrong because they do not consider, as they should, relevant conditions, such as transaction costs, timing of arbitrage, non-perfectly identical products, and resale opportunities.

The question appears to be methodological: only a Walrasian perfectly competitive world would accept LoOP without exceptions. In true markets, even identical goods can be sold at different prices, as documented by Elzinga-Hogarty (1978) or by Asplund-Friberg (2001), just to mention two examples: the same bituminous coal was sold in two zones of same country with different prices; the same good was sold at two different prices on the same boat. Why?

Only restrictive and hypothetic conditions preserve validity of the law. Looking for a theory which fits reality, many try to redefine reality to enslave it to comfortable theories but, as Keynes (1923, p. 92) pointed out, 'if we restrict ourselves […] we should find that the theory is always in accordance with the facts. In fact, the theory, stated thus, is a truism, and as nearly as possible jejune'.

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THE YIELD CURVE AND THE PREDICTION ON THE BUSINESS CYCLE: A VAR ANALYSIS FOR THE EUROPEAN UNION

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Abstract

The literature on the yield curve deals with the capacity to predict the future inflation and the future real growth from the term structure of the interest rates. The aim of the paper is to verify this predictive power of the yield curve for the European Union at 16 countries in the 1995-2008 years. With this regard we propose two VAR models. The former is derived from the standard approach. The later is an extended version considering explicitly the macroeconomic effects of the risk premium. We propose the estimates of the models and their out-of-sample forecasts through both the European Union GDP (Gross Domestic Product) quarterly series and the European Union IPI (Industrial Production Index) monthly series. We show that our extended model performs better than the standard model and that the out-of-sample forecasts of the IPI monthly series are better than ones of the GDP quarterly series. Moreover the out-of-sample exercises seems us very useful because they show the jump out arising from Lehman Brother's unexpected crash and the becoming next fine tuning process.

Keywords: yield curve, monetary policy, business cycle, risk premium, real growth

JEL Classification: E43, E44, E47, E52

1. Introduction

In this paper we investigate on the yield curve and on its predictive power for the Euro Area (fixed at 16 countries) in the 1995-2008 years. In order to forecast the future growth of the real activities for the European Union we consider two VAR models. The former is the standard model where the yield spread is only used to forecast the output growth. Next, we present a more extensive model consistently with the macroeconomic and the financial theory; it is represented by six risk adjusted equations in order to include the impact of the market risk premium on the economic system. We use the VAR estimations to propose the out-of-sample forecasts both for Gross Domestic Product, GDP, (on quarterly frequency) and for Industrial Production Index, IPI, (on monthly frequency) annual growth rates of the European Union. We use also the monthly IPI series because we seem us embedding better the volatility of the changes of the interest rates. This last exercise seems us very useful because it allows us to show and to analyse the jump out on the predictive power of the yield curve following the explosion of the bubble at the unexpected Leman Brother's crash and the expectations' next fine tuning. The data source is coming from the statistics of the European Central Bank.

The paper is organised as follows. Besides this introduction, in Section 2 we discuss about the economics of the yield curve, while in the Section 3 we investigate graphically about the basics of the yield curve of the European Union in the involved years. In the Section 4 we present the methodology and the data of the empirical analysis. The Section 5 is devoted to show the results of the VAR empirical analysis according to typical approach, while in the Section 6 the results of the both VAR's estimations and forecasts are illustrated. Finally there are some conclusive remarks and the appendix.

2. The economics of the yield curve

The literature on the yield curve is very extensive and we are not able to discuss it exhaustively. The first papers investigating the relationship between the term structure of the interest rates and the inflation and output growth go back in the 1980s. These analyses found that the yield curve contains more information than stock returns in order to predict both the future inflation and the future growth of the real activities. On the one side, Harvey (Harvey 1988,1989) introduced the methodology showing as the term structure spread can predict the GDP growth accurately; on the other side, Mishkin's model derived from the Fisher condition (Mishkin 1990,1991) found that through the yield curve it's possible forecast the future inflation. These results have been confirmed and extended by a lot of next papers. All of these studies dealing with the predictability of the yield

curve are devoted to US countries and they confirm that the relationship between yield curve and both inflation and output growth is highly significant. With regard to the forecast of the output they are explicitly suggesting in a period between the 4 and the 6 quarter ahead the 'optimum' horizon and they find that an inverted yield curve can announce an impending recession (amongst the other Chu1993, Estrella, and Hardouvelis 1991, Estrella Mishkin1997, 1998). Subsequent researches investigate on whether the relationship between yield spread and future economic growth holds in countries other than the United States and they find that the term structure predicts the output growth in several other countries, UK and Germany particularly (amongst the other, Plosser, and Rouwenhorst 1994, Davis, and Henry 1994, Davis, and Fagan 1997, Funke 1997, Ivanova *et al.* 2000). Finally, some studies are recently devoted in the EU Area and they confirm this relationship too (Moneta 2003, Duarte *et al.* 2005).

The main questions arising from latest contributions concern the stability of the relationships over time and across countries (amongst the other, Chauvet, and Potter 2002, Li *et al.* 2003). Therefore, although the relationship is strong, there are some theoretical reasons indicating that she may not be sTable. For instance, the theory suggest that the results may be different if the economy is responding to real (productivity) or monetary shocks, or if the central bank is targeting output or inflation. Estrella (2004) develops an analytical model in order to explain the empirical results. He suggests that the relationships are not structural, but they are influenced by the monetary policy regime. However, the yield curve should have predictive power for inflation and output in the most circumstances, for instance, when the monetary authority follows inflation targeting or when he follows the Taylor rule. In all the cases, '*…the information of the yield curve can be combined with other data to form the optimal predictors of output and inflation*.' (Estrella 2004, 743). On the empirical field, Estrella *et al.* (2003) use new econometric techniques to test the empirical relationships; they find that the models that predict real activity are more sTable compared with the models that predict inflation. Chauvet and Posset (2003) use different models in order to take into account some of the potential causes of the predictive instability of the yield curve; they also develop a new approach in order to forecasting of the recession probabilities. Ang *et al.* (2006) propose a dynamic model that characterizes completely the expectations on the output growth correcting the unconstrained and endogeneity problems arising from the previous studies.

It is well known that the yield curve is defined by the term structure of the interest rates on assets of different maturities. The slope of this curve is represented by the differences between the long-term and the short-term interest rates and it gives the shape of the yield curve; this shape can differ over the time following the variations of the expectations on the inflation rate and on the business cycle.

Fisher equation takes into account this dynamic because it analysis the link between the nominal yield on the different maturities r_t, the real interest rate r_t^r and the expected inflation rate π_t^e:

$$r_t = r_t^r + \pi_t^e \ [+ r_t^r \ \pi_t^e] \quad (1)$$

The real interest rate summarizes the real economic conditions while the expected inflation rate is represented by the inflation premium demanded by the investors in order to be ensured against the expected loss due to the future inflation. Therefore, the role of the time structure of the expected inflation in the shape of the yield curve increases when the expected inflation rate is higher.

Fisher condition has to be adjusted if the uncertainty is introduced in the analysis. Given the hypothesis of risk-aversion of the investor, there is a risk premium devoted to compensate for the losses. This market risk should be embedded in the nominal yield as a *risk premium* component[20].

Therefore, since the term in brackets $[r_t^r \ \pi_t^e]$ is too small and it isn't relevant for the analysis, a risk adjusted Fisher equation is

$$r_t = r_t^r + \pi_t^e + mrp_t \quad (2)$$

where mrp_t is the market risk premium at time t. Naturally, in the short term there isn't the risk premium because there isn't uncertainty.

Given that the slope of yield curve is the difference between the long-term rate (lr_t) and short-term interest rate (sr_t), we have

$$lr_t - sr_t = lr_t^r + l\pi_t^e + mrp_t - (sr_t^r + s\pi_t^e)$$

and so

[20] Generally longer is the maturity of a bond, greater is the time of uncertainty and so higher is the market risk.

$$[lr_t - sr_t = (lr_t^r - sr_t^r) + (l\pi_t^e - s\pi_t^e]) + mrp_t \quad (4)$$

that is, the difference between the nominal long-term rate and short-term rate is the expected change of real economic conditions ($lr_t^r - sr_t^r$) plus the expected change of inflation ($l\pi_t^e - s\pi_t^e$) plus the market risk premium (mrp_t).

The shape of the yield curve reflects the dynamic of these three components[21]. Since long-term debt is less liquid and his price more volatile, the short-term yields are usually lower than long-term yields. Therefore a change in the shape of yield curve during the business cycle is often due to large movements in short-term rates without equal variations in long-term rates. Instead, a business expansion increases the short-term rate faster than long-term rate while during a recession it falls more rapidly.

Therefore, a 'normal' shaped curve is evident when the economic activity is in the steady growth[22]. The inflation pressure is not high and there are not expectations on sudden changes in the business cycle. In this context the monetary policy is implemented in a neutral way in terms of targets as regard to the changes of the level prices or to the extension of the output gap.

A 'steep' shaped curve signals a stag of accommodative monetary policy in order to stimulate the economic activity. It is frequent at the trough of the business cycle and it anticipates of some months (6-12 months) a economic expansion phase. The spread is obviously greater than the upper limit of the one showed in the 'normal shaped'[23].

The change from a positive to a negative economic growth phase can be anticipated by a *flattening* of yield curve that does not last for so too much time. A 'flat' yield curve is usually near the peak of a business cycle and it is due generally to a sharp increase in short-term rates caused, for examples, by a strong demand for short term credit, by a credit crunch due a monetary tightening implemented against a large inflation pressure and by sudden movements in the expectations.

Finally, when the long-term rates are lower than short-term rates the yield curve is 'inverse'. This can be evident when the Central Bank implements a huge and fast restrictive monetary policy to fight the inflationary shocks, as the ones due large and sudden increases of the oil prices. The business cycle suddenly changes when the slope of yield curve is negative and the recession is probably for-coming or just acting.

3. The yield curve for the European Monetary Union in 1994-2009 years

We have determined the shape of the yield curve for the European Union (at 16 countries) on monthly basis in the years 1994-2009; she is represented by the difference between 10-year Euro Area Government Benchmark Bond yield and Euribor 3-month interest rate[24]. This curve with the line representing the European Central Bank (ECB) interest rate which has been plotted in Figure1[25].

As it can be noted, the shape of the yield curve is asymmetric as regard to the choice of monetary policy of the European Central Bank. The ECB interest rate increases and the slope of the curve goes down when there is a monetary tightening. Instead, the ECB interest rate decreases while the slope goes up when the monetary policy is accommodating.

Then, we have proposed a classification of the shape for the EU yield curve following the criteria by Taylor (Taylor 1998)[26]. In Figure 2 there is plotted a quarterly version of this curve for the period 1994:Q1-2009:Q2 with the legend of the different kinds of shape. This enables us to analyse the different stances of monetary policy and to forecast the turning points of the business cycle.

---

[21] Generally, four kinds of the shape of the yield curve are considered: 'normal curve', 'steep curve', 'flat curve' and 'inverse curve'.

[22] Taylor (1998) arguments that for the U.S.A treasury bonds the yield curve takes this kind when the spread between the long-term and the short-term interest rates is in the range of [1.50 , 2.50] basis points.

[23] *See* Taylor (1998).

[24] For a detailed description of these data see next section.

[25] The ECB interest rate is the reference when the European Central Bank is implementing the monetary policy.

[26] We have considered that the yield curve is 'normal' when the slope is limited in this range of basis points [1.50, 2.50]; it is a 'steep curve' when the slope is higher than the upper limit of the 'normal' one; it is an 'inverse curve' when the slope is less than zero; it is a 'flat curve' when the slope is greater than zero and lower than the inferior limit of the 'normal curve'.

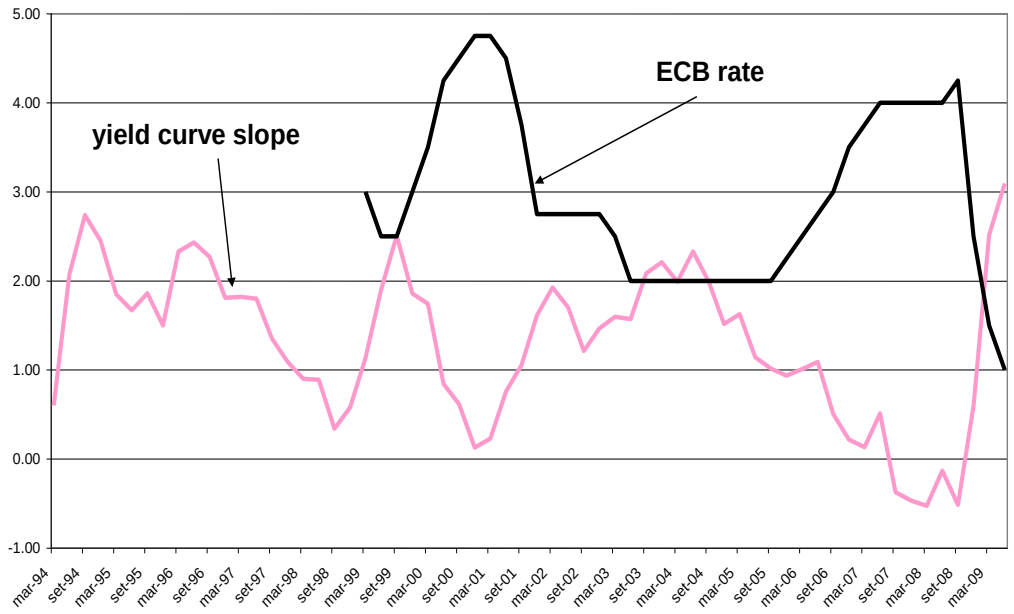


Figure 1. Yield Curve Slope and European Central Bank Interest Rate (ECB) (Euro Area)

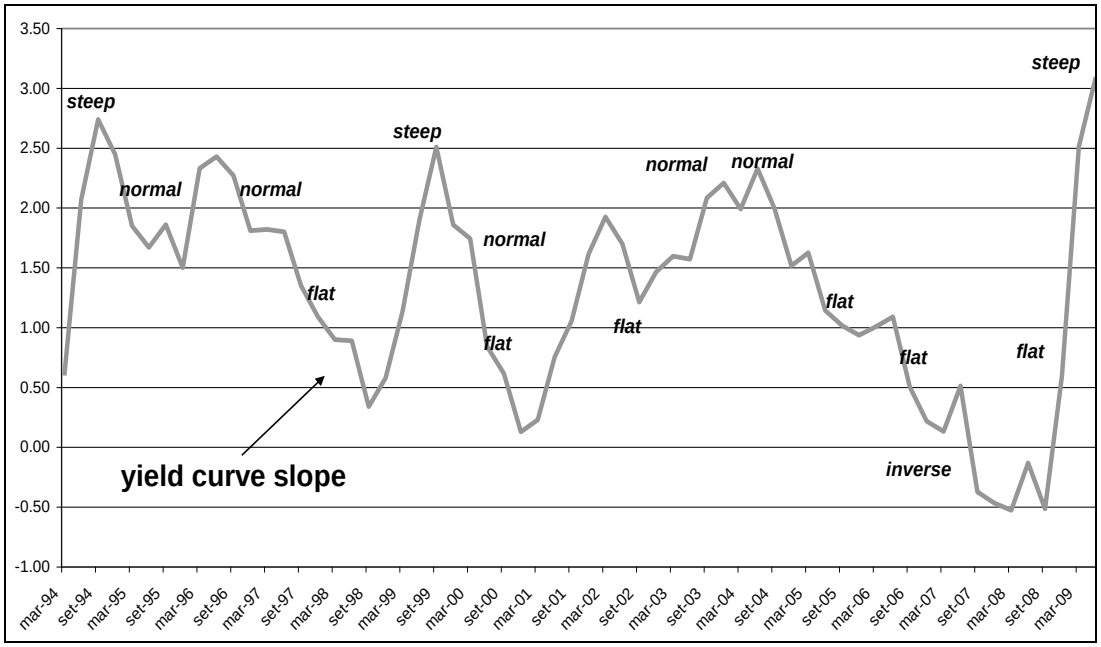


Figure 2. Yield Curve Slope reclassified (Euro Area)

If this line is compared with the GDP of the Euro Area (chain linked) at market prices, the relationship between the business cycle and the expectations embedded in the slope of the term structure of the interest rates can be graphically investigate[27]. In the Figure 3 we have plotted the annual growth rate of GDP, the yield curve slope for the EMU and the ECB interest rate for the quarters 1994:Q1-2009:Q2. We are able to confirm that the shape of the yield curve could be interpreted both as a predictor of the business cycle and as a tool to explain the effects on the real economy of the monetary policy implementation[28].

In the observed years a 'steep curve' appears three times: on September 1994, on September 1999 and from March to June 2009. The steeping of the yield curve in the third quarter of 1999 points out an economic expansion achieving the peak nine months later: on June 2000 the annual growth rate for the Euro Area of GDP

[27] GDP is considered in annual growth rate on quarterly frequency.

[28] *See* Howard, 1989.

(chain linked) is equal to 4.6 %, the grater in the years from 1996 to 2009. The 'steeped' Section of the curve in the second quarter of 2009 is indicating a prediction of a large boost of the business cycle between the end of the previous year and the beginning of the actual one. The negative stage of the economy was been foresighted too much ahead of time by an inverted yield curve. In particular there was been a change in the direction of the yield curve with a flattening trend started from June 2005 up to September 2007 when the slope became negative: the 'through' of the business cycle was on March 2009 after a big fall from September 2008. Another flattening trend of the yield curve, that it's exhausted itself at the end of 2000, looks like to predict the fall on the business cycle culminated on March 2002 with an annual growth rate of the GDP chain linked equal to 0.5 %.

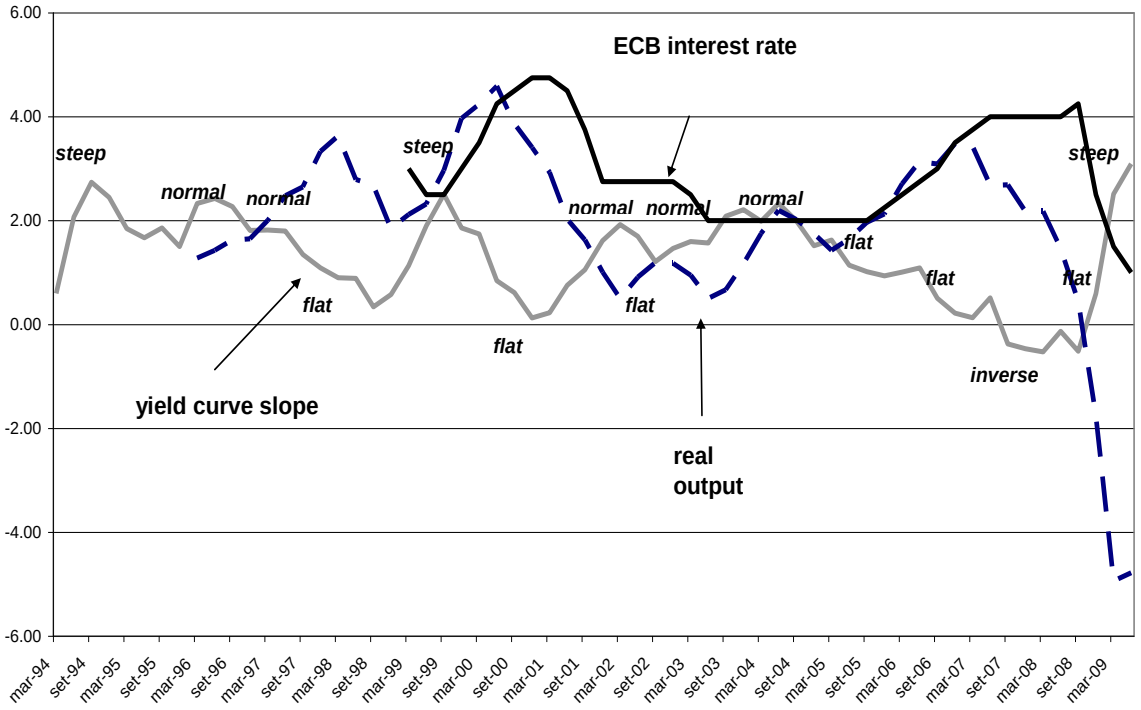


Figure 3. Yield Curve Slope and Business Cycle (Euro Area)

5. The methodology and the data for the empirical analysis

In order to analyse the relationship between the slope of the yield curve and the business cycle in the European Monetary Union, we present two Vector Auto-Regressive models. The former (VAR1) lies on the typical approach because it investigates only the information embedded in the interest rate spread to forecast the output growth. Moreover, we propose an alternative approach to estimate a more extensive model (VAR2) and to forecast the output growth from it.

The large volatility of the short-term interest rates as much as the statistical restrictions suggest that both quarterly data and a monthly data must be consider in order to be able to catch the underlying dynamic of the yield curve. The estimates and the forecasts concern two different output growth indices: the Gross Domestic Products (GDP) on quarterly basis and the Industrial Production Index (IPI) on monthly basis.

We estimate the two models with references to the Euro Area 16. The information source for the empirical analysis is the statistical data warehouse of the European Central Bank (http://sdw.ecb.europa.eu/). The variables taken into account to investigate the relationship between the slope of the yield curve and the business cycle are:

a. *EONIA* is the European Overnight Interest Rate for Euro Area on monthly basis from 1994:1 up to 2009:7;

b. *ECB* interest rate is the interest rate of European Central Bank for the main refinancing operations. It is the fixed rate tenders (fixed rate - date of changes) on monthly basis from 1999:1 up to 2000:5 and from 2008:10 up to 2009:7 and it is the variable rate tenders (minimum bid rate - date of changes) from 2000:6 up to 2009:7;

c. *EURIBOR3* is Euro Inter Bank Offered Rate 3-month on monthly basis from 1994:1 up to 2009:7;

d. *GBBY10* is 10-year Euro area Government Benchmark Bond Yield provided by ECB on monthly basis from 1970:1 up to 2009:7;

e. *GDP* is Euro area 16 (fixed composition) Gross Domestic Product at market price, chain linked, ECU/euro, seasonally and partly working day adjusted, mixed method of adjustment, Annual growth rate on quarterly basis from 1996:Q1 up to 2009:Q2;

f. *IPI* is Euro area 16 (fixed composition) Industrial Production Index, Total Industry (excluding construction) - NACE Rev2, Eurostat, working day and seasonally adjusted, on monthly basis from 1990:1 up to 2009:8;

g. *HICIP* is Harmonised Index Consumer Prices - Overall index, annual rate of change, Eurostat, neither seasonally nor working day adjusted, Euro Area;

h. *DOW50* is Dow Jones Euro Stoxx 50 Price Index, historical close, average of observations through period, Euro Area, provided by ECB on monthly basis from 1970:1 up to 2009:8;

i. VOLATILITY is Eurex Generic 1st `RX` Future, implied bond volatility, end of period, provided by Bloomberg on monthly basis from 1993:6 up to 2009:8.

6. The empirical analysis in accordance with the typical model

The typical model is based on two endogenous variables: the slope of the yield curve and the output gap. The first variable ($SPREAD_t$) is determined as

$$SPREAD_t = GBBY10_t - EURIBOR3_t$$

while the second variable ($OUTPUT_{z,t}$ with z=GDP or IPI) as

$$OUTPUT_{GDP,t} = \Delta REAL\_GDP_t = \Delta_{t-4}\, GDP_t = \log(GDP_t) - \log(GDP_{t-4})$$

on quarterly basis, or

$$OUTPUT_{IPI,t} = \Delta_{t-12}\, IPI_t = \log(IPI_t) - \log(IPI_{t-12})$$

on monthly basis.

With reference to the European Union the previous two output indices present on quarterly frequency the same dynamic; this is showed clearly from the Figure 4 where there is plotted the $\Delta REAL\_GDP_t$ [Real output growth rate] and the $\Delta_{t-12} IPI_t$ [Industrial production growth rate] quarterly series for the period 1996:Q1-2009-Q2 (correlation and statistics are in Appendix, Tabb. A.I and A.II)[29].

Therefore in the first VAR model (VAR1) there are two endogenous variables ($i=1,2$) with two lags ($j=1,2$)

$$SPREAD_t = \beta_{1,t}\, SPREAD_{t-j} + \delta_{1,t}\, OUTPUT_{t-j} + \alpha_1 + \varepsilon_{1,t} \quad (5a)$$

$$OUTPUT_{i,t} = \beta_{2,t}\, SPREAD_{t-j} + \delta_{2,t}\, OUTPUT_{t-j} + \alpha_2 + \varepsilon_{2t} \quad (5b)$$

where $SPREAD_t$ is the difference between the long-term interest rate and the short-term interest rate for t = 1,2, …,T; $OUTPUT_{i,t}$ is the output gap for t = 1,2, ……. T; α_1 , α_2 are the exogenous variables (intercepts); $\beta_{i,t}$ and $\delta_{i,t}$ are the coefficients of the two lagged endogenous variables; $\varepsilon_{i,t}$ are the stochastique innovations[30].

[29] The correlation coefficient between Δ REAL_GDP and $\Delta_{t-12} IPI_t$ quarterly series is 0.959723.

[30] The assumptions about the innovations are that they may be correlated with each other but they are uncorrelated with their own lagged values and uncorrelated with all of the right-hand side variables respectively in the equations [5a]-[5b].

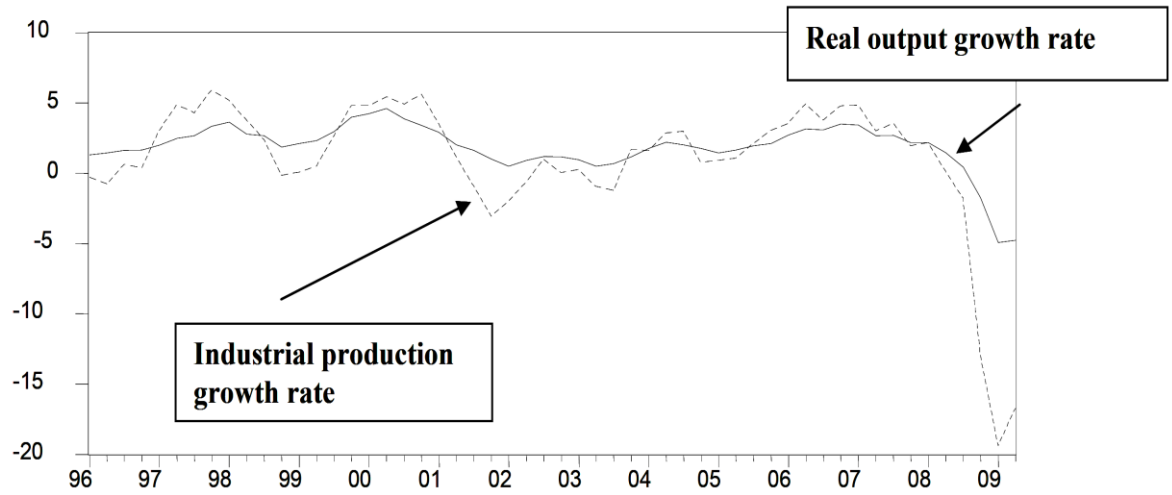


Figure 4. GDP versus IPI annual growth rate (Euro Area)

The estimation of VAR equations (5a) – (5b) with two lags GDP quarterly series for the period 1996:Q1-2008:Q4 confirms that the information embedded in the slope of the yield curve are useful to forecast the down turning of the business cycle. The impulse response function of ΔREAL_GDP$_t$ to innovations in SPREAD$_t$ points out that the changes in the slope of the yield curve are affecting on the business cycle with a persistence from the 3th up to the 8th quarter later (Figure 5). The sum of β_{11} and β_{12} coefficients in equation (5b) is positive and equal to 0.308 (the sum of δ_{11} and δ_{12} coefficients is 1.030) confirming the theoretical predictions; their t-students statistics are rejecting the null hypothesis for each parameter ($H_0: \beta_{11} = \beta_{12} = \delta_{11} = \delta_{12} = 0$) (*see* Appendix, Table A.III).

The VAR estimations in the model with six lags the $\Delta_{t-12}IPI_t$ monthly series confirm the results obtained on the quarterly ones (*see* Appendix – Table A.IV)[31]. The impulse response functions of this model are plotted in Figure 6.

[31] However the standard errors of each coefficient of the equations [5a]-[5b] on monthly series are larger than the quarterly estimated ones.

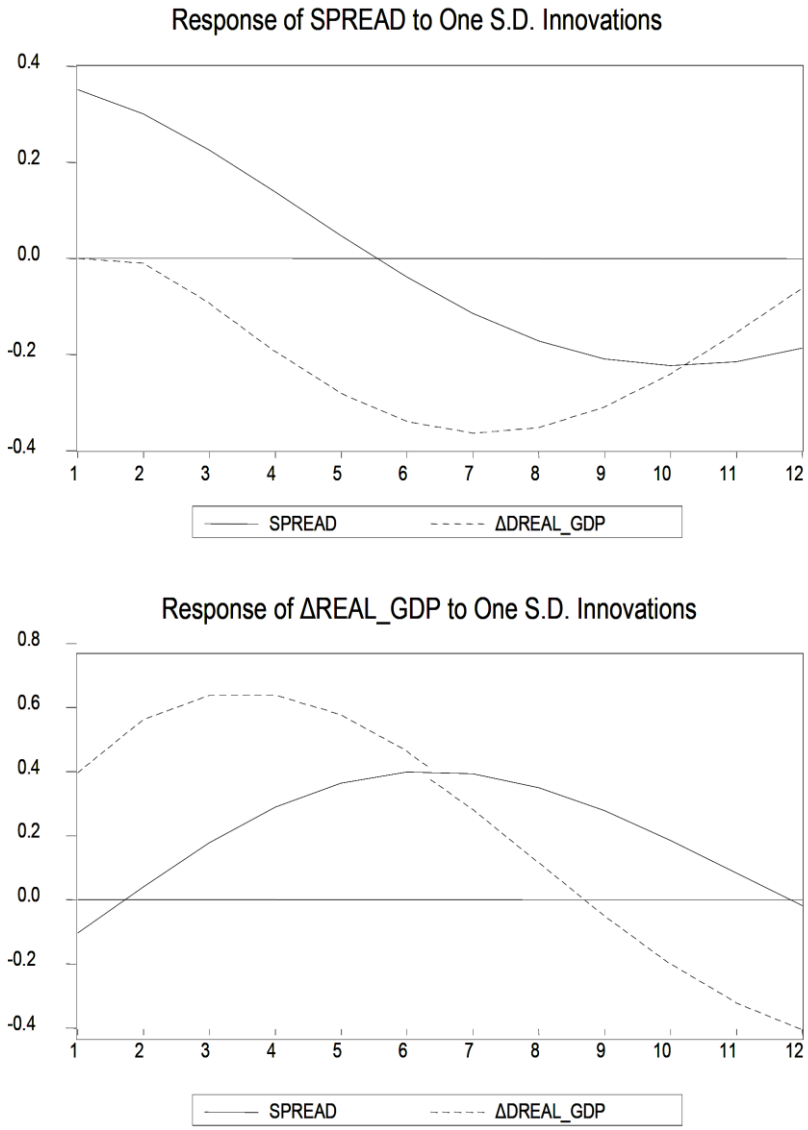


Figure 5. Impulse response functions for GDP in VAR1 Model (Euro Area)

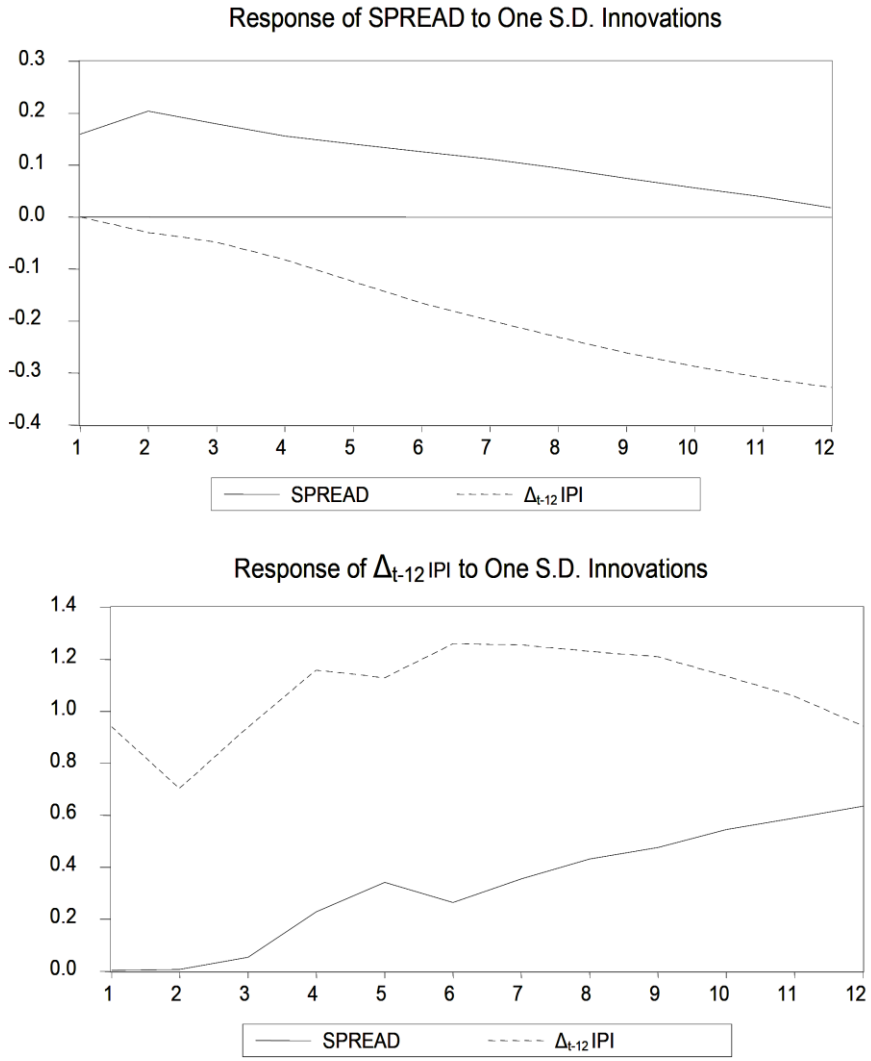
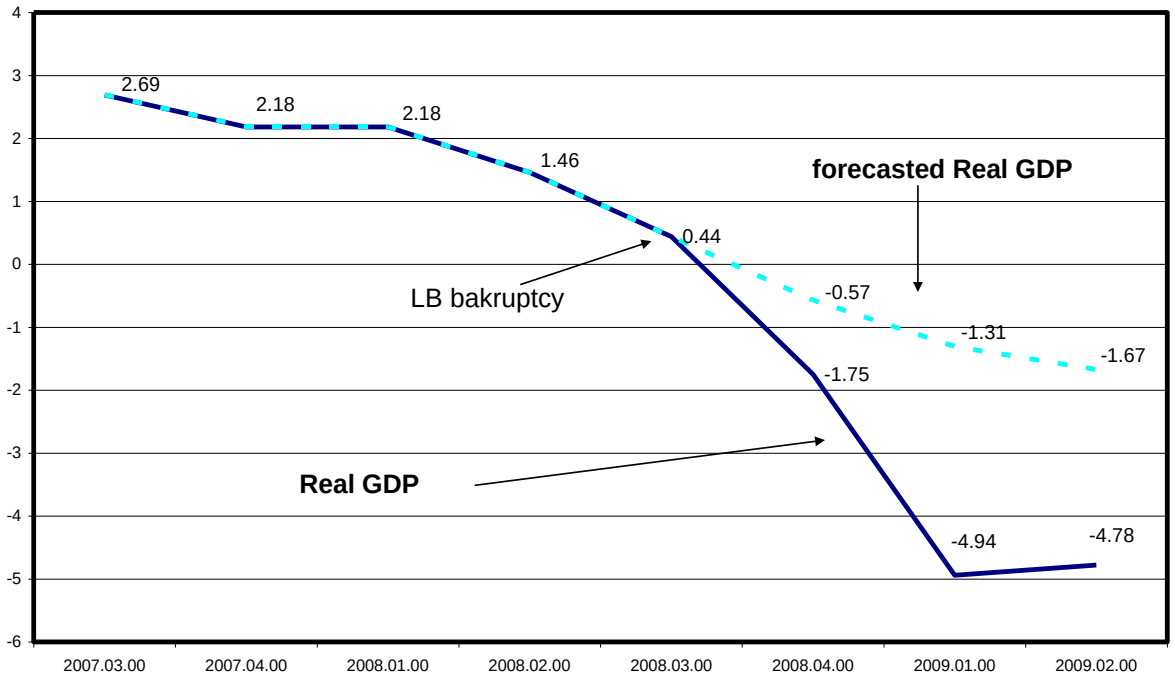
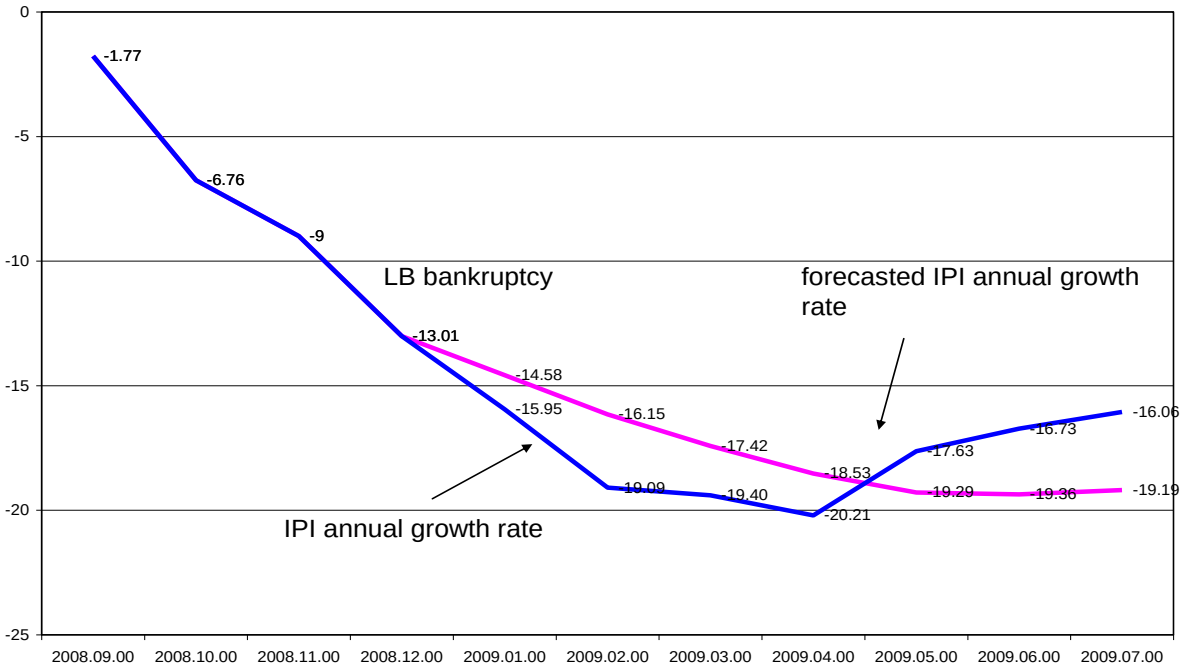


Figure 6. Impulse response functions for IPI in VAR1 Model (Euro Area)

Then, we provide an exercise of the out-of-sample forecast for quarterly ΔREAL_GDP$_t$ series and for monthly $\Delta_{t-12}IPI_t$ series according to the estimated coefficients of equations (5a) – (5b) of the VAR1 model; the forecast method is dynamic. Both the forecasts are plotted in the Figure 7. In the upper side of Figure (7.1) there is the forecast of ΔREAL_GDP$_t$ series for the period 2008:Q4-2009:Q2; it shows that the estimated coefficients in equations (5b) takes into accounts the expectations of a thorough of the business cycle embedded in the slope of the yield curve from the end of the second quarter of 2008. The bankruptcy of Lehman Brothers causes an acceleration in the fall of the Gross Domestic Product (Euro Area), but the model is not able to have an precise measure of this phenomenon even though it catches up the beginning of the recession. In the down side of the same Figure (7.2) there is the out-of-sample forecast for the monthly $\Delta_{t-12}IPI_t$ series for the period 2009:1-2009:7; it seems to perform relatively better than the previous forecast.



7.1. Quarterly GDP series



7.2. Monthly IPI series

Figure 7. Out-of-sample forecast according to VAR1 Model

7. The analysis according to macro-finance model

According to the previous condition (4), we can note that the difference between the nominal long-term and short-term rates is affected by the output growth, by the innovations in the inflation rate and by the capital market risk (both equity and bond risks). The short-term interest rate is determined by these same components on the basis of the risk adjusted Taylor rule (Taylor 1993). Therefore we can say that between the spread, the output, the innovation in the inflation rate, the short-term interest rate, the equity risk, the bond risk there is a

relationship. We present a VAR model where all of these variables are endogenous without an identification framework in order to include the impact of the market risk premium.

This different approach contains six risk adjusted equations; it is formed precisely by the following economic models:

(6a) – risk adjusted Fisher condition;
(6b) – risk adjusted Taylor Rule;
(6c) – risk adjusted Inflation Targeting Model;
(6d) – risk adjusted Output Gap Model;
(6e) – Arbitrage Pricing Theory Model[32];
(6f) – Bond Risk Premium Model.

In the model (6a) – (6f) the risk adjusted factor is the market risk premium (mrp_t) consisting of two components: the former is the equity risk premium embedded in the equity return, $RETURN_t$, the latter is represented by the bond risk premium, BRP_t.

Therefore, the second model, VAR2, can be represented by the following six equations with six endogenous variables and six lags ($j=1,...,6$):

$$SPREAD_t = \beta_{1,j}\, SPREAD_{t-j} + \eta_{1,j}\, SR_{t-j} + \kappa_{1,j}\, IR_{t-j} + \delta_{1,j}\, OUTPUT_{t-j} + \theta_{1,j}\, RETURN_{t-j} + \lambda_{1,j}\, BRP_{t-j} + \alpha_1 + \varepsilon_{1,t} \quad (7a)$$

$$SR_t = \beta_{2,j}\, SPREAD_{t-j} + \eta_{2,j}\, SR_{t-j} + \kappa_{2,j}\, IR_{t-j} + \delta_{2,j}\, OUTPUT_{t-j} + \theta_{2,j}\, RETURN_{t-j} + \lambda_{2,j}\, BRP_{t-j} + \alpha_2 + \varepsilon_{2,t} \quad (7b)$$

$$IR_t = \beta_{3,j}\, SPREAD_{t-j} + \eta_{3,j}\, SR_{t-j} + \kappa_{3,j}\, IR_{t-j} + \delta_{3,j}\, OUTPUT_{t-j} + \theta_{3,j}\, RETURN_{t-j} + \lambda_{3,j}\, BRP_{t-j} + \alpha_3 + \varepsilon_{3,t} \quad (7c)$$

$$OUTPUT_t = \beta_{4,j}\, SPREAD_{t-j} + \eta_{4,j}\, SR_{t-j} + \kappa_{4,j}\, IR_{t-j} + \delta_{4,j}\, OUTPUT_{t-j} + \theta_{4,j}\, RETURN_{t-j} + \lambda_{4,j}\, BRP_{t-j} + \alpha_4 + \varepsilon_{4,t} \quad (7e)$$

$$RETURN_t = \beta_{5,j}\, SPREAD_{t-j} + \eta_{5,j}\, SR_{t-j} + \kappa_{5,j}\, IR_{t-j} + \delta_{5,j}\, OUTPUT_{t-j} + \theta_{5,j}\, RETURN_{t-j} + \lambda_{5,j}\, BRP_{t-j} + \alpha_5 + \varepsilon_{5,t} \quad (7f)$$

$$BRP_t = \beta_{6,j}\, SPREAD_{t-j} + \eta_{6,j}\, SR_{t-j} + \kappa_{6,j}\, IR_{t-j} + \delta_{6,j}\, OUTPUT_{t-j} + \theta_{6,j}\, RETURN_{t-j} + \lambda_{6,j}\, BRP_{t-j} + \alpha_6 + \varepsilon_{6,t} \quad (7g)$$

where $SPREAD_t$ and $OUTPUT_t$ are as previously, while SR_t is short-term interest rate, IR_t the inflation rate, $RETURN_t$ the equity return, BRP_t the bond risk premium. β , η , κ , δ , θ , λ are the parameters of the six lagged endogenous variables.

For the estimation of VAR2 model we take into account many other factors affecting the financial and economic system, not only the slope of the yield curve and the GDP annual growth rate.

First of all, Fisher condition also implies that the market risk premium and the innovation in the inflation rate cause changes in the spread between the long-term and short-term interest rates. For this reason we consider the annual growth rate of Dow Jones Euro Stoxx 50 Price Index; this is determined as:

$$RETURN_t = [\Delta_{t\text{-}e}\, DOW50_t = \log(DOW50_t) - \log(DOW50_{t-4})]$$

while the risk premium of the Bond Market is identified empirically by *VOLATILITY* variable[33]. We assume as a proxy of the inflation innovation in the equations (7a) – (7f) the difference between HICIP and an annual rate of 2 per cent, the upper target which European Central Bank is committed to keep in the medium-term.

[32] Ross, 1976.

[33] These two variables are respectively the equity and the bond components of the Market Risk Premium, mrp_t (*see* Equation (4).

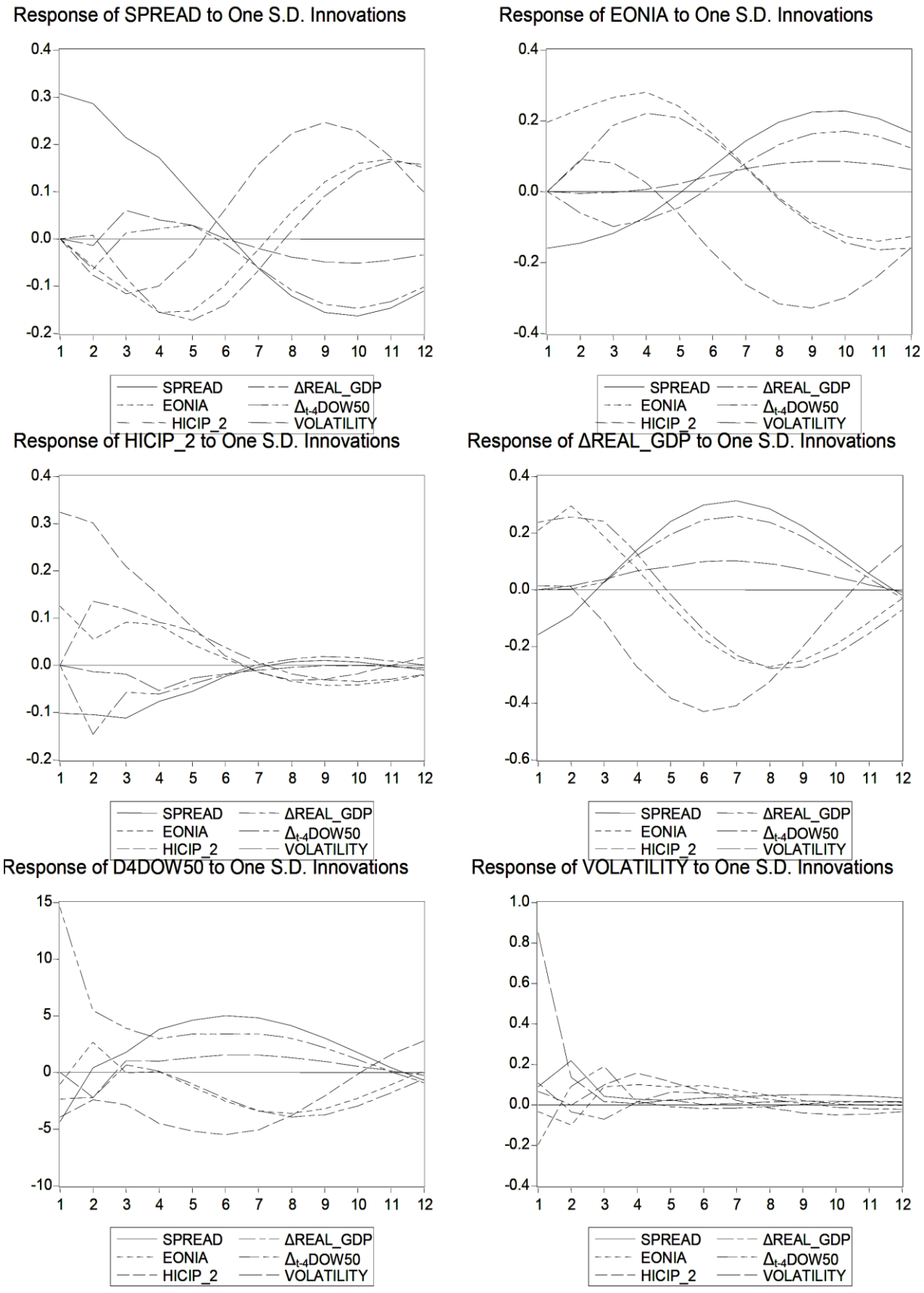


Figure 8. Impulse response functions for GDP in VAR2 Model

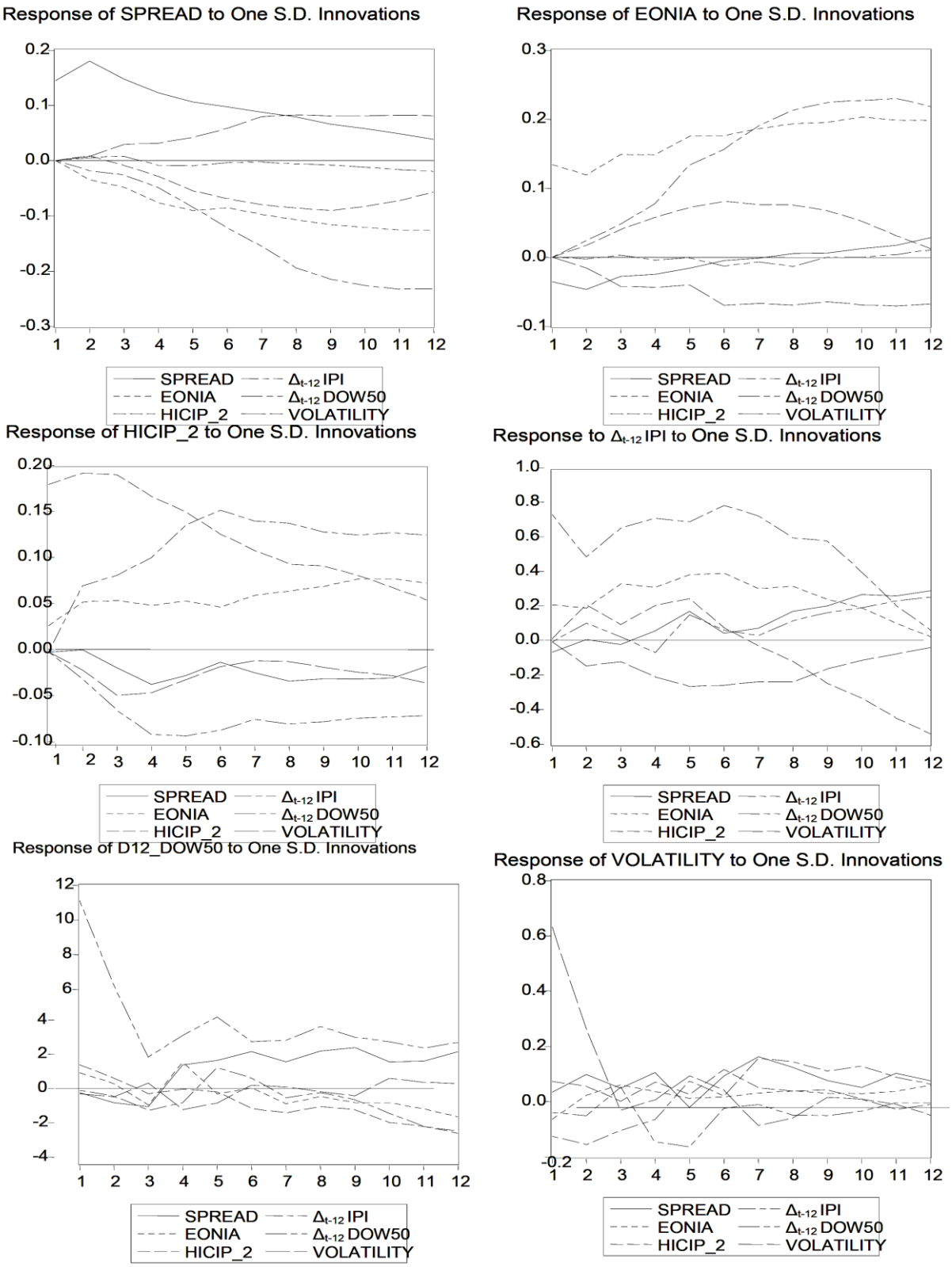


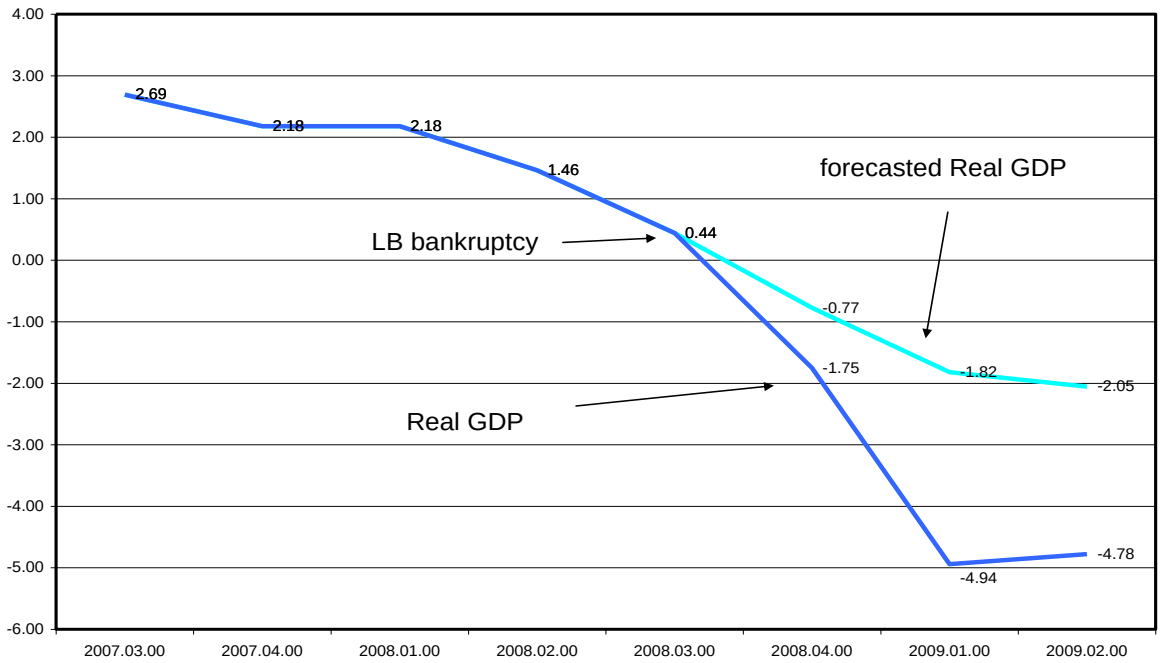
Figure 9. Impulse response functions for IPI in VAR2 Model

The statistics on the estimated coefficients of the VAR2 model for the $\Delta REAL\_GDP_t$ quarterly series are reported in Appendix (*see* the Table A.V)[34]. In particular, it can see that the coefficients of the equation (7d) are statistical significant and have predicted sign. The estimation of the coefficients of equations (7a) – (7f) on monthly $\Delta_{t-12}IPI_t$ series are less performing than the coefficients of the quarterly series. Both the six lag VAR estimations of the quarterly GDP series and of the monthly IPI series are convergent (*see* Appendix, Table A.VI)[35]. The impulse response functions of both the models are plotted in Figures 8 and 9, respectively, and confirm the previous conclusions. This enable us to present in Figure 10 the same out-of-sample exercises in a dynamic context for $\Delta REAL\_GDP$ (for period 2008:4-2009:2) and for $\Delta_{t-12}IPI_t$ (period 2009:1-2009:7). Both the forecasts provide results more performing than the previous exercise.

8. Concluding remarks

The paper aims to test the predictive power of the yield spreads in order to forecast the future growth of the real activities in the European Union in the 1995-2008 period. With this regard we present a yield curve model more explicitly founded than one of the typical approach. This model provides a contribution of efficiency in the estimates and it allows an further in-depth analysis about the impact on the output growth of the monetary and the financial dynamics.

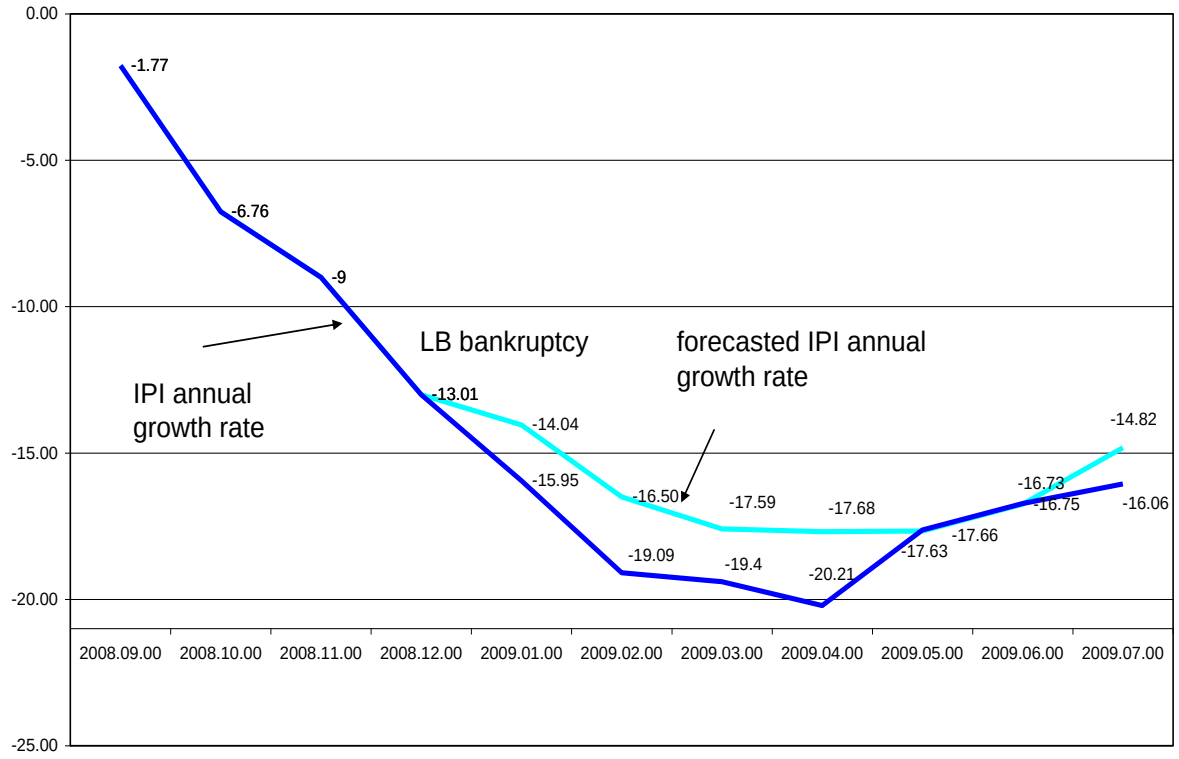
We produce the VAR estimations and the out-of-sample forecasts both for the Gross Domestic Product (GDP) quarterly series and for Industrial Production Index (IPI) monthly series of the EU (at 16 countries). The estimates confirm the robustness of the positive relationship between the monthly changes in the slope of the yields curve and the GDP (or IPI) growth rate on the same quarter (month) of the previous year. In particular the impulse response function indicates that an innovation in the change of the spread between the long-term and the short-term interest rates is persistent on the IPI growth rate from the 8th month and on the GDP growth rate from the 3th quarter. The quarterly estimates are significant while the monthly estimates show standard errors larger. Moreover, from the analysis it is possible verify that the IPI estimates and forecasts perform better than the GDP estimates and forecasts and that our model version performs weakly better than one of the standard approach. The monthly frequency of the IPI series seems to catch up the signals of the changes in the business cycle better than quarterly frequency of the GDP series.



10.1. Quarterly GDP Series

[34] In the equations [7.a]-[7.f] we use $EONIA_t$ variable as a proxy of the short-term rate. This solution is consistent with an econometric estimation of the parameters of a risk adjusted Talyor Rule.

[35] However the standard errors of each coefficient of the equations (5a) – (5b) on monthly series are larger than the quarterly estimated ones.



10.2. Monthly IPI Series

Figure 10. Out-of-sample forecast according to VAR2 Model

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APPENDIX

Table A.I. Correlation and statistics of IPI_t and GDP_t in logs (Euro Area)

Correlation		
	LIPI	LGDP
LIPI	1	0.8892
LGDP	0.8892	1
Statistics		
	LIPI	LGDP
Mean	4.567787	4.628017
Median	4.570423	4.636572
Maximum	4.700208	4.750741
Minimum	4.425445	4.475972
Std. Dev.	0.072808	0.080089
Skewness	-0.070806	-0.288259
Kurtosis	2.348496	2.034569
Jarque-Bera	1.000149	2.844967
Probability	0.606485	0.241114
Observations	54	54

Table A.II. Correlation and statistics of $\Delta_{t-12} IPI_t$ and Δ *REAL_GDP* (Euro Area)

Correlation		
	Δ_{t-12} IPI	ΔREAL_GDP
Δ_{t-12} IPI	0.959723	1
ΔREAL_GDP	1	0.959723
Statistics		
	Δ_{t-12} IPI	ΔREAL_GDP
Mean	1.006296	1.860185
Median	1.835	2.025
Maximum	5.92	4.59
Minimum	-19.4	-4.94
Std. Dev.	4.850362	1.741143
Skewness	-2.67573	-2.11124
Kurtosis	10.94694	9.278514
Jarque-Bera	206.532	128.8104
Probability	0	0
Observations	54	54

Table A.III. Estimated VAR1 model (5a) – (5b), GDP quarterly series (Euro Area)

Sample(adjusted): 1996:3 2008:4 **Included observations: 50 after adjusting endpoints** **Standard errors & t-statistics in parentheses**	**SPREAD**	**ΔREAL_GDP**
SPREAD(-1)	0.849458	0.533289
	(0.14985)	(0.17471)
	(5.66889)	(3.05247)
SPREAD(-2)	-0.137119	-0.224990
	(0.15548)	(0.18127)
	(-0.88192)	(-1.24115)
ΔREAL_GDP(-1)	-0.026141	1.418446
	(0.13497)	(0.15736)
	(-0.19368)	(9.01407)
C	0.752772	-0.465340
	(0.20803)	(0.24254)
	(3.61859)	(-1.91857)
R-squared	0.803460	0.872148
Adj. R-squared	0.785990	0.860783
Sum sq. resids	6.173742	8.392353
S.E. equation	0.370397	0.431853
Log likelihood	-18.65398	-26.32937
Akaike AIC	-18.45398	-26.12937
Schwarz SC	-18.26278	-25.93817
Mean dependent	1.112000	2.149200
S.D. dependent	0.800666	1.157416
Determinant Residual Covariance		0.019376
Log Likelihood		-43.30065
Akaike Information Criteria		-42.90065
Schwarz Criteria		-42.51825

TABLE A.IV. Estimated VAR1 model (5a) – (5b), IPI monthly series (Euro Area)

Sample(adjusted): 1995:07 2008:12 **Included observations: 162 after adjusting endpoints** **Standard errors & t-statistics in parentheses**	**SPREAD**	**Δ_{t-12} IPI**
SPREAD(-1)	1.279885	0.031590
	(0.08166)	(0.48179)
	(15.6726)	(0.06557)
SPREAD(-2)	-0.512008	0.255649
	(0.13231)	(0.78058)
	(-3.86981)	(0.32751)
SPREAD(-3)	0.204487	0.800375
	(0.13843)	(0.81670)
	(1.47718)	(0.98001)
SPREAD(-4)	-0.014183	-0.422760
	(0.13231)	(0.78057)
	(-0.10720)	(-0.54161)
SPREAD(-5)	0.002319	-1.265008
	(0.12503)	(0.73764)
	(0.01855)	(-1.71493)
SPREAD(-6)	0.007851	0.958435
	(0.07989)	(0.47132)
	(0.09828)	(2.03349)
Δ_{t-12} IPI(-1)	-0.032055	0.747547
	(0.01411)	(0.08327)
	(-2.27099)	(8.97703)
Δ_{t-12} IPI(-2)	0.013275	0.439016
	(0.01766)	(0.10421)
	(0.75152)	(4.21282)
Δ_{t-12} IPI(-3)	-0.015684	0.166935
	(0.01816)	(0.10712)
	(-0.86376)	(1.55834)
Δ_{t-12} IPI(-4)	-0.002114	-0.241149
	(0.01867)	(0.11012)

Sample(adjusted): 1995:07 2008:12 Included observations: 162 after adjusting endpoints Standard errors & t-statistics in parentheses	SPREAD	Δ_{t-12} IPI
	(-0.11327)	(-2.18987)
	-0.002392	-0.029239
Δ_{t-12} IPI(-5)	(0.01782)	(0.10515)
	(-0.13421)	(-0.27807)
	0.013494	-0.089717
Δ_{t-12} IPI(-6)	(0.01532)	(0.09039)
	(0.88078)	(-0.99260)
	0.079732	-0.508507
C	(0.03851)	(0.22720)
	(2.07036)	(-2.23810)
R-squared	0.959797	0.886378
Adj. R-squared	0.956559	0.877228
Sum sq. resids	4.119063	143.3695
S.E. equation	0.166267	0.980924
Log likelihood	67.56159	-219.9722
Akaike AIC	67.72209	-219.8117
Schwarz SC	67.96986	-219.5639
Mean dependent	1.193827	1.866975
S.D. dependent	0.797729	2.799530
Determinant Residual Covariance		0.022502
Log Likelihood		-152.4098

Table A.V. Estimated VAR2 Model (7a) – (7f), GDP quarterly series (Euro Area)

Sample(adjusted): 1996:3 2008:4 Included observations: 50 after adjusting endpoints Standard errors & t-statistics in parentheses	SPREAD	EONIA	HICIP-2	ΔREAL_GDP	ΔT-4DOW50	VOLATILITY
	0.701975	0.060995	-0.384416	0.455656	14.91301	0.561117
SPREAD(-1)	(0.18784)	(0.15435)	(0.22083)	(0.21660)	(9.70097)	(0.54088)
	(3.73701)	(0.39516)	(-1.74075)	(2.10363)	(1.53727)	(1.03742)

Sample(adjusted): 1996:3 2008:4 Included observations: 50 after adjusting endpoints Standard errors & t-statistics in parentheses	SPREAD	EONIA	HICIP-2	ΔREAL_GDP	ΔT-4DOW50	VOLATILITY
	-0.072576	0.089384	0.355707	-0.277195	-4.211229	0.101625
SPREAD(-2)	(0.18504)	(0.15205)	(0.21754)	(0.21338)	(9.55635)	(0.53281)
	(-0.39221)	(0.58785)	(1.63512)	(-1.29910)	(-0.44067)	(0.19073)
	-0.135869	0.688287	-0.787399	0.380967	21.62361	-0.341843
EONIA(-1)	(0.33964)	(0.27909)	(0.39929)	(0.39164)	(17.5404)	(0.97796)
	(-0.40004)	(2.46619)	(-1.97200)	(0.97274)	(1.23279)	(-0.34955)
	0.129769	0.131851	0.716479	-0.493110	-21.57456	0.703513
EONIA(-2)	(0.32143)	(0.26413)	(0.37788)	(0.37065)	(16.6000)	(0.92553)
	(0.40372)	(0.49920)	(1.89604)	(1.89604)	(-1.29968)	(0.76012)
	-0.290112	0.212089	0.787424	-0.016227	-2.531786	0.072370
HICIP-2(-1)	(0.15668)	(0.12875)	(0.18420)	(0.18067)	(8.09150)	(0.45114)
	(-1.85163)	(1.64735)	(4.27494)	(-0.08981)	(-0.31289)	(0.16041)
	0.114381	-0.165188	-0.003256	-0.292934	-3.109295	0.657223
HICIP-2(-2)	(0.16904)	(0.13890)	(0.19873)	(0.19492)	(8.72989)	(0.48673)
	(0.67665)	(-1.18923)	(-0.01638)	(-1.50283)	(-0.35617)	(1.35027)
	-0.004634	0.321066	0.474741	1.074805	-4.755787	-0.138424
ΔREAL_GDP(-1)	(0.17406)	(0.14303)	(0.20463)	(0.20071)	(8.98912)	(0.50119)
	(-0.02662)	(2.24478)	(2.32001)	(5.35501)	(-0.52906)	(-0.27619)
	-0.196860	0.029840	-0.218170	-0.252922	5.726020	0.116864
ΔREAL_GDP(-2)	(0.15613)	(0.12830)	(0.18355)	(0.18004)	(8.06335)	(0.44957)
	(-1.26084)	(0.23258)	(-1.18858)	(-1.40481)	(0.71013)	(0.25995)
	-0.004671	-0.004225	-0.010230	0.000357	0.340670	0.008446
ΔT-4DOW50(-1)	(0.00321)	(0.00264)	(0.00378)	(0.00370)	(0.16589)	(0.00925)
	(-1.45416)	(-1.60049)	(-2.70886)	(0.09640)	(2.05358)	(0.91315)
	0.003273	-0.000120	0.002153	0.005269	0.326839	0.011042
ΔT-4DOW50(-2)	(0.00358)	(0.00294)	(0.00421)	(0.00413)	(0.18478)	(0.01030)
	(0.91488)	(-0.04097)	(0.51192)	(1.27714)	(1.76883)	(1.07183)
	-0.017171	-0.006164	-0.015911	0.015668	-2.614500	0.160719
VOLATILITY(-1)	(0.05739)	(0.04715)	(0.06746)	(0.06617)	(2.96360)	(0.16524)
	(-0.29922)	(-0.13072)	(-0.23584)	(0.23678)	(-0.88221)	(0.97267)
	0.067340	-0.008263	-0.052910	0.034281	2.919187	0.026158
VOLATILITY(-2)	(0.05207)	(0.04278)	(0.06121)	(0.06004)	(2.68884)	(0.14992)
	(1.29338)	(-0.19313)	(-0.86442)	(0.57100)	(1.08567)	(0.17449)
	0.617778	-0.289836	0.121900	0.211376	-13.39809	2.074933
C	(0.37556)	(0.30860)	(0.44151)	(0.43306)	(19.3952)	(1.08138)

Sample(adjusted): 1996:3 2008:4 Included observations: 50 after adjusting endpoints Standard errors & t-statistics in parentheses						
	SPREAD	EONIA	HICIP-2	ΔREAL_GDP	ΔT-4DOW50	VOLATILITY
	(1.64496)	(-0.93919)	(0.27609)	(0.48810)	(-0.69079)	(1.91879)
R-squared	0.849467	0.912429	0.689162	0.904215	0.609881	0.385947
Adj. R-squared	0.800645	0.884027	0.588350	0.873150	0.483356	0.186795
Sum sq. resids	4.728583	3.192812	6.535302	6.287402	12611.49	39.20420
S.E. equation	0.357491	0.293755	0.420273	0.412225	18.46215	1.029356
Log likelihood	-11.98699	-2.168897	-20.07681	-19.11005	-209.2054	-64.86595
Akaike AIC	-11.46699	-1.648897	-19.55681	-18.59005	-208.6854	-64.34595
Schwarz SC	-10.96987	-1.151771	-19.05969	-18.09292	-208.1883	-63.84882
Mean dependent	1.112000	3.283800	0.048000	2.149200	9.049800	5.224200
S.D. dependent	0.800666	0.862597	0.655040	1.157416	25.68543	1.141473
Determinant Residual Covariance		0.003289				
Log Likelihood		-282.7524				
Akaike Information Criteria		-279.6324				

Table A.VI. Estimated VAR2 Model (7a) – (7f), IPI monthly series (Euro Area)

Sample(adjusted): 1995:07 2008:12 Included observations: 162 after adjusting endpoints Standard errors & t-statistics in parentheses						
	SPREAD	EONIA	HICIP-2	ΔT-12 IPI	ΔT-12 OW50	VOLATILITY
	1.179193	-0.104556	0.074214	0.424248	-3.875682	0.667265
SPREAD(-1)	(0.09138)	(0.08752)	(0.11623)	(0.48991)	(7.14184)	(0.41299)
	(12.9041)	(-1.19471)	(0.63853)	(0.86596)	(-0.54267)	(1.61570)
	-0.484393	0.280744	-0.238985	-0.137729	0.206907	-0.535581
SPREAD(-2)	(0.14034)	(0.13440)	(0.17849)	(0.75237)	(10.9678)	(0.63423)
	(-3.45167)	(2.08888)	(-1.33893)	(-0.18306)	(0.01886)	(-0.84445)
	0.221756	-0.155683	0.072234	0.684432	20.50495	0.867317
SPREAD(-3)	(0.14964)	(0.14331)	(0.19032)	(0.80223)	(11.6947)	(0.67627)
	(1.48197)	(-1.08636)	(0.37954)	(0.85316)	(1.75335)	(1.28251)
	-0.073876	0.112746	0.141840	0.002937	-12.90291	-1.348473
SPREAD(-4)	(0.14698)	(0.14077)	(0.18695)	(0.78801)	(11.4874)	(0.66428)
	(-0.50261)	(0.80094)	(0.75873)	(0.00373)	(-1.12322)	(-2.02998)
	0.103461	-0.071072	-0.073364	-1.399680	9.210657	1.477910
SPREAD(-5)	(0.13838)	(0.13252)	(0.17600)	(0.74186)	(10.8147)	(0.62538)
	(0.74768)	(-0.53630)	(-0.41685)	(-1.88671)	(0.85168)	(2.36323)

Sample(adjusted): 1995:07 2008:12 Included observations: 162 after adjusting endpoints Standard errors & t-statistics in parentheses	SPREAD	EONIA	HICIP-2	ΔT-12 IPI	ΔT-12 OW50	VOLATILITY
	-0.048221	-0.015801	-0.003472	1.068051	-7.598777	-0.282876
SPREAD(-6)	(0.09150)	(0.08763)	(0.11637)	(0.49054)	(7.15089)	(0.41351)
	(-0.52702)	(-0.18032)	(-0.02983)	(2.17732)	(-1.06263)	(-0.68408)
	-0.229776	0.812019	0.033634	0.035739	-0.302426	0.586698
EONIA(-1)	(0.10108)	(0.09681)	(0.12857)	(0.54193)	(7.90016)	(0.45684)
	(-2.27312)	(8.38790)	(0.26161)	(0.06595)	(-0.03828)	(1.28425)
	0.160538	0.266502	-0.003281	1.060061	-4.054411	0.056695
EONIA(-2)	(0.12754)	(0.12214)	(0.16221)	(0.68374)	(9.96742)	(0.57638)
	(1.25877)	(2.18193)	(-0.02023)	(1.55038)	(-0.40677)	(0.09836)
	-0.093475	-0.088399	-0.163539	-0.720338	16.36230	-0.115914
EONIA(-3)	(0.12835)	(0.12292)	(0.16325)	(0.68812)	(10.0312)	(0.58007)
	(-0.72828)	(-0.71914)	(-1.00178)	(-1.04682)	(1.63113)	(-0.19983)
	0.100638	0.062646	0.121083	0.129889	-17.55057	-0.046091
EONIA(-4)	(0.12879)	(0.12335)	(0.16381)	(0.69049)	(10.0658)	(0.58207)
	(0.78139)	(0.50789)	(0.73917)	(0.18811)	(-1.74358)	(-0.07919)
	0.147343	-0.066288	-0.082672	0.274951	10.66369	-0.614290
EONIA(-5)	(0.12654)	(0.12118)	(0.16094)	(0.67839)	(9.88944)	(0.57187)
	(1.16443)	(-0.54700)	(-0.51368)	(0.40530)	(1.07829)	(-1.07417)
	-0.096835	-0.015465	0.089401	-0.694428	-5.139587	0.364739
EONIA(-6)	(0.09981)	(0.09558)	(0.12694)	(0.53508)	(7.80027)	(0.45106)
	(-0.97023)	(-0.16179)	(0.70427)	(-1.29780)	(-0.65890)	(0.80862)
	0.038183	0.105770	1.095902	1.118003	-0.006941	0.179253
HICIP-2(-1)	(0.07039)	(0.06741)	(0.08953)	(0.37739)	(5.50145)	(0.31813)
	(0.54244)	(1.56894)	(12.2406)	(2.96248)	(-0.00126)	(0.56346)
	-0.109313	0.016317	-0.173724	-1.391301	-1.380248	-0.204543
HICIP-2(-2)	(0.10544)	(0.10098)	(0.13411)	(0.56531)	(8.24092)	(0.47654)
	(-1.03669)	(0.16158)	(-1.29537)	(-2.46113)	(-0.16749)	(-0.42922)
	0.040508	-0.047448	-0.006626	0.717379	3.229292	0.592113
HICIP-2(-3)	(0.10665)	(0.10214)	(0.13565)	(0.57179)	(8.33536)	(0.48201)
	(0.37981)	(-0.46453)	(-0.04885)	(1.25462)	(0.38742)	(1.22844)
	-0.044239	-0.018224	-0.055013	-0.158021	-6.100906	-0.661652
HICIP-2(-4)	(0.10891)	(0.10430)	(0.13852)	(0.58389)	(8.51177)	(0.49221)
	(-0.40620)	(-0.17472)	(-0.39715)	(-0.27064)	(-0.71676)	(-1.34426)
	0.046182	-0.029857	-0.067920	-0.956219	-3.421459	0.702882
HICIP-2(-5)	(0.10747)	(0.10292)	(0.13669)	(0.57616)	(8.39909)	(0.48569)

Sample(adjusted): 1995:07 2008:12 Included observations: 162 after adjusting endpoints Standard errors & t-statistics in parentheses	SPREAD	EONIA	HICIP-2	ΔT-12 IPI	ΔT-12 OW50	VOLATILITY
	(0.42973)	(-0.29010)	(-0.49691)	(-1.65964)	(-0.40736)	(1.44718)
	-0.048469	0.011581	0.128847	0.248709	4.815903	-0.581574
HICIP-2(-6)	(0.07688)	(0.07363)	(0.09779)	(0.41219)	(6.00878)	(0.34747)
	(-0.63042)	(0.15728)	(1.31764)	(0.60339)	(0.80148)	(-1.67375)
	-0.023027	0.028591	0.091927	0.627656	-0.400003	-0.139009
ΔT-12 IPI(-1)	(0.01770)	(0.01695)	(0.02251)	(0.09490)	(1.38337)	(0.08000)
	(-1.30093)	(1.68664)	(4.08330)	(6.61415)	(-0.28915)	(-1.73771)
	0.019388	-0.003289	-0.062226	0.347335	-0.813592	-0.024436
ΔT-12 IPI(-2)	(0.02104)	(0.02015)	(0.02676)	(0.11279)	(1.64427)	(0.09508)
	(0.92155)	(-0.16322)	(-2.32544)	(3.07940)	(-0.49481)	(-0.25700)
	-0.009786	0.003532	-0.021646	0.136046	0.748997	0.055823
ΔT-12 IPI(-3)	(0.02064)	(0.01976)	(0.02625)	(0.11064)	(1.61288)	(0.09327)
	(-0.47422)	(0.17868)	(-0.82469)	(1.22963)	(0.46439)	(0.59853)
	-0.013109	0.039861	0.033662	-0.189721	2.533220	0.189505
ΔT-12 IPI(-4)	(0.02067)	(0.01980)	(0.02629)	(0.11084)	(1.61575)	(0.09343)
	(-0.63411)	(2.01324)	(1.28020)	(-1.71172)	(1.56783)	(2.02824)
	-0.002376	-0.021012	0.022870	0.036981	-0.382505	-0.111548
ΔT-12 IPI(-5)	(0.02055)	(0.01968)	(0.02614)	(0.11019)	(1.60638)	(0.09289)
	(-0.11562)	(-1.06742)	(0.87482)	(0.33560)	(-0.23812)	(-1.20085)
	-0.000466	-0.011410	-0.035457	-0.042150	-1.022229	0.140851
ΔT-12 IPI(-6)	(0.01721)	(0.01648)	(0.02189)	(0.09226)	(1.34496)	(0.07777)
	(-0.02706)	(-0.69233)	(-1.61994)	(-0.45686)	(-0.76005)	(1.81102)
	0.000513	-0.000330	-0.002793	0.009019	0.562868	-0.003094
ΔT-12 DOW50(-1)	(0.00116)	(0.00111)	(0.00147)	(0.00620)	(0.09041)	(0.00523)
	(0.44373)	(-0.29753)	(-1.89805)	(1.45427)	(6.22593)	(-0.59174)
	0.000279	0.000489	-0.002324	-0.006590	-0.119950	0.009223
ΔT-12 DOW50(-2)	(0.00135)	(0.00129)	(0.00172)	(0.00725)	(0.10567)	(0.00611)
	(0.20598)	(0.37775)	(-1.35109)	(-0.90908)	(-1.13509)	(1.50932)
	-0.001835	-0.000113	0.000152	-0.005099	0.267674	-0.019625
ΔT-12 DOW50(-3)	(0.00135)	(0.00129)	(0.00172)	(0.00725)	(0.10567)	(0.00611)
	(-1.35714)	(-0.08724)	(0.08822)	(-0.70339)	(2.53316)	(-3.21174)
	0.000786	0.000832	0.001697	0.015786	0.067201	0.004120
ΔT-12 DOW50(-4)	(0.00137)	(0.00131)	(0.00174)	(0.00733)	(0.10690)	(0.00618)
	(0.57454)	(0.63479)	(0.97545)	(2.15271)	(0.62865)	(0.66650)
ΔT-12 DOW50(-5)	0.000592	-0.002146	-0.002008	-0.008623	-0.031764	0.001913

Sample(adjusted): 1995:07 2008:12 Included observations: 162 after adjusting endpoints Standard errors & t-statistics in parentheses	SPREAD	EONIA	HICIP-2	ΔT-12 IPI	ΔT-12 OW50	VOLATILITY
	(0.00138)	(0.00132)	(0.00176)	(0.00742)	(0.10812)	(0.00625)
	(0.42824)	(-1.61983)	(-1.14130)	(-1.16262)	(-0.29378)	(0.30592)
	-0.001063	0.001345	0.001909	-0.001778	0.088974	0.004472
ΔT-12 DOW50(-6)	(0.00121)	(0.00116)	(0.00154)	(0.00648)	(0.09443)	(0.00546)
	(-0.87998)	(1.16250)	(1.24248)	(-0.27455)	(0.94224)	(0.81902)
	0.012065	-0.023985	-0.031454	-0.222853	-0.298344	0.419850
VOLATILITY(-1)	(0.01927)	(0.01845)	(0.02451)	(0.10330)	(1.50584)	(0.08708)
	(0.62619)	(-1.29983)	(-1.28354)	(-2.15739)	(-0.19812)	(4.82155)
	0.017762	-0.025767	-0.007715	0.082841	1.223028	-0.247311
VOLATILITY(-2)	(0.01859)	(0.01780)	(0.02364)	(0.09966)	(1.45278)	(0.08401)
	(0.95551)	(-1.44741)	(-0.32634)	(0.83126)	(0.84185)	(-2.94386)
	-0.017932	0.015706	0.014739	-0.136669	-2.826182	0.132338
VOLATILITY(-3)	(0.01903	(0.01822)	(0.02420)	(0.10200)	(1.48697)	(0.08599)
	(-0.94247)	(0.86196)	(0.60906)	(-1.33985)	(-1.90063)	(1.53905)
	0.017628	0.010321	0.025677	-0.003655	1.373316	0.057664
VOLATILITY(-4)	(0.01937)	(0.01855)	(0.02463	(0.10383)	(1.51365)	(0.08753)
	(0.91021)	(0.55642)	(1.04238)	(-0.03520)	(0.90729)	(0.65879)
	0.002462	-0.022383	0.019163	-0.029027	0.186125	0.015186
VOLATILITY(-5)	(0.01888)	(0.01808)	(0.02401)	(0.10120)	(1.47525)	(0.08531)
	(0.13040)	(-1.23817)	(0.79819)	(-0.28683)	(0.12617)	(0.17802)
	0.010620	0.016710	0.005797	-0.020280	-0.274649	-0.165381
VOLATILITY(-6)	(0.01777)	(0.01702)	(0.02261)	(0.09529)	(1.38905)	(0.08032)
	(0.59755)	(0.98169)	(0.25646)	(-0.21283)	(-0.19772)	(-2.05892)
	0.000234	0.101079	-0.103911	0.714884	-3.260020	2.002962
C	(0.10671)	(0.10220)	(0.13573)	(0.57211)	(8.34010	(0.48228)
	(0.00219)	(0.98904)	(-0.76559)	(1.24955)	(-0.39089)	(4.15311)
R-squared	0.966913	0.981229	0.911034	0.922780	0.783600	0.632309
Adj. R-squared	0.957383	0.975822	0.885411	0.900541	0.721277	0.526414
Sum sq. resids	3.389994	3.109267	5.483891	97.43737	20706.38	69.24051
S.E. equation	0.164681	0.157715	0.209454	0.882892	12.87055	0.744261
Log likelihood	83.34018	90.34193	44.38027	-188.6887	-622.7667	-161.0172
Akaike AIC	83.79697	90.79872	44.83706	-188.2319	-622.3099	-160.5604
Schwarz SC	84.50216	91.50391	45.54225	-187.5267	-621.6047	-159.8552
Mean dependent	1.193827	3.469198	0.066667	1.866975	9.703765	5.200617

Sample(adjusted): 1995:07 2008:12 Included observations: 162 after adjusting endpoints Standard errors & t-statistics in parentheses						
	SPREAD	EONIA	HICIP-2	ΔT-12 IPI	ΔT-12 OW50	VOLATILITY
S.D. dependent	0.797729	1.014303	0.618755	2.799530	24.37872	1.081498
Determinant Residual Covariance		0.000338				
Log Likelihood		-731.7952				
Akaike Information Criteria		-729.0545				
Schwarz Criteria		-724.8233				

NEUROECONOMICS AND DECISION MAKING PROCESS

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Abstract

Neuroeconomics unified the once disparate fields of economics and psychology. The central thesis of the paper is that the development of behavioral economics in important respects parallels the development of cognitive science – Neuroeconomics has inspired more change within economics than within psychology because the most important findings in Neuroeconomics have posed more of a challenge to the standard economic perspective. The single most important source of inspiration for behavioral economists has been behavioral decision research, which can, in turn, be seen as an integration of ideas from cognitive science and economics. Neuroeconomics has primarily challenged the standard economic assumption that decision making is a unitary process – a simple matter of integrated and coherent utility maximization – suggesting instead that it is driven by the interaction between automatic and controlled processes. This paper reviews neuroeconomic research in areas of interest to both economists and psychologists: decision making under risk and uncertainty, intertemporal choice, and social decision making.

Keywords: neuroeconomics, behavioural economics, affect, behavioral welfare economics, decision making, caeteris paribus

JEL Classification: A12, D81

1. Introduction

In the last decades has been made Considerable progress, and increasingly, economists are taking up the challenge of attaching economic theory to psychological foundations. In the 1970s cognitive psychologists began studying judgment and economic decision making. They took maximization of utilities and logical rules of probability judgment as benchmarks and used conformity or deviation from these benchmarks as a way to theorize about cognitive mechanisms (much as optical illusions are used to understand perception). Important psychology of this sort was done Ward Edwards in the 1950s, and later by Amos Tversky, Daniel Kahneman, Baruch Fischhoff, Paul Slovic, and others. As more economists come to accept and incorporate findings from behavioral economics, the approach is likely to become such an integral part of the toolkit of economic analysis that we will no longer speak of a distinct 'behavioral economics.'

In its relatively short lifetime behavioral economists has influenced a wide range of subtopics of economics and allied fields, such as *behavioral law and economics* (Jolls, Sunstein, and Thaler 1998; Sunstein 2000) to *behavioral finance* (Shleifer, 2000; Bică and Constantinescu 2007), *behavioral development economics* (Mullainnathan, and Thaler 2000), *behavioral public finance* (McCaffery, and Slemrod 2006), *behavioral game theory* (Camerer (2003), and *behavioral macroeconomics* (Akerlof 2003). All of these are booming areas of research that not only extend the influence of the ideas coming out of behavioral economics, but also throw back insights and findings that enrich the foundation of the basic science core of the field.

Evaluating economic behavior without taking account of the findings of psychology is like dealing with quantitative relationships without using readily available techniques of mathematics. Nonetheless, since the beginning of the twentieth century, mainstream economics has done just that, limiting itself to the assumption of optimization or to others of an ad hoc basis that have struck individual economists as plausible for the time and circumstances. But investors often continue to hold onto stocks that have declined in value and have poorer prospects than before, compared to others.

In traditional economic thought, the analysis focuses on how to allocate resources efficiently. That is supposed to maximize welfare for consumers (or the potential of that), enabling consumers to do the best that is possible. Behavioral economics indicates that there are serious limits to that theory insofar as it describes how humans actually behave. Behavioral economics focuses more modestly on how to move economic behavior away from manifestly poor choices towards better ones – without venturing whether the result comes particularly close to any standard of optimization, which it contends, often is simply not ascertainable, in any event. It is concerned not only with what takes place when supply and demand are neatly in balance, but when, as is so often the case, market forces are in disequilibrium, as is common aftershocks to the system such as natural

catastrophes, outbreaks of war, unanticipated bankruptcies and other market failures often due to a lack of information or to an incorrect perception of it, and, of increasing importance, because of breakthrough technological innovations. Behavioral economics considers whether there are *regularities* in what have been termed *anomalies* – the inconsistencies of what happens in actual life with mainstream economic theory – whether what that theory indicates should happen if we succeed in doing the best possible, fails to occur on a rather predictable basis.

Most behavioral economics has been micro in focus, but some also deals with macroeconomic analysis, most notably with the micro foundations of macro analysis. To the extent that the findings of behavioral economics are incorporated into economic theory, the latter shifts from a purely deductive theory, as has been the case to date, to an increasingly inductive one, relying on empirical findings, much as biology does. The principal standard by which behavioral economics should be judged is whether the more complex approach predicts sufficiently better to justify its additional cost, or, in those cases in which the approach of behavioral economics is less complex, in which the lesser cost is great enough to warrant sacrifice of the benefits forgone by feasible optimization. The findings of behavioral economics appear to offer hope for improving our ability to deal more effectively than heretofore with such complex interdisciplinary matters as health, environmental safety, organizational behavior and national development.

2. Actual directions in behavioral economics

Behavioral economics has seen a remarkable expansion since its emergence as an independent subdicipline, and in light of this fact, it would be impossible to accurately describe current research in but a few paragraphs. Nevertheless, some of the few developments can be tied to the loosening of ties between behavioral economics and behavioral decision research and the importation of insights from other subfields of psychology. In this article we discuss two of them: the emergence of neuroeconomics and the increased interest in the role of affect in economic behavior. The other major new development that we describe in this article is the emergence of behavioral welfare economics, which attempts to draw normative conclusions on the basis of the research. A core question addressed by *Kahneman's Nobel Lecture* (2002), where he distinguishes (see Figure 1) two modes of thinking and deciding: what he calls *intuition* and *reasoning*. Kahneman notes that there is considerable agreement among psychologists on the characteristics that distinguish these two cognitive processes. Following Stanovich and West (2000), he calls them respectively System 1 and System 2.

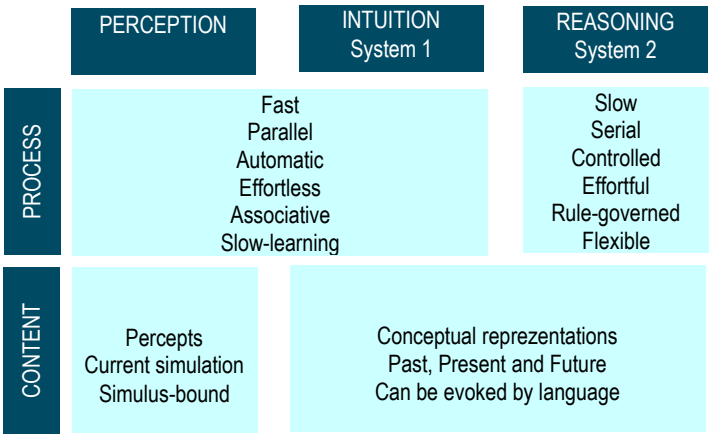

Figure 1. Kahneman's description of cognitive processes

Neuroeconomics involves using the emerging array of tools developed by neuroscientists to study the neural underpinnings of economic behavior. Neuroeconomics, a field initiated by the work of neurologists, explains the basis of at least some of the emotional and presumably all of the visceral factors in economic behavior. Eventually it may help explain all aspects of economic decision making, revealing how we are influenced by bio-regulatory signals to combine cognitive with affective and visceral processes.

Neuroeconomists have already conducted studies in which subjects' brains are scanned while they engage in mainstay behavioral economics tasks, such as the *ultimatum game* (Sanfey *et al.* 2003), *decision making under risk* (Tom *et al.* 2006) and *uncertainty* (Hsu *et al.* 2005) and *intertemporal choice* (McClure *et al.* 2004), as well as more traditional economic behaviors such as *deciding whether to purchase consumer goods*

(Knutson 2007). These studies have generally come to similar conclusions, namely that decision making can be understood, not as a matter of implementing existing preferences, but rather as the resolution of interaction, and often competition, between different specialized neural systems (Sanfey 2006). Neuroeconomics not only encompasses empirical work using neuroscience methods, but also involves importing insights from neuroscience to refine economic models of behavior. Again, perhaps the most important of these insights is that behavior, including economic behavior, results from the interaction of multiple interacting specialized neural systems. Thus, for example, Thaler and Shefrin (1981) proposed a multiple-self model in which a person's behavior is directly controlled by a series of myopic 'doers' who maximize short-run satisfaction, but the behavior of th doers is itself influenced by a farsighted 'planner' who maximizes the discounted sum of the doers' utilities (Fudenberg, and Levine 2004). Bernheim and Rangel (2004) built a dual-process model of addiction which assumes that the brain can operate in one of two modes, a 'cold mode' – the person makes sound, deliberative decisions with a broad, long-term perspective – or a 'hot mode' – the person's decision-making is influenced by emotions and motivational drives. Benhabib and Bisin (2002) assume that a person's behavior can be determined either by 'automatic processes' or by 'controlled processes'. They apply this framework to understanding saving behavior and describe how its predictions differ from those in saving-consumption models with hyperbolic discount.

Although neuroscience methods are ideas have up until now influenced economics in a fairly incremental fashion, it is possible that their influence will ultimately prove to be much more radical (Camerer, Lowenstein, and Prelec 2005). Incremental approaches take as their starting point orthodox decision theory and favour piece-meal, step-wise change (Camerer, and Lowenstein 2003). Many of the most important developments in behavioral economics – like prospect theory – were the results of an incremental approach. By contrast, radical approaches (Shafir, Simonson, and Tversky 1993) try to improve the predictive power and explanatory adequacy of current theory by starting from scratch. Though radical approaches have not yet scored any successes comparable to prospect theory, it is still too early to judge this research program. Neoclassical economics has dominated the economic scene for almost as long as classical economics dominated before it, so the time may be ripe for a new revolution. If so, behavioral economics, and perhaps its neuroeconomic variant, show promise of identifying the direction for such a transformation.

Affect**.** Like cognitive scientist, early behavioral economists tended to emphasize cognitive types of errors, such as judgmental biases, framing effects, hyperbolic time discounting and nonlinear probability weighting, as the main sources of suboptimaly in decision making. A number of new lines of research, however, have begun to draw attention to the important role of affect in judgement and choice (Loewenstein 1996; Loewenstein, and Lerner 2003; Loewenstein *et al.* 2001; Mellers, Schwartz, Ho, and Ritov 1997; Rick, and Loewenstein 2007). The new research is drawing new attention to, and providing new evidence for, the idea that affect can distort decision making – that people can behave self-destructively in the 'heat of the moment'. Indeed, the new research is also pointing to the conclusion that many biases that had earlier been viewed in cognitive terms, such as nonlinear probability weighting (Loewenstein *et al.* 2001; Rottenstreich, and Hsee 2001) or hyperbolic time discounting (Loewenstein 1996; McClure *et al.* 2004) may in fact reflect the influence of affective factors. Parallel developments have been occurring in psychology, with a large amount of work in the field of social psychology focusing on the role of emotion in behaviour (Wilson, Lindsey, and Schooler 2000). And similar developments are accruing in decision research and neuroscience, with the latter showing signs of splitting into two subfields, one focusing on 'cognitive neuroscience' and the other on 'affective neuroscience' (LeDoux 1996).

In an indication that behavioral economics is responsive to new developments in the fields it draws on, in both empirical work and in theory-development, a number of behavioral economists have been incorporating insights from the new research on affect into their work (Rick, and Loewenstein 2007). Whether it is for the purpose of understanding problems of self-control, destructive conflict, market gyrations or gambling behavior, there is a growing recognition among economists that large domains of economic behavior will remain outside of the range of economic models unless economists begin to get a grip on the role of emotions in behavior.

Behavioral welfare economics. Although behavioral economics began as a purely descriptive enterprise, its practitioners have always been interested in how people's decision making can improved (Fischhoff 1988). Thus, it should not be surprising that some behavioral economists have drawn normative conclusions and offered policy prescriptions. Many of the proposed interventions are motivate by the belief that people often fail to act rationally, and are intended to help people make better choices – that is, choices that better serve chooser's interests – than they would in the absence of the interventions. In the last few years, a whole program of what could be called 'light paternalism' has gained prominence. The hope underlying this program is that it may be possible to help people make better choice – choices that better serve to their own interests – without significantly

restricting their autonomy or freedom of choice (Camerer *et al.* 2003). Sunstein and Thaler (2003) note that in many situations it is possible to help people make better decisions without restricting their autonomy. They illustrate the point with the hypothetical case of a company cafeteria manager who has the option of placing healthy items before unhealthy items in the food lie or doing the reverse, but does not have the option of doing neither. They argue that in such situations it make perfect sense for managers to adopt that they believe will help employees make better choices – namely placing the healthy food ahead of the unhealthy food. Similarly, Camerer *at al*., argue that it is often possible to craft policies that will benefit people if they do mistakes, but will not hurt people who are fully rational. Although the cognitive revolution, in effect, provided the impetus that sent behavioral economics 'into orbit', the field has maintained its vibrancy by drawing on other sources of inspiration, notably, input from research on neuroscience and affect. It has also increased its broader relevance by pioneering new approaches to public policy, most notably those based on different forms of light paternalism. Finally, in a pattern much like that of rational choice theory, but compressed into a much shorter period, behavioral economics has begun to export its insights to allied fields which have not only increased the range of applications but also thrown insights and research findings back to the core of the field.

3. Neuroeconomics and Decision Making Process

3.1. Homo Neuroeconomicus and decision making process

Neuroeconomics explains decision-making as the product of brain processes involved in the representation, anticipation, valuation and selection of choice opportunities. It breaks down the whole process of decision into mechanistic components: certain brain areas may represent the value of the outcome of an action before decision, other ones may represent the value of the action *per se*, and yet other ones may represent these values at the time of the decision. Although such dispersion of data may appear confusing, economic psychology provides us with a useful framework for understanding the mechanics of rationality at the neural level in a coherent manner. Kahneman and his collaborators suggest that the concept of utility should be divided in subspecies. While *decision* utility is important (the expected gains and losses, or cost and benefits), decision-makers also value *experienced* utility (the hedonic, pleasant or unpleasant affect), *predicted* utility (the anticipation of experienced utility) and *remembered* utility (how experienced utility is remembered after the decision, e.g. as regretting or rejoicing). Neuroeconomics should identify neural structures and processes associated with these variables or, if necessary, suggest another typology.

The main contribution of neuroeconomics to decision theory so far is a new picture of decision-makers as adaptive and affective agents. *Homo Neuroeconomicus* is a fast decider that relies less on logic and more on a complex collection of flexible neural circuits associated with affective responses. Everyday utility maximization is more about feelings and less about the objective outcome of a decision: we use emotions to anticipate emotions in order to control our behavior toward a maximization of positive emotions and a minimization of negative ones. The neuroeconomic picture of individual rationality is thus affective through and through.

It is hard to accept that people make decisions in a laboratory setting similarly to how they would make those same decisions in the real world. Harrison points out that the representation of a task in an artificial lab environment is different from a real one. Yet research shows that the representation of something fake is very real in the mind of an individual.

3.2. Utility computation in decision making

Utility is a key concept in economics. Economists assume that people assign a utility for each option and then make choices by comparing these utilities. However, since these options might involve a wide range of rewarding stimuli, how our brain computes the utility for these diverse stimuli remains unknown. Recent *functional magnetic resonance imaging* (fMRI) studies suggest that different types of rewarding stimuli consistently increase activity in a common set of neural structures, including the *orbitofrontal cortex* (OFC), *amygdale*, and *nucleus accumben* (NAc). Studies have shown that rewards such as money activate the same coterie of neural structure (Elliott, Friston, and Dolan 2000) such as fruit juice and water, appetitive smells, and social rewards such as attractive faces, romantic love, aesthetic paintings, humor, music, cultural objects (sports cars). This pattern of activation, responding to these diverse stimuli, suggests that the brain may process rewards along a single common pathway. This network allows widely different rewards to be directly compared for the purpose of choosing between possible courses of action (Montague and Berns (2002).

One important area where neuroeconomics can contribute is in identifying neural substrates associated with economic concepts and in understanding their psychological functions. Kahneman *et al.* distinguish between 'decision utility,' which refers to the weight of an outcome in a decision, and 'experience utility,' which refers to its

hedonic quality (Kahneman, and Tversky 1979). Although decision utility may be derived from predictions of the experience utility of different options, anticipated, experienced, and decision utilities often diverge in dramatic ways.

Neuroeconomic studies also support previously discovered economic rules concerning utility computation. The expected utility theory proposes that the expected utility of a choice is the sum of probability-weighted utilities for each possible outcome (von Neumann, and Morgenstern 1944). Neuroscience methods now offer researchers an opportunity to identify neural substrates that support the computation of these financial parameters and then to predict financial choices from brain activation. More importantly, Knutson *et al.* (2007) provided evidence that specific patterns of brain activation predict purchasing decisions. A core idea of prospect theory is that utility is computed by comparing the absolute value to some reference point (Tversky, and Kahneman 1981). Another important phenomenon concerning utility computation in economic decision is the *time discounting of utility*. Time discounting refers to the fact that people compute the utility at a future point according to a unified discount rate. Economic models assume that people discount future utility by a discount rate (Frederick, Loewenstein, and O'Donoghue 2002). McClure *et al.* (2004) used fMRI to examine the neural correlates of time discounting while subjects made a series of choices between monetary reward options that varied by delay to delivery. This study suggests that the brain houses at least two discounting mechanisms, one of which is sensitive to the value of immediate rewards and another is more sensitive to the value of future rewards.

3.3. The role of emotions in decision making

Emotions influence our decisions. However, since it is not easy to measure emotions quantitatively, traditional economic studies usually ignore such influence and leave emotion outside the scope of decision making research. Behavioral economics begins to pay attention to the role that emotions play in decisions. The regret theory proposes that decision-makers can predict the regret they would experience when they realize that the chosen outcome is disadvantageous compared with alternative outcomes available if they choose alternative choices. The regret theory also states that people would choose options that would minimize future regret. Neuroeconomic studies on regret support these assumptions. Camille *et al.* (2004) tested the prediction that advantageous choice behavior depends on the ability to anticipate and hence minimize regret. Regret is mediated by a cognitive process known as counterfactual thinking. Counterfactually thinking is the mechanism by which we compare 'what is' with 'what might have been'. Ursu *et al.* (2005) showed that counterfactual effects are manifested in the human orbitofrontal cortex during expectation of outcomes. Taken together, these studies suggest that the orbitofrontal cortex has a fundamental role in mediating the experience of regret. They also confirm that the ability to experience and anticipate emotions is crucial to advantageous decision making (Bechara *et al.* 1997). Of course, emotions are not always beneficial to decisions. Extreme emotions can lead to irrational behaviors such as crime of passion. The influence of emotions on decision making can be both positive and negative, depending on the situation in which the decision is made. Shiv *et al.* (2005) found that dysfunction in neural systems subserving emotions lead to more advantageous decisions. Another study also showed that patients with sTable focal lesion in brain regions related to emotion also made more advantageous decisions and ultimately earned more money from their investments than normal participants and control patients (Shiv, Loewenstein, and Bechara 2005). These studies support the hypothesis that emotions play a central role in decision making under risk and demonstrate that the failure to process emotions can lead people to make more advantageous decisions when faced with the types of positive-expected-value gambles that most people routinely shun.

The role of emotions is also highlighted in the framing effect. The framing effect refers to the phenomenon that human choices are remarkably susceptible to the manner in which options are presented (Kahneman, and Tversky 1979; Tversky, and Kahneman 1981). This effect represents a striking violation of standard economic accounts of human rationality, although its psychological and neural mechanisms are not well understood. Martino *et al.* (2006) found that the framing effect was specifically associated with amygdale activity, suggesting a key role for the emotional system in mediating decision biases. Importantly, orbital and medial prefrontal cortex activity predicted a reduced susceptibility to the framing effect, reflecting the role of cognitive control in modulating the framing effect. Kahneman and Frederick (2007) interpreted these results with a dual system framework, in which different frames evoke distinct emotional responses that different individuals can suppress to various degrees. They emphasized that the ability to control emotions is important to make optimal decisions in some circumstances. Lo and Repin (2002) found that less experienced traders showed significant physiological reactions to about half of the market events (e.g. trend reversals). More experienced traders reacted much less to the same events, suggesting that years of experience enabled these traders to react less emotionally to dramatic

events and thus to work efficiently. Moral decisions, the evaluation of actions of other people or of our own actions made with respect to social norms and values, are not the main topic in economics. However, moral does play an important role in our daily economic decisions. Psychological research on moral decision making has long been dominated by cognitive models that emphasize the role that reasoning and 'higher cognition' plays in the moral judgment (Kohlberg 1969).

However, neuroscience studies on moral decisions emphasize the role that emotions play in making moral judgment. Greene *et al.* (2001) found that brain areas associated with emotional processing were much more activated in moral-personal condition rather than moral-impersonal and non-moral conditions. These authors argued that moral dilemmas vary systematically in the extent to which they engage emotional processing and that these variations in emotional engagement influence moral judgment. Emotion might lead us to irrational decisions such as not to push a stranger onto the railway tracks to save five others. Further study has shown that brain regions associated with abstract reasoning and cognitive control are recruited to resolve difficult personal moral dilemmas in which utilitarian values require personal moral violations (Greene *et al.*(2004). It has been proposed that the controversy surrounding utilitarian moral philosophy reflects an underlying tension between competing subsystems in the brain: cognition and emotion (Montague, King-Casas, and Cohen 2006).

3.4. Economic decisions in social context

Human always make decisions in social situations. We care about others' decisions and outcomes and learn from others' behaviors. The game theory proposes that people make decisions based on the prediction of others' possible actions and the associated outcomes. Neuroeconomic studies have found evidence to support this view. Recently, a number of studies showed that decisions in social context are closely related to theory of mind, which is the ability to attribute various mental states to self and others in order to explain and predict behavior. Rilling *et al.* (2004) examined whether playing interactive economic games with social partners similarly engaged the putative theory of mind neural network. They observed stronger activations in these regions for human-human interaction than for human-computer interaction. Fukui *et al.* (2006) also found that the counterpart effect (human minus computer) exclusively activated mentalizing related areas (medial frontal area and superior temporal sulcus). Other studies also showed that it is not easy to resist the influence of the other's behavior and the outcome. Asch *et al.* (1951, 1952) showed that people tend to conform to others.

Cooperation behaviors, especially those that happen among strangers are common but still not well-understood by economists. The neuroeconomics studies of cooperation are now helping to shed light on these interesting controversies in behavioral and game theory. Rilling *et al.* (2002) used fMRI to scan women as they played the iterated *Prisoner's Dilemma Game*, a famous game used by economists to model cooperation. Mutual cooperation was found to be associated with consistent activation in brain areas that have been linked with reward processing. Overall, these studies consistently suggest that prosocial behaviors such as cooperation, trust, and donation are rewarding in themselves.

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5. Conclusions

In conclusion, we should stress that behavioral economics is not meant to be a separate approach in the long run. Nevertheless, behavioral economics is more like a school of thought or a style of modelling, which should lose special semantic status when it is widely taught and used. Our hope is that behavioral models will gradually replace simplified models based on stricter rationality, as the behavioral models prove to be tracTable and useful in explaining anomalies and making surprising predictions.

Economics stands only to gain from the tools of neuroeconomics. Of course, similarly to the standard supply and demand model taught in every introductory economics class, the benefits accrue to the average and not to each individual. It is possible that some economic theories will be proven wrong and those who coined them will feel hurt and bruised. On the flip side, there will be many whose theories will be proven to stand taller than ever.

This article reviews three research fields in which the neuroeconomic endeavor can make important contributions to economic theories. Neuroscientific methods offer the promise of identifying neural substrates that support the emotional and high level cognitive process. Thereby neuroeconomics has the advantage of providing

direct tests of existing as well as new economic theories. To facilitate the build up of more revealing models of decision making, it should be taken into account the underlying neural mechanisms that drive economic behaviors.

Neuroeconomic studies can deepen our understating of various decision making phenomena and the clinic symptoms such as addictive gambling, compulsive shopping, and so on. It also has great applicable implications in areas such as making more effective advertising, building cooperative relationship in economics trade, and designing more reasonable payment protocol to enhance the work efficacy and happiness of workers. But there are several challenges ahead for neuroeconomic research. First of all, each of cognitive neuroscience methods has it own inherent disadvantages (Shiv, Bechara, and Levin 2005). More importantly, cognitive neuroscience studies usually cannot establish the causal relationship between a pattern of brain activity and a particular psychological function. Cognitive neuroscience methods, such as fMRI, reveal only a correlation between brain activity and a task manipulation or behavioral response. Such correlations should be taken with caution and must not be misunderstood as a proof of causality. Furthermore, high level cognitive processes such as cooperation are challenging to emulate and control in the psychology or neuroscience laboratories. Researchers have to be cautious when they extend conclusions from neuroeconomic studies in the laboratory to the real social life. Nevertheless, it is clear that although neuroeconomics is still far from opening the 'black box' of the brain completely, it offers tremendous potentials to shed new and important insights on the mental and neural processes underlying economic behaviors.

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THE EVOLUTIONARY DYNAMICS OF TOLERANCE*

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Abstract

This paper incorporates the phenomenon of tolerance into an economic analysis, showing how different attitudes to trust and cooperation can affect economic outcomes. In the economic system we propose, tolerance is associated with the different weight that agents attribute to their own nature and to the institutional parameters in their utility function. We thus construct an overlapping generations model (OLG), showing that the incentives that influence descendants' predisposition to tolerance depend on both institutional factors, where behaviour is imposed by rules, and on social (or cultural) factors, found in popular customs and established traditions. Our study highlights the absolute impossibility of affirming tolerance through formal rules. In fact, we show that intolerance emerges as persistent attitude (intolerance trap) and its control is only possible through constant and continuous interventions on the educational processes of new generations.

Keywords: tolerance, overlapping generation model

JEL Classification: D1, Z1

1. Introduction

This paper shows that the phenomenon of tolerance, defined as a generic ability to accept diversity, can easily be integrated into an economic model, providing a new explanation for a number of both economic and social phenomena. The economic literature on this subject is fairly recent; intolerant behaviour inevitably affects several important factors of economic growth and social development, such as trust between economic agents, cooperation, the free movement of ideas and talent and at the same time promoting corruption and rewarding group membership rather than merit (Tabellini 2010).

The theory developed in this article is the natural continuation of Iannaccone's (1997) economic study on fundamentalism that recently culminated in Arce-Sandler's (2003-2008) and Epstein-Gang's (2007) theoretical models and in Corneo-Jeanne's (2009) preliminary and pioneering study on the economic theory of tolerance.

In this paper, we adopt a model to analyse the evolution and persistence of social attitudes towards tolerance through the dynamic properties of a precise mechanism of cultural transmission and socialization.

More specifically, tolerance is incorporated in an OLG model, showing that this has a remarkable impact on the economic equilibrium of the system. In our model, the cultural values of tolerance are transmitted through the educational efforts exerted by parents on their children. However, the incentives that influence the descendants' predisposition to tolerance depend on both institutional factors, where behaviours are imposed by rules, and on social (or cultural) factors, found in popular customs and established traditions. The tolerant individual reaches a compromise between the different influences by minimizing the friction between her own and social choices. In this choice, economic-type evaluations will prevail.

Our model assumes that there are two social categories, 'tolerant' and 'intolerant', identified on the basis of their different behavioural characteristics, or rather, by a different representation of own preferences. Each

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member of the population has either the 'tolerant' or 'intolerant' characteristics deriving from the educational efforts of parents in the transmission of these characteristics. According to Bisin and Verdier's (1998, 2001) approach, parents choose the cultural transmission coefficient (educational effort), or rather, the probability with which their cultural traits (their true disposition to tolerance) are adopted by the child. If the child (i.e. the new generation) does not learn from the parent, then she will assume the character of an individual at random. Our analysis demonstrates that the model is able to replicate some important social and historical phenomena, such as the persistence of widespread intolerance in countries that have adopted strong legislation to protect freedom and respect for diversity (Inglehart 1997, Inglehart, and Baker 2000). As it is confirmed by empirical evidence (Corneo, and Jeanne 2009), in our model intolerance is much more common and persistent than tolerance.

Under specific conditions and institutional arrangements, society can converge on one of two possible stable equilibriums: a 'good equilibrium' where there is a balance between the share of tolerant and intolerant individuals and a 'bad equilibrium' characterized by widespread intolerance where tolerant individuals, representing a minority, are encouraged to hide their true character.

What is interesting is that equilibrium with widespread tolerance ('good equilibrium') is particularly fragile in the sense that, following a minimal change in the agent expectations, the system tends to move away from this, automatically converging towards the 'bad equilibrium'. In contrast, equilibrium with widespread intolerance is particularly robust, insensitive to any changes in agent expectations. The system, therefore, tends to naturally exist in a situation called the 'intolerance trap' where the only means to exit is through constant public interventions. Significant policy implications derive from these propositions. The maintenance of a social system inspired by the values of tolerance requires a steady and sustained commitment from the authorities, since the system is unable to ensure its own stability. This result provides a convincing explanation of the frequent outbursts of intolerance that occur in societies, which for some time now have been considered free from ideological constraints and a respectful of diversity, but also explains the profound differences in the levels of tolerance between different industrialized countries (*see* for example Florida 2004).

From an economic perspective, this study allows assessing the effectiveness of specific policy interventions in order to facilitate the dissemination and integration of values in society. The model demonstrates the ineffectiveness of policies aimed at spreading tolerance based exclusively on legislative and institutional reforms, suggesting instead the adoption of systems that leverage on 'profound' factors, through the appropriate education of young generations. Such interventions, however, must never stop: any disruption would in fact plunge society back into a state dominated by intolerance. The analysis proceeds as follows. Section 2 outlines the model or agents' preferences and associated educational choices; in Section 3 we determine the equilibrium steady state of the system by identifying its main characteristics and showing under which conditions the system enters into the *intolerance trap*; in Section 4 we analyse the economic policy implications arising from the propositions set forth in the previous sections; section 5 contains our conclusions.

2. The model

In this section, we propose an OLG model in which each individual lives for two periods, first as a child (*new agent*) and then as an adult (*older agent*). In the first period of life, the child has not yet assumed well-defined cultural traits and preferences, which are instead acquired through observation, imitation and the adoption of the cultural models that they will come into contact with.

Each child, in fact, is first subjected to the influences of the family (represented by an adult) and then to those of society. In the former case, this is about *vertical* transmission, in the latter the *oblique* transmission of cultural traits[36]. In this context, the socialization process can be interpreted as the result of an economic choice: each parent (adult) will invest resources in an effort to educate the child according to her aptitudes. The parent's educational effort is subject to a form of myopia known as 'imperfect empathy' and plays a key role in the analysis: the parent is altruistic but perceives the child's welfare through a filter of her own preferences.

The tolerant parent exercises an educational effort τ^i, which also indicates the probability with which this effort will succeed, in which case the child will assume the same preferences as the parent. Otherwise, she will remain *naive* (without well-defined preferences), and will begin to be subjected to the influences of society. That is she will become a tolerant adult with probability z_i (which indicates the portion of tolerant individuals in society) and she will become intolerant with a specular probability of $1 - z_i$.

[36] The transmission mechanism of cultural traits hypothesized in the paper is in accordance with Cavalli, and Sforza and Feldman's (1981) key studies on cultural anthropology.

The incentive for adults to influence their descendants' predisposition towards tolerance also depends on institutional factors, specifically on the expectations of how much the value of tolerance will be protected by regulations and social relations. To this end, the model hypothesizes a simple mechanism for the formation of institutions whereby norms and attitudes are affirmed, incorporating that which has been affirmed on a social level.

The social life of an individual can thus be ascribed to three environmental influences[37]:

- an *institutional environment,* in which behaviours and attitudes are governed by laws (formal rules);
- a *social environment*, which summarizes customs and traditions (informal norms), not necessarily in line with that established by law;
- an *individual environment*, represented by the individual's set of values and attitudes, the result of upbringing and social conditioning.

The three environments are closely interlinked: the generalized attitudes of individuals consolidate traditions and customs that, in turn, contribute to the formation of laws (North 1990). On the other hand, as will become clearer later on, the regulatory apparatus of a State can induce significant changes in the evolutionary dynamics of individual aptitudes, thus inverting the causality link. The tolerant individual makes a clear compromise between the different influential environments, endeavouring to create the least amount of friction between her choices and those imposed by norms and personal aptitudes. To the contrary, the intolerant individual, in making her own choices, takes into account only the values and standards pertaining to her individual sphere, not accepting any compromise with that established by the rules (formal and informal) that are inconsistent with her own principles. The ideological fundamentalism that characterizes the intolerant person leads her to assign the maximum loss of welfare to any deviation, even minimal, from her own principles and to attribute the highest satisfaction in all cases where these principles are fully respected, even if the institutional context openly condemns them[38].

As observed by Sen (2006), the fundamentalist has a strong sense of belonging to specific values and principles, which sooner or later will lead to conflict with people and institutions that do not share them, openly manifesting her intolerance.

2.1 The preferences

Economic agents are distinguished by their predisposition to tolerance. This model studies the simplest case where there are only two types of individuals: those with attitude a, the tolerant, and those with attitude b, the intolerant. Let us suppose that tolerance is measured by an index i so that $a = sup[i]$ and $b = inf[i]$ where $a = 1$ and $b = 0$.[39]

As will be made clearer later on, an individual type that has a measure of tolerance $i = a, b$ can actually manifest behaviour that is 'remote' from her own nature, i.e., declaring through her choices a tolerance level $b < j < a$ as a result of the conditions created by formal and informal rules. An individual of type $i = a, b$ can manifest her predisposition to tolerance in such a way as to maximize the following quadratic (utility) function:

$$U_i = -\left[a_{1i}\left(\theta^f - m_i\right)^2 + a_{2i}\left(\theta^{nf} - m_i\right)^2 + a_{3i}\left(i - m_i\right)^2\right] \qquad (1)$$

where $b \le m_i \le a$ indicates the declared predisposition to tolerance, $b \le \theta^f \le a$ the tolerance level of formal institutions, $b \le \theta^{nf} \le a$ the tolerance level of informal institutions and i the individual's actual predisposition to tolerance. The vector (a_{1i}, a_{2i}, a_{3i}) is indicative of the saliency that the individual assigns to the various environmental influences (institutional, social and individual), with $\sum_{j=1}^{3} a_{ji} = 1$ and $a_{ji} \ge 0$.

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[37] Many sociological studies use similar conceptualizations to those we have introduced. *See* in this regard the work of Persell, Green, and Gurevich (2001).

[38] Rather often, individuals openly demonstrate intolerance despite facing sanctions, in demonstration of how ideology prevails over evaluations of convenience.

[39] A possible objection could be that the model corresponds to a boundary (knife-edge) case in the set of possible specifications. However it is easily to show that even considering a non-degenerate case with $a<1$ and $b>0$ with $0<b<a<1$ for respectively tolerant and intolerant individuals, our main results do not change.

In distinguishing only two types of individuals, the objective function becomes:

$$U_a = -\left[a_{1a}\left(\theta^f - m_a\right)^2 + a_{2a}\left(\theta^{nf} - m_a\right)^2 + a_{3a}\left(1 - m_a\right)^2\right] \qquad (2)$$

for the tolerant individual and

$$U_b = -\left[a_{1b}\left(\theta^f - m_b\right)^2 + a_{2b}\left(\theta^{nf} - m_b\right)^2 + a_{3b}\left(0 - m_b\right)^2\right] \qquad (3)$$

for the intolerant individual[40].

The difference between a tolerant and an intolerant individual resides in the different weight they attribute to their own nature (a_{3i}) and to the institutional parameters (a_{1i}, a_{2i}).

The intolerant individual is by nature averse to the principles of sharing and socializing with people who do not have the same preferences. It is therefore reasonable to assume that she tends to indulge and manifest high levels of intolerance, even though condemned at the institutional and social level. In her decisional process, therefore, the intolerant individual attaches little weight to institutional parameters: without compromising the results of the model, it is assumed that $a_{3b} = 1$, for which the objective function is reduced to $U_b = -\left(m_b\right)^2$.

To the contrary, the tolerant individual tries to create minimal friction between her attitude and that determined by formal and informal rules. The distribution of weight will thus be less unbalanced than that of the intolerant individual, i.e. $\left(a_{1a}, a_{2a}, a_{3a}\right) >> 0$.

By maximizing the objective function, we obtain the tolerance attitude of the two types of agents:

$$\begin{aligned} m_a^* &= a_{1a}\theta^f + a_{2a}\theta^{nf} + a_{3a} \\ m_b^* &= 0 \end{aligned} \qquad (4)$$

where $0 < m_a^* \leq 1$ and $m_a^* = a = 1$ when $\theta^f = \theta^{nf} = 1$.

Now we expand the model by adding the temporal dimension and considering an overlapping generation mechanism by which parents and society transmit cultural traits to future generations.

Each agent lives two periods. In the first period, she is a child and has no specific preferences; in the second, she becomes an adult with a definitive attitude towards tolerance and chooses to manifest the attitude by maximizing her utility function.

Preferences are transmitted to the child by the parent's educational efforts (vertical transmission) and by the cultural influences of society (oblique transmission)[41]: if the child does not learn from the parent, she adopts the preferences of a randomly chosen adult. Parents want to maximize their child's future well-being, but they evaluate the welfare of their children through their own preference structure according to the hypothesis of imperfect empathy (*see* Bisin, and Verdier 2001)[42].

Empathy is the psychological process that consists in directly absorbing the emotional conditions of another person; the imperfection we attribute to this process consists in a kind of myopic behaviour of the parent who evaluates the future choices of her child without considering the child's effective preferences and exclusively referring to their own.

To formalize these concepts let us suppose at time t each adult of type i $(i = a, b)$ has a child and chooses the effort τ_t^i to educate her. This effort equates to the probability with which the child will adopt the

[40] In this first version of the model we suppose society as divided in totally tolerant and totally intolerant individuals. The dichotomy allow us an easily application of the cultural transmission mechanism introduced by Bisin-Verdier (2000) widely applied in important studies on cultural transmission of preferences (see Hauk-Marti, 2002). Further and more advanced reelaboration of the model could adopt a representation of the evolution of tolerance in the cultural formation of continuous preferences framework, which has recently been introduced by Pichler (2010).

[41] On the concepts of vertical and oblique transmission of cultural traits, see Cavalli-Sforza, (1996) and Cavalli-Sforza, Fieldman, (1981).

[42] Given that at the time of its education the child still has no precise preferences, the parent evaluates the child's future utilities through her own perspective. In other words, she will use her own utility function as if it were the child's.

parent's preferences $\left(0 \le \tau_t^i \le 1\right)$. Now, letting $P_t^{i,j}$ be the transition probability that a child of parent i is of type j and considering a tolerant adult, we can write

$$P_t^{a,a} = \tau_t^a + \left(1-\tau_t^a\right)z_t \qquad (5)$$

$$P_t^{a,b} = \left(1-\tau_t^a\right)\left(1-z_t\right) \qquad (6)$$

where z_t is the proportion of tolerant adults at time *t*. Similarly, for the intolerant adult we have

$$P_t^{b,b} = \tau_t^b + \left(1-\tau_t^b\right)\left(1-z_t\right) \qquad (7)$$

$$P_t^{b,a} = \left(1-\tau_t^b\right)z_t \qquad (8)$$

2.2 The education choice

We can now characterize the education choice following Bisin, and Verdier (1998, 2001).

A type *i* parent will choose the educational effort $\tau^i \in [0,1]$, which maximizes

$$\Gamma_i = \beta\left(P_t^{i,i}U_t^{i,i}\left(\theta^e\right) + P_t^{i,j}U_t^{i,j}\left(\theta^e\right)\right) - C\left(\tau^i\right) \qquad (9)$$

where β is the discount rate, $C\left(\tau_t^i\right)$ the cost of educational effort made by the type *i* parent which is assumed to be twice continuously differentiable, strictly convex with $C(0)=0$, $C'(0)=0$ and that for all τ $C'' > C' > 0$, and $U_t^{i,j}\left(\theta^e\right)$ the expected utility from the economic action of a type j child as perceived by a type i parent when she expects $\theta^e = [E\left(\theta^f\right), E\left(\theta^{nf}\right)]$. $U_t^{i,j}\left(\theta^e\right)$ is therefore dependent on the expectations on the future level of tolerance in formal and informal institutions.

Given the assumption of imperfect empathy, when estimating $U_t^{i,j}\left(\theta^e\right)$ the type *i* parent will apply its own utility function.

However we suppose a fundamental difference in the educational aptitude of intolerant adults. The intolerant adult will only accept the full sharing of her own values, assigning any deviation from them to a maximum loss of wellbeing. Despite the tolerance manifested by a tolerant child being $b < m_a^* \le a$, the intolerant parent will value this choice as if $m_a^* = a = 1$, thus assigning a maximum loss of wellbeing to tolerance: in fact, it can be demonstrated that $b = argmaxU_b$ and $a = argminU_b$. From these considerations we can see that, independently of expectations, for the intolerant parent it will always be $U^{bb} = 0$ and $U^{ba} = -1$.

We consider this behavior to be close to the 'fundamentalist' attitude typical of intolerant individuals.

Furthermore, given that $m_a^* > m_b^* = 0$ we get $U^{i,i}\left(\theta^e\right) > U^{i,j}\left(\theta^e\right)$ for each θ^e. That is, each parent prefers a child that adopts her own preferences.

By solving the maximization problem[43] and suppressing the time indicators, we obtain the following conditions[44]:

$$\beta\left(U^{a,a} - U^{a,b}\right)\left(1-z\right) = C'\left(\tau^a\right) \qquad (10)$$

$$\beta\left(U^{b,b} - U^{b,a}\right)z = C'\left(\tau^b\right) \qquad (11)$$

From these equations, it follows that the optimal effort level is $\tau^i = \tau^i\left(z, U^{ii} - U^{ij}\right)$, $i, j = a, b$ $i \ne j$.

[43] Note that $C(\tau)$ must be sufficiently convex so that the optimal solution is $0 < \tau < 1$.

[44] Expressions (9) - (15) are a recapitulation of results already shown in Bisin, and Verdier (2001).

Using the implicit function theorem, we get

$$\frac{\partial \tau^a}{\partial z} = -\frac{\beta\left(U^{a,a} - U^{a,b}\right)}{C''\left(\tau^a\right)} < 0 \qquad (12)$$

$$\frac{\partial \tau^b}{\partial z} = \frac{\beta\left(U^{b,b} - U^{b,a}\right)}{C''\left(\tau^b\right)} > 0 \qquad (13)$$

Given that $U^{i,i} - U^{i,j}$ depends on the expectations, the same will apply to the educational effort $\tau^i = \tau^i\left(z, U^{ii} - U^{ij}\right)$.

The educational effort of type a (tolerant agent) decreases as the proportion of tolerant agents increases. In fact, higher values of z indicate a higher probability that the child assumes the same preferences as the parent simply by socializing with a member of society; this induces the parent to reduce the educational effort. Similarly, if the proportion of tolerant agents increases, intolerant parents must intensify their educational efforts.

We can now characterize the dynamic behaviour of z_t with the following difference equation:

$$z_{t+1} = z_t P_t^{a,a} + (1 - z_t) P_t^{b,a} \qquad (14)$$

where substituting for $P_t^{a,a}$ and $P_t^{b,a}$ the dynamic equations becomes

$$z_{t+1} = z_t + z_t(1 - z_t)\left(\tau_t^a - \tau_t^b\right) \qquad (15)$$

The analysis of the dynamic equation will focus on the stable expectation hypothesis, with $U^{aa} - U^{ab}$ and $U^{bb} - U^{ba}$ constant for each *t*.

In this hypothesis this difference equation has two unstable fixed points $z = 0$ and $z = 1$, and a unique stable fixed point $z = z^*$

$$z^*\left(\theta^e\right) = \frac{U^{a,a}\left(\theta^e\right) - U^{a,b}\left(\theta^e\right)}{U^{a,a}\left(\theta^e\right) - U^{a,b}\left(\theta^e\right) + U^{b,b}\left(\theta^e\right) - U^{b,a}\left(\theta^e\right)} \qquad (16)$$

with $\tau^a = \tau^b$.

(**Proof**: *see* Appendix)

2.3 The choice of institutions

In this model we distinguish between formal and informal institutions, according to North's definition (North, 1990), and formalize the concept by using the vector $\theta = \left(\theta^f, \theta^{nf}\right)$. According to this definition, formal institutions are the political, social and economic regulations in force; they usually emerge to increase the effectiveness of habits, customs and religious traits (informal institutions) diffused in the population. We can thus suppose that informal institutions represent the level of tolerance of the prevailing type in each period. If the fraction z_t is larger than $\frac{1}{2}$, then tolerant agents are in the majority and their attitudes constitute informal institutions, and $\theta^{nf} = a = 1$. On the other hand when z_t is less than $\frac{1}{2}$, the level of θ^{nf} will be strongly affected by fundamentalist customs and $\theta^{nf} = b = 0$.

To summarize

$$\theta^{nf}(z_t)=\begin{cases} a & if \quad z_t > \frac{1}{2} \\ b & if \quad z_t \leq \frac{1}{2} \end{cases} \qquad (17)$$

The mechanism we have introduced allows us to formalize the idea that tolerant habits and beliefs spread when there is insufficient social aversion to oppose them.

On the other hand, institutions reduce the cost of individual convictions, and hence ideologies, religion and moral codes can produce very significant institutional alterations (North 1990). This consideration allows us to assume that when formal institutions evolve freely (that is, without exogenous impositions) they will tend to coincide with informal rules as time goes by, that is, for a fixed level of θ^{nf}, $\theta^{f} \to \theta^{nf}$ during a finite time *t*.

3. The steady state

We can now characterize the steady states according to the expected level of formal and informal institutions.

Lemma 1

Given an expected institutional vector θ^{e} then $\tau^{a} \gtreqless \tau^{b}$ when $z_t \lesseqgtr z^{*}\left(\theta^{e}\right)$.

(**Proof:** *see* Appendix).

Lemma 2

Each institutional combination $\theta^{e}=(i,j)$, with $b \leq i \leq a$ and $b \leq j \leq a$, generates a unique and different stable steady state $z_{i,j}=z^{*}(i,j)$ with $i=\theta^{f}$ and $j=\theta^{nf}$. However, given the assumptions on institutions, we only consider institutional situations with $\theta^{f}=a,b$ and $\theta^{nf}=a,b$; thus the following relations hold:

1. $z_{a,a}=1/2$.
2. $z_{b,b}<1/2$; $z_{b,b}<z_{ba}$; $z_{b,b}<z_{ab}$.
3. $z_{a,b}<1/2$, $z_{b,a}<1/2$, $z_{a,b} \lesseqgtr z_{b,a}$.

(**Proof:** *see* Appendix).

The stable steady state $z_{b,a}$ can be excluded from the analysis inasmuch as, given the hypothesis on the formation mechanism of institutions; tolerance is not possible on the level of informal institutions when the proportion of tolerant individuals is in the minority.

For the moment, we also exclude from the analysis the study of convergence towards the equilibrium point $z_{a,b}$, since this can be reached only with intervention on a regulatory level that imposes tolerance through formal rules. This aspect will be discussed in detail in Section 4.1, which further analyses the role of policy in the dissemination of tolerance.

Proposition 1 (intolerance trap): As Bisin, and Verdier (1998), we assume that the cost function has the quadratic form $C\left(\tau^{i}\right)=\frac{\left(\tau^{i}\right)^{2}}{2}$ [45], $z_0 \neq \{0,1\}$ and that agents have rational expectations. We further indicate with

[45] It can be easily verified that this function of cost respects all the properties hypothesized at the beginning and ensures $0 \leq \tau^{i} \leq 1$ being $0 \leq U^{ii}-U^{ij} \leq 1$.

z_{t+1}^{ij} the proportion of tolerant individuals at time $t+1$ if at time t the expectations are $\theta^e = (i, j)$ where $i = a, b$ and $j = a, b$.

Thus:

1. z_t converges to z_{bb} if $z_t < 1/2$;

2. if $z_t > 1/2$ then

2.1 z_t converges to z_{aa};

2.2 z_t converges to z_{bb} only if z_t is sufficiently close to 1/2 such that $z_{t+1}^{bb} < 1/2$.

(**Proof:** *see* Appendix).

The multiplicity of stable steady states depends on the possibility of having different institutions that are able to influence adult expectations on the future utility of their children and therefore the amount of educational effort exercised by them.

Only in one case does the educational effort of the tolerant agent exceed that of the intolerant agent i.e. when $z_t < z_{bb}$. In this case, however, the only rational expectation is (b,b) which determines the convergence to $z_{bb} < 1/2$.

In general, the equilibrium point z_{aa} or at least a proportion of tolerant individuals $z_t > 1/2$ can never be attained under the assumption of rational expectations if $z_0 < 1/2$.

The 'resistance' of the equilibrium point with intolerance is strongly linked to the fact that the intolerant individual assigns a maximum utility loss to preferences that are different from her own, i.e. $U^{ba} = -1$; for this individual the difference $U^{bb} - U^{ba}$ that determines her educational effort τ^b is always maximum. Only a sufficiently low value of z_t, i.e. $(z_t < z_{bb})$ can guarantee that $\tau^a > \tau^b$. In all other cases, the educational effort of the intolerant individual tends to prevail, trapping the system in a state where the proportion of tolerant individuals can at most be equal to the proportion of intolerant individuals $(z_t \le z_{aa} = 1/2)$[46]. This consideration is far from absurd when you consider that in reality the fundamentalist attitude of intolerant individuals leads them to strongly defend their positions (that is, to exert considerable educational efforts to conserve their ideas), even in social contexts where tolerance seems to be a custom, and this would explain why intolerance is so persistent.

Nevertheless, even in a best-case scenario, with the equilibrium proportion of tolerant individuals equal to $z_{aa} = 1/2$, a resumption of convergence towards the 'bad' steady state is still possible. In this situation, any expectation $(i, j) \neq (a, a)$ would provoke an immediate reduction of the proportion of tolerant individuals with $z_{t+1}^{ij} < 1/2$. The expectation will be confirmed given that $\forall (i, j) \neq (a, a)$ $z_{ij} < 1/2$ and the system will start to converge again towards z_{bb}.

This phenomenon is also possible due to the proportion of tolerant individuals being above 1/2, provided that the pessimistic expectations (b,b) or (a,b) are able to bring that proportion, as early as in the next period, to below 1/2.

A high tolerance steady state is fragile. A change in expectations is enough to take the system back to bad equilibrium. Once the proportion of tolerant individuals has become the minority, the system is no longer able to re-converge towards the 'good' equilibrium, not even in the presence of positive expectations since these will never be confirmed.

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[46] If we were to also permit the intolerant individual to assign positive weights to the institutional dimension (i.e., $a_{3b} < 1$) we would have $z_{aa} = \frac{1}{1 + a_{3b}^2} > 1/2$ i.e., an increase in the share of tolerant individuals in equilibrium. That affirmed in proposition 1 would still be valid. However, in this case the system could converge to z_{aa} if $z_{t+1}^{aa} > 1/2$ even with $z_t < 1/2$.

4. Policy implications

As demonstrated in Proposition 1, under the hypothesis of rational expectations the steady state to which the system converges depends on the initial proportion of tolerant agents. Moreover, under appropriate hypotheses, society is unable by itself to exit from the 'intolerance trap'; if $z_t < 1/2$, the proportion of tolerant agents remain a minority even in the future.

The model suggests two possible policy measures aimed at increasing the proportion of tolerant agents in the population:

1. introduction of formal rules that penalize intolerant behaviour;
2. educational development of the younger generations.

With the first measure, the steady state becomes $z_{ab} > z_{bb}$ giving rise to an increase in the proportion of tolerant agents in equilibrium.

In fact, we hypothesize a majority share of intolerant individuals characterize the system, $z_t < 1/2$, and that the government announces an institutional reform imposing tolerance for the subsequent periods. This measure will apply only to formal institutions so that agents' expectations will be $\theta^e = (a,b)$ from then onwards, and z_t will converge to $z_{ab} > z_{bb}$. Given that $z_{ab} < 1/2$, intolerant individuals will nevertheless remain in the majority; the action was unable to change the preferences of society enough so that, although sanctioned by law, intolerance will continue to be practiced by the majority of individuals. The system will converge again to z_{bb} as soon as the legislation in favour of tolerance is withdrawn. This type of intervention is not very effective in the long term. Tolerance, in fact, is the result of a cultural process whose evolution involves several generations. It is therefore unreasonable to think of influencing the nature and preferences of individuals through legal provisions that contrast the customs that are prevalent in society.

The second measure consists in the institutions' direct efforts in educating new generations in tolerance.

We have thus far considered the possibility of modifying a society's predisposition to tolerance through regulatory action imposing tolerant behaviour. However, these interventions do not significantly condition the educational process that regulates the transmission of preferences.

In this regard, it is appropriate to evaluate the effect of government policies aimed at spreading tolerance through the educational system. This type of policy, unlike the preceding, has a direct impact on the processes of preference transmission, inasmuch as the government's efforts are integrated with the educational efforts of parents.

Following Hauk-Marti (2002) we hypothesize that when the parent's educational effort is unsuccessful, there is a probability ρ that the individual becomes tolerant thanks to the education received in schools. If even this is unsuccessful in defining the preferences of the individual, then she will assume the preferences of a subject chosen randomly from the population.

The transition probabilities thus become:

$$P_t^{a,a} = \tau_t^a + (1-\tau_t^a)(z_t(1-\rho)+\rho) \qquad (18)$$

$$P_t^{a,b} = (1-\tau_t^a)(1-z_t)(1-\rho) \qquad (19)$$

$$P_t^{b,b} = \tau_t^b + (1-\tau_t^b)(1-\rho)(1-z_t) \qquad (20)$$

$$P_t^{b,a} = (1-\tau_t^b)(z_t(1-\rho)+\rho) \qquad (21)$$

generating the following dynamic equation:

$$z_{t+1} - z_t = (1-z_t)\{z_t(1-\rho)(\tau_t^a - \tau_t^b) + (1-\tau_t^b)\rho\} \qquad (22)$$

The stable steady states are $z=1$ and $z=0$ if $\rho=0$.

If an internal equilibrium exists, then $\tau^b > \tau^a$.

With $\rho=1$ the system converges to 1. Thus, due to continuity, there must be $0<\rho<1$ such that $z_{t+1}-z_t>0$ for any $z<1$.

More precisely, $z_{t+1}-z_t>0$ if $\rho > \dfrac{z_t\left(\tau^b-\tau^a\right)}{1+z_t\left(\tau^b-\tau^a\right)-\tau^b} \equiv \Omega$.

Immediately verifying that $\partial\Omega/\partial z_t > 0$ and that for $z_t=1$, $\Omega=\tau^b(1)$. So it is sufficient that the government exercises an educational effort $\rho > \tau^b(1)$ so have a growing proportion of tolerant individuals[47].

The educational effort towards tolerance exercised by the government must never cease, even when $z_t > 1/2$. The discontinuity ($\rho=0$) would make the system converges (at best) to z_{aa} where we have already witnessed that a worsening of expectations would plunge the system back towards intolerance.

The lesson is that tolerance can spread in society only if governments agree on permanent dissemination through direct interventions in the educational processes of new generations. Schools at every level, information, politics and religious institutions must be vigilant and continually educate on tolerance. The social system cannot autonomously guarantee, i.e. relying only on the role of families, the stable establishment of tolerance as a consolidated and permanent principle over time.

5. Conclusion

Building on recent efforts on the evolutionary dynamics of fundamentalism and cultural transmission, the present paper concentrates on issues relating to the formation and stability of attitudes towards tolerance and intolerance. The dynamic equation of the model demonstrates that a degenerate distribution of the population (whereby agents are all tolerant or all intolerant) is dynamically unstable. Moreover, under some conditions and for a specific institutional asset a unique non-degenerate stationary distribution exists (in which both tolerance and intolerance co-exist in the population), and this distribution is locally stable.

Finally, we studied the dependence of the population dynamics on institutional changes and policy interventions showing that tolerance cannot be disseminated through formal rules but require that authorities act directly on the educational processes of new generations. In this sense, it is recommended that the government carries out an educational effort through schools in an attempt to predispose young people towards tolerance. Furthermore, intolerance is a persistent attitude; it can not be totally ruled out from society and tends to reemerge also in social contexts that are characterized by a widespread respect for diversity as soon as the public educational commitment (mainly through schools) stops being sufficiently effective.

However, the assumption that the different predispositions to tolerance do not have effect on the economic opportunities of agents is somewhat limited. Further developments of the model should remove this assumption, in order to apply the analysis to contexts where agents belonging to different social groups interact not only in relation to cultural conditioning but also in real and actual business transactions.

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APPENDIX

The proofs we develop in this section follow the same methodology used by Hauk-Marti (2002).

Considering the dynamic equation of population $z_{t+1} = z_t + z_t(1-z_t)(\tau_t^a - \tau_t^b)$; we note that it has three rest points: i) $z=0$, ii) $z=1$ and iii) $z=z^*$ with $\tau^a = \tau^b$.

Deriving the dynamic equation with respect to z_t we obtain

$$\frac{\partial z_{t+1}}{\partial z_t} = 1 + (1-2z_t)(\tau^a - \tau^b) + z_t(1-z_t)\left(\frac{\partial \tau^a}{\partial z_t} - \frac{\partial \tau^b}{\partial z_t}\right).$$

Then

$$\left.\frac{\partial z_{t+1}}{\partial z_t}\right|_{z_t=0} = 1+\tau^a > 1 \text{ given that } (z_t=0) \Rightarrow (\tau^b = 0)$$

$$\left.\frac{\partial z_{t+1}}{\partial z_t}\right|_{z_t=1} = 1+(-1)(-\tau^b) > 1 \text{ given that } (z_t=1) \Rightarrow (\tau^a = 0)$$

then points $z=0$ and $z=1$ are not stable.

To evaluate the stability of point $z^*(\theta^e)$, rewrite the derivative of the dynamic equation as

$$\frac{\partial z_{t+1}}{\partial z_t} = 1 + (1-2z_t)(\tau^a - \tau^b) + z_t(1-z_t)\left(\frac{-\beta\Delta^a}{C''(\tau^a)} - \frac{\beta\Delta^b}{C''(\tau^b)}\right)$$

given $\Delta^a = \dfrac{C'(\tau^a)}{\beta(1-z)}$ e $\Delta^b = \dfrac{C'(\tau^b)}{\beta z}$;

thus

$$\frac{\partial z_{t+1}}{\partial z_t} = 1 + (1-2z_t)(\tau^a - \tau^b) + \left(z_t\frac{-C'(\tau^a)}{C''(\tau^a)} - (1-z_t)\frac{C'(\tau^b)}{C''(\tau^b)}\right).$$

Evaluating this derivative in $z_t = z^*$, i.e. considering $\tau^a = \tau^b$ and given $C' < C'' \ \forall \tau$ we have

$$\left.\frac{\partial z_{t+1}}{\partial z_t}\right|_{z_t=z^*} = 1 - \left(\frac{C'(\tau)}{C''(\tau)}\right) \in (0,1)$$

and conclude that $z_t = z^*$ is asymptotically stable. ■

Lemma 1: Given that $U^{aa}(\theta^e) > U^{ab}(\theta^e)$ and $U^{bb}(\theta^e) > U^{ba}(\theta^e)$, by the first order condition of the parent maximization problem, each type of agent chooses a positive educational effort, $\tau^a > 0$ and $\tau^b > 0$.

To obtain point $z^*(\theta^e)$ we have to consider that $\tau^1 > \tau^2$ implies $C'(\tau^a) > C'(\tau^b)$. Thus $\beta(\Delta^a)(1-z) > \beta(\Delta^b)z$ and hence $z < \dfrac{\Delta^a}{\Delta^a - \Delta^b}$, with $\Delta^i = U^{i,i}(\theta^e) - U^{i,j}(\theta^e)$, $i,j = a,b$ and $i \neq j$.■

Lemma 2: Let $m_{h,k}^i$ be the tolerance shown by an individual of type *i* when the tolerance at institutional level is $\theta^f = t_h$ and $\theta^{nf} = t_k$; let $U_{h,k}^{i,j}$ be the expected utility that a parent of type i associates with a type *j* child, being the expectation $\theta^f = t_h$ and $\theta^{nf} = t_k$.

Maximization of the utility function gives the following:

- for type t_a: $m_{aa}^a = 1$; $m_{ab}^a = 1-a_2$; $m_{ba}^a = 1-a_1$; $m_{bb}^a = a_3$.
- for type t_b: $m^b = 0 \ \forall \theta^e$.

from which, given the assumption of imperfect empathy, we obtain:

for type t_a:

$U_{aa}^{aa}=0$	$U_{aa}^{ab}=-1$
$U_{ab}^{aa}=-a_2(1-a_2)$	$U_{ab}^{ab}=-(1-a_2)$
$U_{ba}^{aa}=-a_1(1-a_1)$	$U_{ba}^{ab}=-(1-a_1)$
$U_{bb}^{aa}=-a_3(1-a_3)$	$U_{bb}^{ab}=-a_3$

for type t_b:

$U^{bb}=0$ and $U^{ba}=-1 \ \forall\theta^e$

We can now obtain the value of the different stationary points shown in lemma 2:

$$z_{aa}=\frac{1}{2},$$
$$z_{bb}=\frac{a_3^2}{a_3^2+1},$$
$$z_{ab}=\frac{(1-a_2)^2}{(1-a_2)^2+1},$$
$$z_{ba}=\frac{(1-a_1)^2}{(1-a_1)^2+1}$$

and given these, proving points 1) 2) and 3) of Lemma 2 is straightforward. ■

Proposition 1

From the assumption of proposition 1, we can verify $z_{aa}=1/2$ and $\partial z_{t+1}/\partial z_t>0 \ \ \forall z_t\in(0,1)$. This latter condition ensures that the convergence occurs without oscillations around the equilibrium point. Thus:

1. if $z_t<1/2$ and $z_{t+1}<1/2 \ \ \forall\theta^e$ and the only rational expectations are $\theta^e=(b,b)$; from lemma 1 z_t converges to z_{bb}.

2. if $z_t>1/2$ then:

a. expectations $\theta^e=(a,a)$ are always rational since $\forall z_t>1/2$, we have $z_{t+1}^{aa}>1/2$. From lemma 1 z_t converges to z_{aa}.

b. There is a $\bar{z}>1/2$ such that if $1/2\le z_t<\bar{z}$ then $z_{t+1}^{bb}<1/2$, to thus verify the expectations $\theta^e=(b,b)$.

DIFFERENTIAL GAMES IN NON–RENEWABLE RESOURCES EXTRACTION

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Abstract

Traditional economic theory, up to the middle of the twentieth century, builds up the production functions regardless the inputs' scarcity. In the last few decades has been clear that both the inputs are depletable quantities and a lot of constraints are imposed in their usage in order to ensure economic sustainability. Furthermore, the management of exploitation and use of natural resources (either exhaustible or renewable) has been discussed by analysing dynamic models applying methods of Optimal Control Theory. This theory provides solutions that are concerned with a single decision maker who can control the model dynamics facing a certain performance index to be optimized.

In fact, market structures or exploitation patterns are often oligopolistic, i.e. there are several decision makers whose policies influence each other. So, game theoretical approaches are introduced into the discussion. According to the theory of continuous time models of Optimal Control, the appropriate analogue of differential games is used. Roughly, this is the extension of Optimal Control, when there is exactly one decision maker, to the case of $N\,(N \geq 2)$ *decision makers interacting with each other.*

Keywords: non-renewable resources, dynamic interaction, economic regulation, differential games

JEL Classification: C61, C62, Q32

1. Introduction

In the literature of environmental economics, existing models often make an assumption in which the involved agents exploit the resource from a common pool area in a non-cooperative way. This approach yields inefficiency in the well-known sense 'tragedy of commons' (Benchekroun 2003). Tragedy of commons refers to a situation in which a producible asset is exploited jointly by several economic agents whose 'noncooperative' behavior results in overexploitation of the asset, i.e., an exploitation of the asset that is not jointly efficient (Pareto optimal).

In fact, market structures of exploitation patterns are often oligopolistic, i.e., there are several decision makers whose policies influence each other. So, game theoretical approaches are introduced into the discussion. According to the theory of continuous time models of Optimal Control, the appropriate analogue of differential games is used. Roughly, this is an extension of Optimal Control, when there is an exactly one decision maker, to the case of N $(N>1)$ decision makers interacting with each other.

Dynamic models of exploitation (or harvesting) and use of natural resources refer to two different systems of property rights: In the case of sole ownership, optimal extraction policies can be obtained by means of Optimal Control Theory (Clark 1976); in the case of open access or common property exploitation, game theoretical models are applicable in the sense that all decision makers exploit a resource from a common pool without any restriction, looking only at their own profits over some time horizon, and without considering the stock of the resource, which is diminished due to the extraction policies of all the players of the game who share the common pool (Clark 1980, Dockner *et al.* 1989).

Environmental problems can be understood as the exploitation of a common pool of a natural resource by several players. For example, activities with polluting results have cumulative future consequences. Activities of some nations may affect the interests of other nations, that is a kind of players' interdependence. The emissions of sulphur lead to acid rain, which does not respect borders, or pollution of the sea caused by industrial activities

in areas located far away but connected with the sea by a river which transports the waste industrial residuals. This pollution may have impacts on other economic sectors of the same nation or of borders.

Whenever decision makers are few, one cannot use models of perfect competition, but the appropriate framework for the discussion of these problems is given by theoretical approaches with special regard to the question of 'how to play the game': cooperatively or non–cooperatively?. Moreover if we assume that there is a regulator managing environmental and natural resources problems, caused by natural resource extraction, it is impossible in our opinion to settle the problem because is difficult to find which is the polluter in order to compensate the pollute for the damage incurred, from the Pigouvian point of view.

In natural resources economics there is a chain of externalities arisen by human activities, known as environmental externalities. Once a natural resource is explored or it is ready for exploitation the first externality arises from the fact that the extraction cost increases not only with the current exploitation rate, but with the cumulative amount extracted to date. Consequently, a unit of resource extracted today will inflict an intertemporal externality in the form of pushing up extraction costs at all future dates, assuming a twice continuously differentiable cost function. The cost function, along the extraction path, must be an increasing function not only with respect to the extraction rate but also it must be an increasing function of the remainder stock. In such a way it is possible to assume that the marginal current exploitation cost is higher both at higher exploitation rate and, for a constant rate of exploitation, at higher depletion rates.

The second externality is in association with the use of the extracted resource. The resource use not only damages the environment through the current flow of an externality, but also damages the environment indirectly by adding to the accumulated stock of an externality and pushing it toward to a critical level. A well-known example is the externalities associated with fossil fuel use when the flow externality may take one of the forms of air pollution, pollution of the seas by oil spills, land pollution caused by dumping of coal wastes, while the stock externality takes the form of greenhouse warming and acid rain.

From the supply side point of view, resource-extracting oligopolists continually engage in the search for additional stocks or in finding new technologies to transform resources that are economically non-exploitable into resources that can be profitably extracted. If the demand curve facing the industry is elastic, the discovery of additional stocks will raise the industry's profit. It is not clear, however, if all firms will benefit from a windfall 'gain' (discovery) that increases the stock of each firm.

When a given number of firms deplete an exhaustible resource with zero extraction costs and iso–elastic demand, it has been argued that the oligopoly and cartel outcomes are efficient and that firms deplete according to the Hotelling's rule (Dasgupta, and Heal 1979). This implies that dynamic oligopolies and cartels cannot be distinguished from perfect competition and that firms act as if there are well defined private property rights. These results are somewhat counter intuitive and cannot explain the phenomena of 'wild – cutting'. One reason for excessive extraction rates in oligopolistic resource markets may be that firms are worried that, if they announce to extract efficiently, one of their rivals with access to current stock levels will have an incentive to deplete more rapidly, therefore yielding inefficiency.

In this paper, we consider oligopolistic equilibrium in subgame-perfect strategies in continuous time, and investigate the effect of stock discovery on the profits of non-identical oligopolists. We show that a uniform addition to all stocks could harm firms that are originally larger than average.

In a static model, this result is not surprising. Starting from Cournot equilibrium it is well known that a marginal reduction of all firms' production will be beneficial to the firms and will move them closer to the cooperative equilibrium. Conversely, increasing the output of all firms is likely to move them further from the cooperative outcome and will reduce their profits. In a dynamic framework with free time horizon, this reasoning is not necessarily valid. The typical extraction path under non-cooperation is monotonically decreasing over time with production level below the production level of cooperative exploitation for at least some interval of time, which we refer to as a scarcity phase. When a firm receives an additional stock it splits its extra-exploitation between the scarcity phase and the phase where production is above the cooperative level. Increasing exploitation during the phase where production is above the cooperative level decreases instantaneous profits but increasing exploitation in the former phase increases instantaneous profits, resulting in an unclear conclusion for the overall impact in firms profits.

Existing models of natural resource oligopoly that use the concept of Markov perfect Nash equilibria are typically based on the assumption that there is only one stock, to which all firms have equal common access (*see* for instance, Benchekroun 2003, Benchekroun, and Long 2002, Dockner, and Sorger 1996, Benhabib, and Radner 1992). Our model has N stocks, and we rule out common access.

The rest of the paper is organized as follows. Section 2 describes the model of resource extraction with an isoelastic demand function. Section 3 provides the Markov perfect Nash equilibrium strategies that are time consistent and the resulting value function for the strategies. Section 4 proposes some policy instruments based on changes (marginal or uniform) of the allowed resource stock, while Section 5 concludes the paper.

2. The basic model

Let us assume that there are N firms in an oligopoly market. Firm i is endowed with a stock of a resource $S_i(t)$ at time t, with $S_i(0)=S_i^0$. Let $S(t)$ denote the sum of all stocks at time t, that is

$$S(t)=\sum_{i=1}^{N} S_i(t)$$

We define $S_{-i}(t)=S(t)-S_i(t)$. We then also assume that the rate of change of firm's i resource stock is[48]

$$\frac{dS_i(t)}{dt}=\dot{S}_i(t)=-h_i(t)$$

where $h_i(t)$ is firm's i extraction rate at time t. The inverse demand function is given by

$$D(h(t))=(h(t))^{f(a(t))}$$

with $f(a(t))=-a(t),\quad a(t)\in(0,1] \quad \forall t\in(0,+\infty)$

and $h(t)=\sum_{i=1}^{N} h_i(t)$ denotes the overall extracted quantity.

The function $\left[f(a(t))\right]^{(-1)}=1/a(t)\geq 1$ determines, in absolute value, the instantaneous elasticity of demand, i.e. the inverse demand function is always elastic and takes the hyperbolic shape if $a(t)=1$ (i.e. a constant), but is always convex.

Here in order to form the dynamic problem we assume utility derived from revenues, so firms in industry are rather revenues maximizers. Moreover we assume that the resource stock is not restrictive for the firms' decisions (i.e. extraction rate) but the regulator is the decision maker of the state variable, i.e. the remainder resource stock as you will see below. One of the results[49] of the paper is that the control trajectory is strictly dependent on the extraction trajectory and on instantaneous elasticity as well. So, the state variable as affected from the control, the problem is an optimal control for every involved firm.

Having these assumptions the dynamic formulation can be presented as follows. Firm's i revenues are given by the expression:

$$R_i(h_i,h_{-i})=h_i(h_i+h_{-i})^{f(a(t))}$$

where

$$h_{-i}=h-h_i$$

The objective function of firm i is to maximize the present value of the stream of cash flow subject to the system dynamics, that is the problem[50]

$$\max \int_0^{\infty} h_i(h_i+h_{-i})^{f(a(t))} e^{-\rho t} dt \qquad (1)$$

subject to

$$\dot{S}_i(t)=-h_i(t)$$

with

$$S_i(0)=S_i^0$$

The control variable of firm i is its quantity h_i, while the state variable is its remainder resource S_i.

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[48] A similar adoption in the resource reduction equation is made by Batabyal (1995a, 1995b)

[49] In another perspective a second result could be the fact that a tightening of the regulation on total allowent resource stock can lead to an increase in firms' NPV of discounted revenues.

[50] In this setting i.e. the state variable doesn't enter into objective function, the induced game seems to be a trivial one.

We seek to find a strategy and the value function of the dynamic problem under the Closed Loop[51] or Markovian Nash informational structure equilibrium which is by definition the concept of equilibrium in which the choice of player's i current action is conditioned on current time t and on state vector too.

Under the closed–loop informational structure and stationarity of the game the player's i strategy space[52] is this of mappings

$$\phi_i : \mathbb{R}^n_+ \to \mathbb{R}$$

which associates to a vector of resource stock $(S_1, S_2, ..., S_N) \in R^n_+$ the quantity $\phi_i(S_1, S_2, ..., S_N)$ to extract. Each player i of the game has to choose a quantity $h_i(t) \in R$ of the resource, and the price of that resource is then set according to

$$D(h_1, h_2, ..., h_N) = \left(\sum_{i=1}^{N} h_i(t)\right)^{f(a(t))}$$

The utility (total revenues) enjoyed by firm i is then given by

$$U_i : (\phi_1, \phi_2, ..., \phi_N) \to \int_0^{\infty} D\left(\phi_1(S), \phi_2(S), ..., \phi_i(S), ..., \phi_N(S)\right) e^{-\rho t} dt$$

where $(S_k)_{k=1,...,N}$ evolve according to the differential equation determined by (1a). An equilibrium should then be defined as a set of strategies for which no player has a profitable deviation.

Imposing this assumption on informational structure of the game, clearly the history of the game is important and is reflected in the current value of the state vector. Consequently, player's i optimal time paths take into account at any point of time the control variables (quantity extracted) of the other players. This type of equilibrium affects the state variables, requiring a revision of the player's i controls at any time instant. Here we apply the Hamilton – Jacobi – Bellman (HJB) equation in order to prove that the conjectured strategy we propose is a Markovian strategy and consequently a strongly time consistent one. In contrast to the open loop informational structure the closed loop is a strongly time consistent one, but the open loop is not. Here the time consistent property is in the sense of sub–game perfectness (for more details *see* Dockner *et al.* 2000).

3. Markov Perfect Nash Equilibrium (MPNE)

We denote by ϕ_i the strategy that specifies firm's i extraction rate as a function of time t and the vector of remainder resource stock at the same time. This is the strategy:

$$h_i(t) = \phi_i(S(t))$$

Each firm takes competitors strategies as given and determines its optimal strategy that solves problem (1) with constraint (1a).

Proposition 1.

A MPNE exists, where the equilibrium strategy of firm i has the property that its extraction level depends on its own resource stock and on elasticity of demand. That is

$$h_i(t) = \frac{\rho}{a(t)} S_i(t) \qquad i = 1, ..., N$$

The discounted sum of firm's i revenues $V_i(S)$, when the total resource stock is S, are given by

$$V_i(S) = \left(\frac{a(t)}{\rho}\right)^{a(t)} \frac{S_i(t)}{S^{a(t)}} \qquad (2)$$

Proof (is given in the appendix)

Given the discounted revenues expression by (2), we are able to see the impact from a change in elasticity of demand in the discounted revenues. Therefore we take the derivative of the value function expression given by (2) with respect to the demand curvature a, assuming that the initial resource stock of firm's i and the overall resource stock S remains unchanged, that is

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[51] For more details about the informational structures of the dynamics games, *see* Olsder and Basar (1998).

[52] By strategy spaces, we mean the information available to each player together with a set of functions with this information as domain. These functions are actually the permissible ways in which the players are allowed to use that information. Open loop strategies, where at each instant of time *t* the players have knowledge of the present time instant *t* and the initial condition *S(0)* of the state, result in different equilibrium from the strategies where at each instant of time *t* the players have knowledge of the time *t*, the initial state *S(0)* and the current state *S(t)*.

$$\frac{dV_i}{da}=\left(\frac{\rho S}{a}\right)^{-a}\left(-\ln\left(\frac{\rho S}{a}\right)+1\right)S_i=V_i(S)\left(1-\ln\left(\frac{\rho S}{a}\right)\right)$$

which is a negative or positive quantity, meaning that the discounted revenues change will be negative or positive, depending on the sign of the quantity

$$1-\ln\left(\frac{\rho S}{a}\right).$$

3.1. The unary elasticity demand (A special case)

Consider for a moment that elasticity of demand equals to one independent of time, $a(t)=1$. As it is simply clear in this case the market demand function collapses to a hyperbolic shape, this being a special case of a more general class of models based on isoelastic demand curves. An isoelastic demand function was used to study the stability for a general Cournot oligopoly (Chiarellan and Szidarovsky, 2002) and in many variations (Puu, 1991, 1996, Puu, and Norin 2003, Puu, and Marin, 2006). Furthermore isoelastic demand functions is a result in the case the consumers maximize utility functions of the Cobb – Douglas type in a static environment. The static problem for the i consumer is $\max\left(D_1^i\right)^{a_1^i}\left(D_2^i\right)^{a_2^i}\cdots$, subject to the budget constraint $y^i=p_1D_1^i+p_2D_2^i+\cdots$ with p_k to denote the prices of the commodities and D_k^i denote the quantities demanded. The well-known outcome of this static constrained maximization is $p_kD_k^i=a_k^iy^i$ whence a_k^i is the fixed spending share of the i's consumer income y^i on the k-th good.

From the above problem solution the resulting demand for each consumer is reciprocal to price charged that is

$$D_k^i=\frac{a_k^iy^i}{p_k},$$

so dropping commodities indices, aggregate demand obtained (the sum of all consumers) as

$$D=\sum\nolimits_i D^i=\frac{\sum\nolimits_i a^iy^i}{p}=\frac{R}{p}.$$

Puu (2008) also uses the following price specification

$$p=\frac{R}{\sum\limits_{i=1}^{N}q_i}$$

where p denotes market price, $\sum\limits_{i=1}^{N}q_i$ is the total quantity produced, while R is the sum of the total budget shares that all consumers spend in the particular good. It is well known from the literature[53] in such a case the maximum problem of a firm choosing the output level is indeterminate if marginal cost is zero, since the revenues generated by a hyperbolic demand are constant, thus economically unacceptable. But even in this special case our model under closed loop informational structure yields linear strategies and value function as well. More precise setting demand elasticity to one, $a=1$, the model solution yields the following results for strategies and value function respectively:

$$h_i=\rho S_i \qquad i=1,\ldots,N \tag{3}$$

$$V_i(S)=\frac{S_i}{\rho S} \tag{4}$$

The latter reasoning leads us to conclude the following corollary.

Corollary 1

[53] For an exposition of a differential oligopoly model where firms face implicit menu costs of adjusting output over time due to sticky market price, *see* Lambertini (2007).

The above proposed model of an exhaustible resource extraction even in the special case of isoelastic demand, i.e. for constant consumers' budget share, yields deterministic Markovian linear strategies and value functions given by (3), (4) respectively.

3.2. Regulating policies in the allowed resource stock

We consider now the impact of a marginal change in the allowed resource stock imposed by an authority into the firms' value function. For this purpose we investigate the total differentiation of the value function

$$V_i(S)=\left(\frac{a}{\rho}\right)^a \frac{S_i(t)}{S^a}$$

with respect to the remainder resource, that is

$$dV_i=\frac{\partial V_i}{\partial S_i}dS_i+\sum_{j\neq i,j=1}^{N}\frac{\partial V_i}{\partial S_j}dS_j \qquad (5)$$

In order to have a unified result into the previous found value function of each firm we record the following proposition.

Proposition 2.

A marginal increase in the total resource stock, affects incrementally the discounted firm's i revenues, if the inequality $\frac{dS_i}{dS}>a\frac{S_i}{S}$ holds, otherwise an increase in the total resource stock reduces the discounted sum of firm's i revenues.

Proof (See Appendix)

In proposition 2 the elasticity of demand plays a crucial role. Inequality in proposition 2 implies that if the marginal changes in resource shares are greater than the marginal resource shares multiplied by the inverse elasticity, then every firm has incremental revenues. Assuming for a moment that a firm decides to extract a more inelastic resource with $a_1>a$ and with the same resource stock S_i. Clearly, the extraction rate of the more inelastic resource will be higher as the Markov strategy in proposition 1 reveals. But it is not clear that the raised revenues requirement $\frac{dS_i}{dS}>a\frac{S_i}{S}$ maintains the same inequality. So the firm decides at the margin which elasticity prefers to supply.

The total derivative of the value function after manipulations (see in the appendix) is given by the expression

$$dV_i=\left(\frac{\rho}{a}S\right)^{-a}dS\left(\frac{dS_i}{aS}-a\frac{S_i}{S}\right) \qquad (6)$$

Since the term $\left(\frac{\rho}{a}S\right)^{-a}$ of (6) always measures the aggregate demand, as

$h=\sum_{i=1}^{N}h_i=\left(\frac{\rho}{a}\sum_{i=1}^{N}S_i\right)^{-a}=\left(\frac{\rho}{a}S\right)^{-a}$ and we have set $\sum_{i=1}^{N}S_i=S$, the rest of term (6) $dS\left(\frac{dS_i}{dS}-a\frac{S_i}{S}\right)$ measures the amount multiplied with the total demand, giving the total marginal change on the discounted revenues.

Furthermore, we assume that the sign of expression (6) is positive, the latter assumption implies an increment of the discounted revenues, that is, $\frac{dS_i}{dS}>a\frac{S_i}{S}$ and firms are ranked by an increasing order of the allowed resource stock, $S_1<S_2<\ldots<S_i<S_{i+1}<\ldots<S_N$, so the initial resource shares are $\frac{S_i}{S}<\frac{S_{i+1}}{S}$. We have

$$dS_i>adS\frac{S_i}{S},\qquad dS_{i+1}>adS\frac{S_{i+1}}{S}$$

Subtracting the LHS and RHS of the two relations we have

$$dS_i-dS_{i+1}>a\frac{dS}{S}(S_i-S_{i+1}) \qquad (7)$$

The LHS of (7) is a small negative number. For a perfectly elastic demand $(a\approx 0)$ the LHS of (7) tends to zero, so we have $dS_i>dS_{i+1}\ \ (\forall i)$. According to (7) we conclude the following corollary.

Corollary 2

In the case of a large number of substitutes an increment in the discounted revenues caused by a marginal increment of the total allowed resource stock, dS*, the order of marginal increments of individual firms,* dS_i*, is ranked by the reverse order rather than the originally allowed set of resource stocks. That is, if* $S_1 < S_2 < ... < S_N$ *the result in the above marginal increase is* $dS_1 > dS_2 > ... > dS_N$.

The impact of an absolute increase to the pollution stocks $dS_i = \varepsilon \quad (\forall i)$ can be expressed as follows.

Corollary 3

A uniform absolute increase in all resource stocks by $dS_i = \varepsilon > 0$*reduces firm's* i *discounted revenues if and only if* $\frac{S_i}{S} > \frac{1}{aN}$.

Proof

The result is easily obtained since $dS = \sum_{i=1}^{N} dS_i = \varepsilon N \Rightarrow \frac{dS_i}{dS} = \frac{1}{N}$ and $a\frac{S_i}{S} < \frac{dS_i}{dS}$.

Next we consider a new allocation of the allowed stocks. With S_i^O we denote firm's i old allowed stock and with S_i^N the reallocated (new) allowed resource stock. Moreover we assume that the new allowed pollution is less than the original, $S_i^O > S_i^N \quad (i = 1,..,N)$.

The next proposition joins the two pollution stocks assuming the last given order.

Proposition 3.

The discounted revenues of each firm increases while the total resource stock falls, caused by a new allocation, if and only if $\sigma_i > (1-\sigma)^a + 1$*, where*

$$\sigma = 1 - \frac{\left(\sum_{k=1}^{N} S_k^N\right)}{\left(\sum_{k=1}^{N} S_k^O\right)}$$

and

$$\sigma_i = 1 - \frac{S_i^N}{S_i^O}$$

Proof (See Appendix)

Remark

The results of Proposition 3 may be used as follows. Suppose that an authority decides to decrease the total resource stock by an amount

$\Delta S \left(\sigma = \frac{\Delta S}{\sum_{i=1}^{N} S_i} \right)$, so in order to have each firm higher revenues, its allowed resource stock must be reduced by the amount

$S_i^O - S_i^N = \Delta S_i = \left((1-\sigma)^a + 1\right) S_i^O$.

In the same way we consider a uniform decrease η to all firms' resource stock. Then

$$\sigma = 1 - \frac{N\eta + \sum_{i=1}^{N} S_i^O}{\sum_{i=1}^{N} S_i^O} = \frac{N\eta}{\sum_{i=1}^{N} S_i^O}$$

and the raised revenues requirement is $\sigma > 1-(\sigma_i - 1)^{-a}$ and finally

$$\frac{N\eta}{\sum_{i=1}^{N} S_i^O} > 1-(\sigma_i - 1)^{-a}$$

where $S^O = \sum_{i=1}^{N} S_i^O$ is the initial allocation of the pollution and $\sigma_i = 1 - \frac{S_i^N}{S_i^O}$ the percentage change on firm's i allowed resource stock.

4. Concluding remarks

In this paper we set up a very simple model of extracting oligopolists where the demand is not linear and the resulting game is not a linear quadratic one. We also make the assumption that each firm is allowed to extract to a variable size depending on the criterion that is given by an authority. The results, in our opinion, are useful for a policy maker to make distributed extraction policies on the industry in total as well as partially on a firm.

One conclusion that could be drawn as a result of the above model is that a new technology that reduces the total amount of the extraction stock is not necessarily welcomed by all firms in the industry. If for example any authority decides to improve the technology that is used by firms previous analysis shows that the bigger, with respect to the allowed resource stock, firm does not always benefit from this decision.

Specifically, our results on a strong time consistent (Markov) equilibrium with conjectured value function and strategies are surprising. Although without exposing the solutions of the problem in full generality, as Tsutsui and Mino (1990) face their linear quadratic differential game in a duopoly with sticky prices, a strong time consistent solution is obtained using the conjectured method.

Moreover testing the above strategies and the value function obtained we are able to conclude some interesting policy implications. In general, we expect that for each firm the higher the extraction rates is the more the utility (discounted revenues) will be. However, the findings of the model are slightly different. It is possible a marginal decrease on the total extraction stock to increase the firms' discounted revenues, provided that the original allowed share multiplied by the elasticity of demand is greater than the marginal change share.

Additionally, a reallocation caused by a uniform decrease into all firms resources, reorders the marginal change of the stocks in reverse to the original order of the allowed stocks and again the reallocation is possible to raise the discounted revenues of each firm.

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APPENDIX

Proofs of Propositions

Proof of Proposition 1

First we check that if firm's j strategy is $h_j = \frac{\rho}{a} S_j$, then firm's i best response will be $h_i = \frac{\rho}{a} S_i$. The Hamilton-Jacobi-Bellman (hereafter HJB) equation for firm's i maximization problem is the following

$$\rho V_i = h_i \left(h_i + \frac{\rho}{a} S_{-i} \right)^{-a} + \frac{\partial V_i}{\partial S_i}(-h_i) + \sum_{j \neq i, j=1}^{N} \frac{\partial V_i}{\partial S_j} \left(-\frac{\rho}{a} S_j \right)$$

Maximization of the RHS of the HJB equation with respect to h_i gives

$$\left(h_i + \frac{\rho}{a} S_{-i} \right)^{-a} - a \frac{h_i \left(h_i + \frac{\rho}{a} S_{-i} \right)^{-a}}{\left(h_i + \frac{\rho}{a} S_{-i} \right)} - \frac{\partial V_i}{\partial S_i} = 0$$

or equivalently

$$\frac{\partial V_i}{\partial S_i} = \left(h_i + \frac{\rho}{a} S_{-i} \right)^{-a} \left[1 - a \frac{h_i}{\left(h_i + \frac{\rho}{a} S_{-i} \right)} \right] \qquad (A.1)$$

Where S_{-i} represents the sum of all resource stocks except firm's i stock, that is $S_{-i} = S - S_i$ and $S = \sum_{j=1}^{N} S_j$

Now we make use the nonlinear conjectured value function

$$V_i = \left(\frac{a}{\rho} \right)^a S_i \left(\sum_{j=1}^{N} S_j \right)^{-a}$$

Differentiation of the value function with respect to S_i yields

$$\frac{\partial V_i}{\partial S_i} = \left(\frac{\rho}{a} S \right)^{-a} \left(1 - a \frac{S_i}{S} \right) \qquad (A.2)$$

with $S = \sum_{j=1}^{N} S_j$ the same as above.

Equating the terms with the same power of $(A.1)$ and $(A.2)$ we have the resulting system of equations.

$$1 - a \frac{h_i}{\left(h_i + \frac{\rho}{a} S_{-i} \right)} = 1 - a \frac{S_i}{S} \qquad (A.3)$$

and

$$h_i + \frac{\rho}{a} S_{-i} = \frac{\rho}{a} S \qquad (A.4)$$

Both equations $(A.3)$ and $(A.4)$ have the same solution

$$h_i = \frac{\rho}{a} S_i .$$

Now we prove that substituting the above strategies into the RHS of the HJB function we have equality with the LHS of the same equation. The partial derivative of the value function V_i with respect to S_j is

$$\frac{\partial V_i}{\partial S_j} = -a\left(\frac{a}{\rho}\right)^a S_i S^{-(a+1)} < 0 \qquad (A.5)$$

so the RHS of the HJB becomes

$$\text{RHS(HJB)} = \frac{\rho}{a} S_i \left(\frac{\rho}{a} S\right)^{-a} - \frac{\rho}{a} S_i \left(1 - a\frac{S_i}{S}\right)\left(\frac{\rho}{a} S\right)^{-a} + \sum_{j\neq i, j=1}^{N} -a\left(\frac{a}{\rho}\right)^a S_i S^{-(a+1)}\left(-\frac{\rho}{a} S_j\right) =$$

$$= \frac{\rho}{a} S_i \left(\frac{\rho}{a} S\right)^{-a}\left(1 - 1 + a\frac{S_i}{S} + a\frac{S_{-i}}{S}\right) = \rho S_i \left(\frac{\rho}{a} S\right)^{-a} = \rho V_i(S) = \text{LHS(HJB)}$$

Whereas above we have set $S = \sum_{j=1}^{N} S_j$ and $S_{-i} = \sum_{j=1, j\neq i}^{N} S_j$

Proof of Proposition 2

The total derivative of the value function for the moment t is

$$dV_i = \frac{\partial V_i}{\partial S_i} dS_i + \sum_{j\neq i, j=1}^{N} \frac{\partial V_i}{\partial S_j} dS_j \qquad (A.6)$$

$$\frac{\partial V_i}{\partial S_i} = \left(\frac{\rho}{a} S\right)^{-a}\left(1 - a\frac{S_i}{S}\right) \quad (A.2) \quad \frac{\partial V_i}{\partial S_j} = -a\left(\frac{a}{\rho}\right)^a S_i S^{-(a+1)} \qquad (A.5)$$

Substituting the partial derivatives $(A.2)$ and $(A.5)$ previously found, into $(A.6)$ the derivative of the value function takes the form:

$$dV_i = \left(\frac{\rho}{a} S\right)^{-a}\left(1 - a\frac{S_i}{S}\right) dS_i + \sum_{j\neq i, j=1}^{N} -a\left(\frac{\rho}{a}\right)^{-a} S_j S^{-(a+1)} dS_j$$

Putting the term $-\left(\frac{\rho}{a} S\right)^{-a} a\frac{S_i}{S} dS_i$ inside the sum, the above expression simplifies to

$$dV_i = \left(\frac{\rho}{a} S\right)^{-a} dS_i + \sum_{j=1}^{N} -a\left(\frac{\rho}{a}\right)^{-a} S_j S^{-(a+1)} dS_j$$

Multiplying and divide the first term the RHS of the latter by $a\left(\frac{\rho}{a} S\right)^{-a} \frac{1}{S}\sum_{j=1}^{N} S_i dS_j$

we have

$$dV_i = \left(\frac{\rho}{a} S\right)^{-a}\left(\sum_{j=1}^{N} dS_j\right)\left(\frac{dS_i}{\sum_{j=1}^{N} dS_j} - a\frac{S_j}{S}\right)$$

Setting $dS \equiv \left(\sum_{j=1}^{N} dS_j\right)$ the latter simplifies to

$$dV_i = \left(\frac{\rho}{a} S\right)^{-a} dS\left(\frac{dS_i}{dS} - a\frac{S_i}{S}\right) \qquad (A.7)$$

The meaning of $(A.7)$ is, as we expect that a change in the allowed resource stocks results in the same sign change on firm's i discounted revenues depending on the sign of the term inside the brackets. That is, if the

sign of the bracketed term is positive an increase in the total resource stock dS increases the discounted revenues of firm's i , as the term outside brackets reveals and vice versa.

Now consider the term of $(A.7)$ $\left(\frac{dS_i}{dS} - a\frac{S_i}{S}\right)$, which shows how the change on firm's i revenues responds to a marginal change in the resource stock. The term under consideration has positive sign which means that

$$a\frac{S_i}{S} < \frac{dS_i}{dS} \qquad (A.8)$$

i.e. the original allowed resource stock share multiplied by the reverse elasticity is less than the marginal change share.

Proof of Proposition 3

From solution of the original value function we have the two value functions of the discounted revenues

$$V_i\left(S^O\right) = \left(\frac{\rho}{a}\right)^{-a} S_i^O \left(\sum_{k=1}^{N} S_k^O\right)^{-a} \qquad (A.9)$$

$$V_i\left(S^N\right) = \left(\frac{\rho}{a}\right)^{-a} S_i^N \left(\sum_{k=1}^{N} S_k^N\right)^{-a} \qquad (A.10)$$

Subtracting $(A.9)$ from $(A.10)$ to have incremental revenues, the positive change in firm's i revenues due to reallocation is

$$\Delta V_i = V_i\left(S^N\right) - V_i\left(S^O\right) = \left(\frac{\rho}{a}\right)^{-a} S_i^N \left(\sum_{k=1}^{N} S_k^N\right)^{-a} - \left(\frac{\rho}{a}\right)^{-a} S_i^O \left(\sum_{k=1}^{N} S_k^O\right)^{-a} =$$

$$= \left(\frac{\rho}{a}\right)^{-a} S_i^N \left(\sum_{k=1}^{N} S_k^O\right)^{-a} \left[\frac{\left(\sum_{k=1}^{N} S_k^N\right)^{-a}}{\left(\sum_{k=1}^{N} S_k^O\right)^{-a}} - \frac{S_i^O}{S_i^N}\right]$$

The latter expression simplifies denoting by $\sigma = 1 - \frac{\left(\sum_{k=1}^{N} S_k^N\right)}{\left(\sum_{k=1}^{N} S_k^O\right)}$ the percentage decrement into the total resource stock and with $\sigma_i = 1 - \frac{S_i^N}{S_i^O}$ the percentage change into firm's i resource stock. In order to have an increment into firms' i discounted revenues it suffices to hold the condition

$$(1-\sigma)^{-a} > \frac{1}{\sigma_i - 1}$$

CONSUMPTION IN DEVELOPED AND EMERGING ECONOMIES

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Abstract:
In what follows various econometric technique is applied to determine the source of consumption growth with historical retrospective to equity and real estate markets as well comparative analysis of US consumer and Chinese consumer is presented. Evidence supports the argument that consumption as economic growth engine has been possible only due to ability to withdraw and spend equity from appreciating assets in the USA. Financial underdevelopment of emerging economies makes replication of this process questionable.

Keywords: consumption, household wealth, consumer credit, credit

JEL Classification: E21

1. Introduction

Consumption is important driver of growth in terms of conventional GDP accounting, therefore determination of the source of consumption financing in developed countries might shed light on how likely is emerging market consumer to become the new engine of economic growth. First, source of increased US consumption during 1995-2005 is determined. Legislative amendments allow identifying possible benchmark years for structural change. Analogue of Chow test via dummies reconfirms structural changes in the economy in 1995 as well as 2000. Due to appreciating asset prices from deregulation of real estate and commercial banking industries, consumption no longer relies on disposable income but rather consumer wealth that translates into stationary between consumer credit and consumer wealth. Consequently, economic growth dependent on consumption is actually economic growth dependent on appreciating assets[54] rather than, say, technological progress. As a result, ability of emerging markets to become new engine of growth requires ability of households to benefit from appreciating equity markets as well as real estate markets. It is shown that these necessary conditions are not present in China as emerging market proxy. Therefore, argument in favor of the superiority of emerging markets in setting global economic growth is questionable.

2. Developed market perspective

Equity boom in the US that started in mid 1990s has been driving consumer wealth (CW[55]) and consumer credit (CC[56]) with it up to the early 2000 when deregulation in the financial sector coupled with development of sophisticated financial products allowed to securitize illiquid assets, increasing wealth of consumer via raise in the price of previously illiquid assets like real estate (Figure 1). Laibson, Mollerstrom (2010) have argued that asset price movements, including the equity markets and residential real estate markets are capable of explaining international financial flows (i.e. private debt build-up). During the period of inflated asset values, US consumers spent their new wealth, with marginal propensity to consume of about 4%. The asset bubble framework also quantitatively explains the large current account deficit of the US.

[54] This is interesting phenomenon when conventional CPI figures do not capture asset price inflation, i.e. CPI in the USA in 1990 – 2005 remained flat. Or rather, this might simply means that CPI is not useful tool in analysing economic situation.

[55] From the Federal Reserve's B.100 Flow of Funds release.

[56] The total outstanding consumer credit amount. This index is taken from the G.19 report disseminated by the Federal Reserve. Covers most short and intermediate term credit extended to individuals, excluding loans secured by real estate.

Figure 1. S&P Index (grey line), Household Wealth (net worth, red line) and House Prices (S&P/Case-Shiller Home Price Index, blue line). 1990-2010

Source: Federal Reserve's B.100 Flow of Funds release, Case-Shiller.

Figure 2 shows that consumer credit started to decouple from disposable income (DI) in mid 1990s when equity market rate of growth has increased.

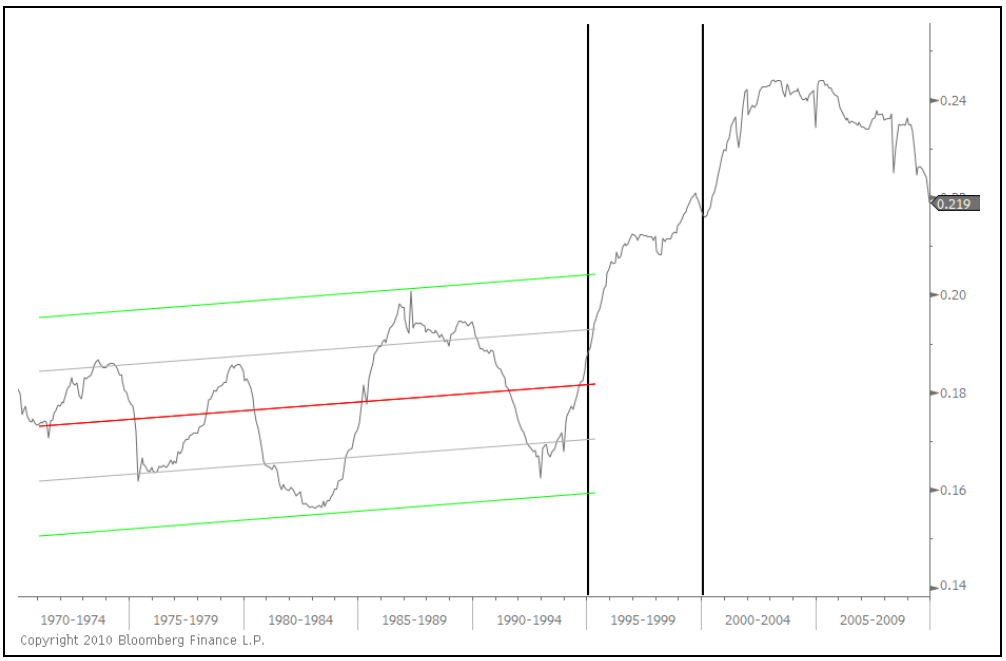

Figure 2. Consumer Debt/Disposable Income ratio, 1970-2009.

Notes: Red line - regression line with 2 STD (green line).
Source: Federal Reserve's G.19. Report, Bureau of economic Analysis.

To account for possible structural change in the rate of growth in equity markets, the analogue of the Chow test[57] via dummy variables is employed. Results in Table 1 confirm that there has been indeed a significant change in the pre and post 1995 equity price growth rates.

Table 1. Structural Break Test for S&P 500 Index

Regression results for $\ln S\&P_t=\alpha_1+ \alpha_2 D_t+\beta_1 t+ \beta_2(D_t*t_t)+\mu_t$		
Variable	**Coefficient**	
C	5.801*	(0.012)
TIME	0.006*	(0.0005)
DUM	-0.740*	(0.035)
DUM*TIME	0.011*	(0.0005)
Adjusted R-squared: 0.9887; F-statistic: 3501; Prob (F-statistic): 0.000; Data adjusted for autocorrelation via Newey-West HAC Standard Errors & Covariance (lag truncation=5). * - significant at the 0.01 level; ** - significant at 0.05 level. Standard errors in ( ).		

Notes: Regressand is the logarithm of S&P500 Index and the regressor is 'time,' which will take values of 1, 2, 3, etc. D=dummy variable. Dummy takes the value of 0 for older subperiod and 1 for latter subperiod. Subperiods 1990-1995 and 1995-2000.

Results show that both differential intercept and slope coefficients are statistically significant, strongly suggesting that the growth rate of S&P Index for two sample periods differ. Since equity income is part of consumer wealth (household worth, as in Federal Reserve form B.100 Flow of Funds release) it comes as no surprise that surge in wealth is caused by S&P index trend change. I test for the structural shift in consumer credit with benchmark year 1995[58]. Results presented in Table 2 in reconfirm the structural change in 1995.

Table 2. Structural Break Test for Consumer Credit

Regression results for $CC_t=\alpha_1+ \alpha_2 D_t+\beta_1 t+ \beta_2(D_t*t_t)+\mu_t$		
Variable	**Coefficient**	
C	88.50*	(12.53731)
TIME	3.159*	(0.078704)
DUM	-1663.7*	(36.39433)
DUM*TIME	6.595*	(0.122910)
Adjusted R-squared: 0.99736; F-statistic: 54018; Prob (F-statistic): 0.000; Data adjusted for autocorrelation via Newey-West HAC Standard Errors & Covariance (lag truncation=5). * - significant at the 0.01 level; ** - significant at 0.05 level. Standard errors in ( ).		

Notes: Regressand is the consumer credit and the regressor is 'time,' which will take values of 1, 2, 3, etc. D=dummy variable. Dummy takes the value of 0 for older subperiod and 1 for latter subperiod. Subperiods 1990-1995 and 1995-2000.

The second benchmark candidate for structural change is expected to be year 2000[59], when Glass–Steagall act has been repealed. Initial assumption has been related to consumption financed with debt or bank debt (which is the asset side of the banking sector). In order to account for possible policy shift after the Glass–

[57] Gregory C. Chow, 'Tests of Equality Between Sets of Coefficients in Two Linear Regressions,' *Econometrica,* vol. 28, no. 3, 1960, pp. 591–605.

[58] It is possible that change in legislation might have caused decoupling of credit aggregates. In particular, the 1995 New Community Reinvestment Act strengthened the role of Fannie Mae and Freddie Mac in mortgage markets and facilitated mortgage securitization. Therefore, 1995 is appropriate candidate for structural change benchmark.

[59] There has been legislation change in 1999 – Gramm-Leach-Bliley Act, which removed the prohibition that prevented bank holding companies from owning other financial companies and 2000 Commodity Futures Modernization Act, which stipulated that financial derivatives such as CDOs would not be regulated as futures contracts, securities.

Steagall act has been repealed at the end of 1999[60] the dummy regression model is applied. Results are presented in Table 3.

Table 3. Stability Tests for GDP, Aggregate Bank Assets (BA)

Regression results for $BA_t=\alpha_1+\alpha_2D_t+\beta_1GDP+\beta_2(D_t*GDP_t)+\mu_t$		
Variable	**Coefficient**	
C	-70.171*	(19.858)
GDP	0.5728*	(0.0052)
GPD*D	0.4590*	(0.0233)
DUM	-4208.0*	(250.74)
Adjusted R-squared: 0.99857; F-statistic: 94214; Prob (F-statistic): 0.000; Data adjusted for autocorrelation via Newey-West HAC Standard Errors & Covariance (lag truncation=5). * - significant at the 0.01 level; ** - significant at 0.05 level. Standard errors in ( ).		

Notes: D=dummy variable. Dummy takes the value of 0 for older subperiod and 1 for latter subperiod. Subperiods 1973-2000 and 2000-2008.

As regression results show, both the differential intercept and slope coefficients are statistically significant, strongly suggesting that the *BANK ASSETS-GDP* regressions for the two time periods are different. The same applies to *BANK-ASSET-DISPOSABLE INCOME* or *BANK ASSETS-CONSUMER CREDIT* relationships (regression results not presented here). It is, therefore evident that banking sector has decoupled from the economy, whether measured relative to disposable income, GDP or consumption. This decoupling however did not bring any surge in disposable income as presented in Table 4.

Table 4. Disposable Income Analysis

Regression results for $\ln DI_t=\alpha_1+\alpha_2D_t+\beta_1t+\mu_t$		
Variable	**Coefficient**	
C	7.01*	(0.0731)
DUM	-0.21**	(0.0828)
TIME	0.07*	(0.0041)
Adjusted R-squared: 0.98701; F-statistic: 1254; Prob (F-statistic): 0.000; Data adjusted for autocorrelation via Newey-West HAC Standard Errors & Covariance (lag truncation=5). * - significant at the 0.01 level; ** - significant at 0.05 level. Standard errors in ( ).		

Notes: Regressand is the logarithm of disposable income and the regressor is 'time,' which will take values of 1, 2, 3, etc. Dummy takes the value of 0 for older subperiod and 1 for latter subperiod. Subperiods 1973-2000 and 2000-2008.

Disposable income has actually been growing more slowly in 2000-2008 period than in 1973-2000 period. Consequently, bank asset growth has not coincided with surge in disposable income but has coincided with surge in consumer credit. This has led to 2nd round of CC decoupling from DI (Figure 2). It seems that it is stock markets that have been driving consumer wealth in mid 1990s that have affected consumption pattern. After 2000 housing was increasing wealth and drove consumption higher. CC/CW is the only variable that remained stationary, i.e. mean reverting, for the period 1973-2008 as shown in Table 5.

[60] The repeal enabled commercial lenders such as Citigroup, which was in 1999 the largest U.S. bank by assets, to underwrite and trade instruments such as mortgage-backed securities and collateralized debt obligations and establish so-called structured investment vehicles, or SIVs, that bought those securities. It was originally introduced in order to separate bank types according to their business (commercial and investment banking) in 1933 to exclude the possibility of commercial banks being too exposed to risky assets.

Table 5. Consumer Credit/Consumer Wealth Stationarity

Null Hypothesis: CC/CW ratio has a unit root			
		t-Statistic	**Prob.***
Augmented Dickey-Fuller test statistic		-3.574630	**0.0067**
Test critical values:	1% level	-3.445701	
	5% level	-2.868202	
	10% level	-2.570384	
Lag Length: 9 (Automatic based on SIC, MAXLAG=17); *MacKinnon (1996) one-sided p-values. Augmented Dickey-Fuller Test Equation			

These results are consistent with Barrell and Davis (2007) who found that removal of liquidity constraints during liberalization may reduce the response of consumption to real personal income, and what is most important, may boost wealth effect correspondingly[61]. By employing various econometric techniques, they test the relationship between consumption, income and aggregate real net wealth in the long term that is augmented by a split between changes in tangible wealth and financial wealth in the short term. What they find is that when financial liberalization takes place, the coefficient on human wealth (i.e. income) may be reduced, as scope for borrowing means consumption is less closely tied to current income. Furthermore, the weights on financial and non-financial nonhuman wealth could change with liberalization. When households are constrained in their borrowing, direct liquidity of the components of wealth will be crucial for their effect on consumption. A lower weight would be anticipated for less liquid assets and especially for tangible wealth. When there are no credits constraints, as in a liberalized financial system, consumers can borrow to cover shortfalls in income and consume out of wealth, and in particular illiquid wealth. Higher wealth effects, especially in the short run dynamics of adjustment, are thus likely both for illiquid financial assets (equities, bonds, pension assets) and non-financial tangible wealth. Byrne and Davis (2003) showed in rolling regressions that there has been a rise in the long run impact of illiquid financial wealth on consumption in G7. Modelling the G-5, Barrell and Davis (2004) highlighted that absence of credit constraints also affects non-financial tangible wealth. The incidence of liquidity constraints was considered to be shown inter alia by the relative size of income and wealth terms in the consumption function, which was a crucial difference between their estimates over 1980-2001 for less liberalized countries such as Germany and Japan vis a vis France, the UK and US. Meanwhile, tangible wealth was generally significant in both the short and long run. Lee, Rabanal and Sandri (2010) found that wealth effect was a primary factor behind the rapid decline in the U.S. saving rate (raise in consumption rate) in the late 1990s. They found that high-wealth groups which benefited most from raising wealth decreased substantially their saving rate, while low-wealth groups changed little or even increased their saving rate.

3. Emerging markets perspective

The Chinese government has called for rebalancing the economy towards greater reliance on consumption as the driver of growth, away from investment and external trade as has been in recent years[62]. Underlying this, is the striking trend of continuing decline in the share of household consumption in GNP, which has fallen to below 40 percent in 2005, despite the remarkable pace of sustained high economic growth. In explaining this declining share of consumption, studies have largely focused on the household savings behavior, arguing that this trend reflects the high and rising savings by Chinese households (Blanchard and Giavazzi (2005), Kujis (2005), Modigliani and Cao (2004), Prasad and Rajan (2006)), due to a range of factors such as the rise in average household income, the increase in the proportion of working age population, and an increase in precautionary savings with the rise in the uncertainties during reforms (especially that of state-owned enterprises) and inadequate public provision of pensions, healthcare, and education. While there is little doubt that these factors could be important in explaining the rise in the household saving rate, it is less convincing that these are the main reasons for the decline in the consumption share. In fact, data suggests that the increase in saving alone explains only a small fraction of the decline in the consumption share. The rise in household saving rate of

[61] Similar studies have been performed by Davis and Palumbo's (2001) study of the US consumption function, which attempted to determine whether changes in wealth as well as income affect the growth rate of consumer spending. Ludvigson and Steindel (1999) also examined wealth effects in a quarterly loglinear long-run US consumption relationship and found a common trend and a statistically significant wealth and income effect (Barrell and Davis (2007))

[62] See for example, Zhou Xiaochuan's (Governor of the People's Bank of China) foreword in Jahangir Aziz et. al edited, 'China and India: Learning from Each Other,' IMF, 2006.

5 percentage points since the early 1990s can only explain 1 percentage of the 9 percentage points decline in the share of consumption that has occurred since then[63]. During the same time the share of household income in GNP declined by 8 percentage points. The decline in household income's share occurred across all major sub-categories, but particularly in wages, which, unsurprisingly, is the largest component of income. The shares of investment income and government transfers also fell. Given that the decline in wage income was the largest contributory factor, it may be tempting to seek an answer in China's labor market. With 100-150 million workers either unemployed or underemployed[64], it is perhaps easy to argue that this slack in the labor market has prevented wages from rising as fast as productivity, leading to the continued decline in the share of wage income. If one adds to that some degree of monopolistic power in the hands of the employers and ineffective worker protection, then it is even easier to see why workers have not benefited from the huge productivity gains the economy has enjoyed.

Aziz and Cui (2007) have shown that China's underdeveloped financial sector and persistent and rising difficulty for average firms to obtain financing has played a major role in explaining the co-movements in employment, household income, and consumption over the last two decades. Specifically, Chinese firms rely on bank financing for working capital to pay wages and other current expenditure, where they are credit constrained. These borrowing constraints act like taxes on labor input that discourage the use of labor and create a wedge between the market wage rate and the marginal product of labor. Because of this wedge, the labor share in national income is less than its technologically determined share and the more difficult it is for firms to borrow, the larger is this wedge and lower is labor share. The paper showed that since the mid-1990s, pressures to reform forced Chinese banks to become more conservative in their lending operations to avoid creating new non-performing loans, which tightened borrowing constraints of firms, leading to a decline in the wage share. The declining share of wage income, however, would not necessarily have led to such a steep fall in household income share, if rising profits were distributed to households. This did not happen in China for several reasons. First, despite some listing in domestic stock markets, ownership of Chinese firms is not widely held, either directly or indirectly (through institutional investors and pension funds), by households. Second, even for firms that are listed, weak corporate governance and minority shareholding rights have allowed firms to accumulate profit instead of distributing dividends.

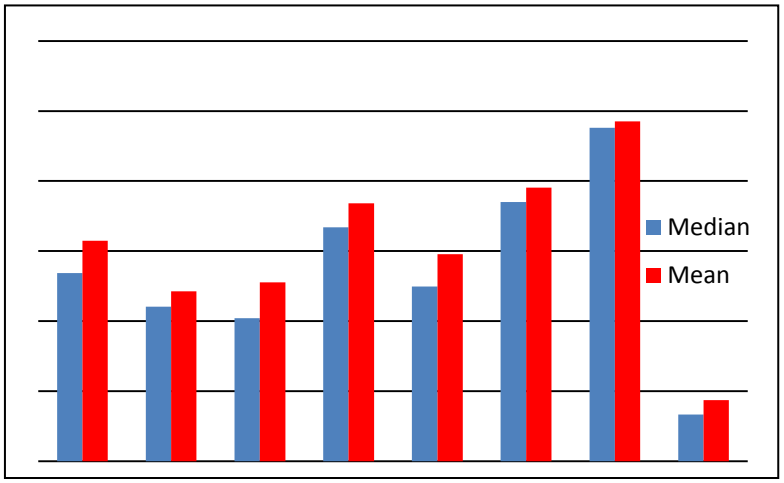

Figure 3. Dividend Yield

Notes: Dividend yield calculated by dividing 2009 dividend per share from the income statement by the period end price per share. Number of companies: USA (1731), Japan (2879), Korea (869), Malaysia (498), Philippines (76), Taiwan (420), Thailand (227), China (875). Companies selected according to country of domicile.

Source: Bloomberg

A string of scandals in the past few years associated with poor supervision of brokerage firms led to a protracted period of depressed equity prices and limited transactions such that households who owned shares did

[63] Aziz and Cui (2007)

[64] Merrill Lynch, February 2009, Asian Economics Snapshot.

not benefit from underlying capital gains. Third, the government still retains considerable ownership of the corporate sector. In most countries, this has been a conduit of indirectly transferring corporate profit to households. State-owned enterprises (SOEs) pay dividends to the government, which uses the funds to provide goods such as education and health that are essentially private goods, and welfare payments. In China, SOEs do not pay dividends to the government, such that this conduit of profit transfer has been closed. Lastly, bank deposits are the main vehicle of savings of Chinese households. However, the interest rate on household deposits has been capped by the government. Consequently, the share of interest earnings has declined over the years. China's banks have, of course, enjoyed higher interest rate margins. However, with much of the banking sector, burdened with high non-performing loans, under-capitalized, and under-provisioned until only last year, the higher interest margin has, for all practical purposes, ended up as being 'transfers' from households to corporations. For these reasons and unlike in many other countries, the rise in corporate profits did not translate into higher household income in China. The comparison with international experience is striking. During the past decade, less than 8 percent of households' disposable income came from investments (including profit, interest rate, etc). This is one of the lowest in the world as presented in Figure 4.

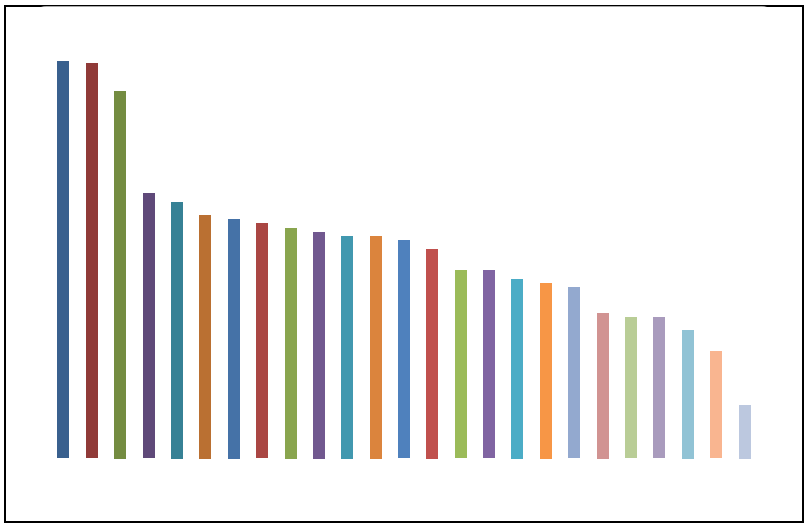

Figure 4. Investment Income (in percent of disposable income)

Source: Aziz and Cui (2007)

The nexus between financial sector development and growth is a long standing branch of economics literature. However, much of this literature, especially on the empirical front, has focused on the role played by financial intermediaries in mobilizing savings and some on their role in allocating savings. On the first role in China, earlier studies found that the banking sector did not contribute that much to growth through resource mobilization and allocation (see e.g., Aziz and Duenwald (2002)). Instead, bank financing was largely concentrated in the more sluggish state-owned enterprises, which could have aided growth indirectly by helping to maintain social stability in the economy. The low share of investment income in China brings into sharp focus the poor performance of the financial sector to distribute profit income from firms to households, both in the form of dividends and interest. China's stock market is relatively small despite the rise of private firms and the dilution of public ownership through listings in the stock market and through sales to foreign investors (Figure 5).

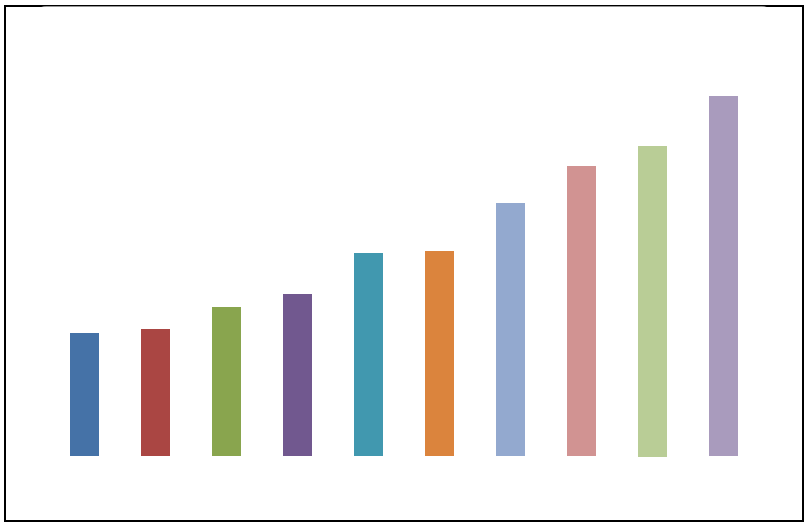

Figure 5. Market capitalization (percent of GDP, 2010)

Notes: Market capitalization includes total equity market capitalization as well as aggregate corporate and sovereign bond market capitalization, i.e. bonds and loans outstanding.
Source: IMF, Bloomberg.

Consequently, it is not surprising that distribution of household financial wealth is mostly concentrated in bank deposits (over 80%, Aziz and Cui (2007)) as compared to equity.

4. Housing wealth in China

During the late 1980s and 1990s, households in most Chinese cities were offered the chance to purchase the apartments that they rented from the state, thereby untying access to housing from working in the state sector and giving urban residents a chance to become private homeowners. Iyer, Meng and Qian (2009) find that the privatization reform caused private ownership of housing to increase from zero to approximately 50% of urban households. The untying of housing from state employment is probably the main driving force for this result, rather than the acquisition of private property rights. While it is not possible to test this directly, it is possible to individually test some of the implications of the different channels of private property rights like the importance of the credit channel for example. Though households in China at the time did not have access to credit from formal financial institutions for small businesses, private property can potentially be used as collateral for informal loans. Iyer, Meng and Qian (2009) present evidence that the housing privatization reform did not increase households' ability to obtain credit, in keeping with the institutional setting in China. Regression showed that households are not more likely to have either a housing loan or a non-housing loan following the enactment of housing privatization reforms. Iyer, Meng and Qian (2009) also find that the estimated coefficients for the effect of the reform on total household consumption and expenditure on housing improvements are small, negative and statistically insignificant. All of this suggests that the reform did not significantly increase household wealth.

5. Conclusion

Consumer credit has decoupled from disposable income in mid 1990s when equity market growth rate has changed. This coincides with 1995's New Community Reinvestment Act, which strengthened the role of Fannie Mae and Freddie Mac in mortgage markets and facilitated mortgage securitization. Consumer credit has also decoupled from disposable income in 2000s when Glass–Steagall act has been repealed, which allowed banks to be involved in investment activity in sophisticated financial instruments which in turn made previously illiquid assets (real estate) liquid, therefore raising demand on such instruments and therefore their price. Increasing consumption in developed markets caused by reliance of consumers on equity markets as well as ability to withdraw equity from appreciating real estate has been at the core of consumer spending expansion. Consumer credit has been increasing with consumer wealth, leaving CC/CW ration stationary. Chinese have neither developed stock market to benefit from raising corporate profits via dividends nor bond market – they are limited to deposits which rates are depressed. Neither there is an ability to withdraw equity from housing as well as privatization did not result in increased wealth by households. Disposable income by itself is not sufficient to fund

increased consumption – neither there are any conditions for increased disposable income in China. In summary, consumer as the engine of economic growth is simply non-existent in China to the degree that it exists in US and this phenomenon has to do with economic structure (financial architecture) of the economy. Credit tightening is closely associated with both rising uncertainty and declining wealth. And a large uncertainty appreciably reduces consumption not only via a lower wealth and tighter credit, but also indirectly via precautionary savings and postponed consumption. Deleveraging cycle in the banking sector has just begun as evident from Figure 6.

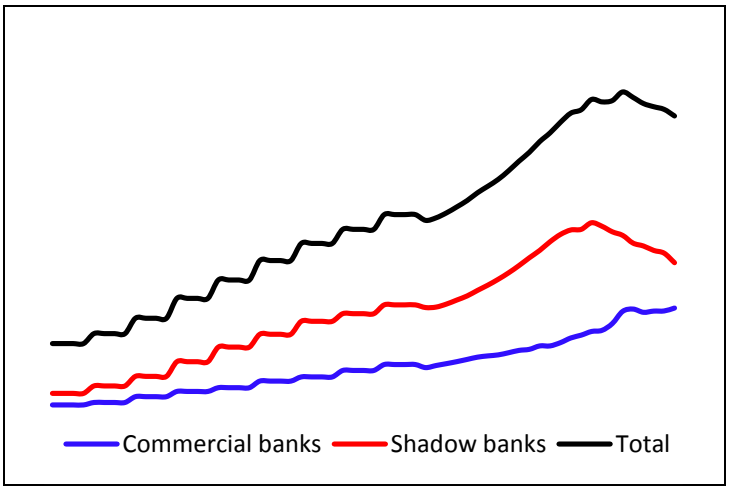

Figure 6. US Bank Liabilities, Trill. USD.

Notes: Traditional bank liabilities refer to total liabilities of the commercial banking sector (line 19 of Table L 109 in Flow of Funds Accounts). Shadow bank liabilities (netted from overlaps with Table L 109) refer to the sum of total outstanding open market paper (line 1 of Table L 208), total repo liabilities (line 1 of Table L 207), net securities loaned (line 20 of Table L 130), total GSE liabilities and pool securities (lines 21 and 6 of Tables L 124 and L 125, respectively), total liabilities of ABS issuers (line 11 of Table L 126), and total shares outstanding of money market mutual funds (line 13 of Table L 121).

Source: US Flow of Funds Accounts, Federal Reserve.

It is unclear to what degree will this have an effect on consumer spending or on the wealth of consumer balance sheet. However it seems that claim of change in paradigm and superiority of emerging market consumer is simply not supported by any plausible argument, empirical research or statistical analysis. Exposure to relative disadvantage of EM (China) consumer can be structured via shorting The Global X China Consumer ETF and taking long positions in Consumer Discretionary SPDR ETF as well as Consumer Staples SPDR ETF (Figure 7).

Figure 7.US Consumer ETF/China Consumer ETF Ratio.

Source: Bloomberg

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INTELLIGENT AGENT APPROACH FOR BUSINESS PROCESS MANAGEMENT

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Abstract

In recent years businesses around the world have been facing the challenges of a rapidly changing environment due to the development of business market and technology. As a result, organizations are paying more attentions to supporting business process management with the ability to adapt to the dynamic environment.

Furthermore, business climate is changing from centralized and closed to distributed and open mainly by virtue of the proliferation of networks.

Therefore, an agent-based approach is proposed in this research to manage complex business activities. In this approach, business activities are delegated to a number of autonomous agents. These agents may be human beings as well as machines or software applications. Each of them has awareness of situation and can make real-time decisions on activities.

Keywords: business process management, real-time decisions, workflow

JEL Classification: D81, L21, O32, M1

1. Introduction

Management of business process in an organizational setting is commonly referred to the development of business applications that directly follow the execution logic of the underlying business processes. However, traditional workflow approaches model and manage business process based on a predefined logical procedure of activities and from a centralized perspective.

That is, a complete list of all the activities and all the paths are provided, the criteria for following a particular path are specified, and the ordering constraints on the actions are given.

The intelligent agents are strictly linked to the existence of informational and communicational technologies, especially the Internet; outlined as a type of specialized activity, autonomous, very useful for an important part of business. According to the specialists' opinion the intelligent agents represent a new type of logicians, specialized in Franklin, and Graesser (1996), and Wooldridge, and Jennings (1999).

Researching, extracting and treat information automatically for the user in an informational network or in a database is a new way to approach a business process. An agent is a computational system located in an execution environment, capable of autonomous action in that environment in order to achieve the planned objectives (So, and Sonenberg 2004).

Unlike the classical interface ways with the computer, the intelligent agent is autonomous and much more active, representing a hardware or software system which has a series of properties (*see* Table 1). In Table 1, we are presenting the main characteristics that we also find in Franklin, and Graesser (1996).

Table1. Main characteristics of intelligent agents

Characteristics	Description
Autonomy	Operates without human intervention and has control on its own actions. The agent accepts requests of user but it is the one that decides how and where these requests will be satisfied.
Initiative	Collaborates with the user or with other agents to satisfy their requests, being able to propose modifications or ask for further clarifications.

Characteristics	Description
Adaptability	It modifies behavior depending on the acquired knowledge.
Rationality	They are able to make inferences.
Communication and co-operation	The capacity to accomplish an exchange of information, more or less complex, with other agents, with other servers or human specialists.
Mobility	It manifests mobility, in the way that they can surf the web without receiving instructions from user.

2. Related researches

The challenge of the changing business environment requires managing complex processes in non-procedure paradigms. Non-procedure paradigms do not depend on systems giving exact details to solve problems, but let systems determine how to accomplish tasks. The questions of which task to execute, and when to execute, is more dependent on the current environment and underlying business policies, other than the static process schema.

Landqvist and Pessi (2004) note how the use of intelligent agent-enabled decision support in conjunction with the organizational trends of more dispersed and decentralized organic organized enterprises, enables new practice in the field of Business Intelligence. Their research focuses on empirical data from two business cases and what organizational implications it might have. The behaviors of the applications in the described business cases show us a trend that is very interesting to further investigate.

Research within agent-technologies usually explore different lab related studies regarding how to cope with the vast information overflow, using intelligent agents mainly based on different rules-based mechanism (Liu 1998).

Decision support systems are usually focused on historical data behavior, and analytical approaches. Many researchers discuss the extension of these mart models, to include real-time data (Bolloju 2001). With an extended model on the use of enterprise decision support environments, future business intelligence will be combination of more traditional decision support systems and intelligent agents.

3. Agent supported process management. Study case in financial management

For the potential or operational managers, the intelligent agents represent or will represent an important economic opportunity. Their use in the area of business management can prove to be a very profitable business. Taking into consideration their multiple abilities in progress, we can assert that the intelligent agents will constitute one of the most attractive business opportunities. Concomitant, the intelligent agents can be used to develop the already existing business, increasing their functional and financial performances.

The intelligent agent approach proposed in this paper is characterized by the ability to continuously perceive the business process environment and make real-time decisions tasks based on underlying business logic. In addition to real/time reaction to the process environment, the proposed approach also supports proactive activities, which refer to the exhibition of goal-oriented behaviors by taking initiatives.

For illustration and evaluation of the proposed cognitive approach, a case application of economic activities is presented in this Section. Relevant information of computer system in financial management can be found in Ştefănescu A. (2005, 2006).

The financial services industry is making efforts to achieve the end-to-end automation of financial activities from order to settlement.

According to Ştefănescu A. (2005, 2006), the major activities/tasks and general procedure of financial management are briefly described below in Table 2.

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Table2. Major tasks of financial activity

Activity	Characteristic complex processes	Elementary Processes
Economical Operations	Opening the work session	▪ confirmation of the possibility of system use; ▪ specification of password and username; ▪ giving the access level.
	Processing dates from accounts	▪ introduction of data in the required working files of the Checking Balance; ▪ processing the clearance scales: debtor/creditor to make the Balance of Accounts; ▪ processing the net hauling time to accomplish the Profit and Loss Account.
Activity Analysis	The structural analysis of the patrimonies	▪ data taking over from the Balance of Accounts and obtaining the Financial Balance-Sheet; ▪ elements processing from the Financial Balance-Sheet for 2 consecutive years and obtaining the cumulative Financial Balance.
	Analysis of the results formation	▪ obtaining a set of indicators to quantify the activity; ▪ checking the levels obtained; ▪ interpretation of results economically and financially.
Financial Diagnosis	Profitableness diagnosis	▪ obtaining the profitableness indicators; ▪ results interpretation.
	Risk diagnosis	▪ determination of the position indicators I% and comparison with the known criteria to determine the relative value of the exploitation and financial risk; ▪ determination of a set of indicators; ▪ models of evaluating the bankruptcy risk.
Financial Anticipation	Elaboration of the financial anticipation documents	- estimations for the indicator level the turnover taking into account the level of the estimated availability; - identification of position from Financial Balance, the Profit and Loss Account which modifies together with the estimated Turnover; - determination of the necessary of the external financing; - specification of the financing ways.

However, the process in real-world situations is more complex than this. Followed are some possible situations that are not covered in the general process:

- information contained in an error report is not enough to make resolution advice, and additional data are required for diagnosis;
- the resolution advice on a problem detected is not produced within a normal time frame due to lack of information or other reasons;
- diagnostic experts need to make some adjustment on advised resolutions;
- the chief manager is not available to validate the resolution advice;
- emergent errors are required to be reported to the chief manager directly for instant actions.

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5. Conclusions

Compared with traditional system approaches focusing on specifying the execution order of activities beforehand, this approaches attempts to declare rules for autonomous agent to manage their activities via perceiving and interacting with the environment.

Also, in this work has made efforts on investing how to employ intelligent agent's technology into business process and financial management, especially from the flexible task management, which is a basis for building intelligent agents to perform rational activities in process management.

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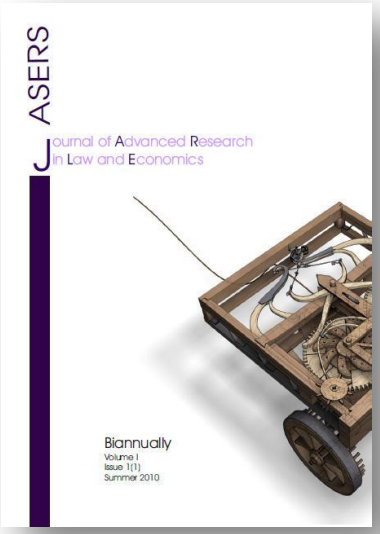

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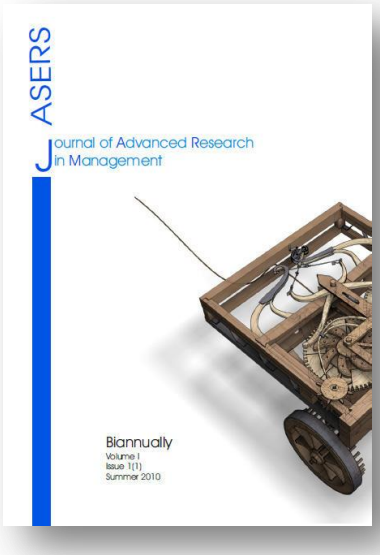

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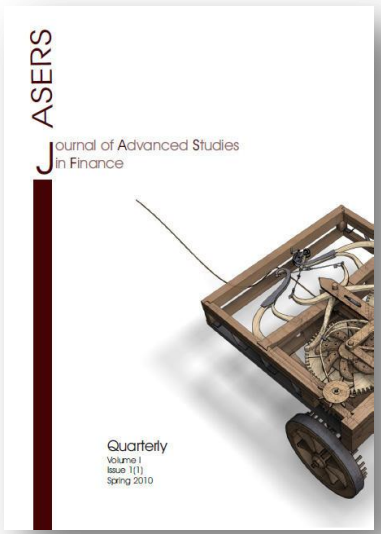

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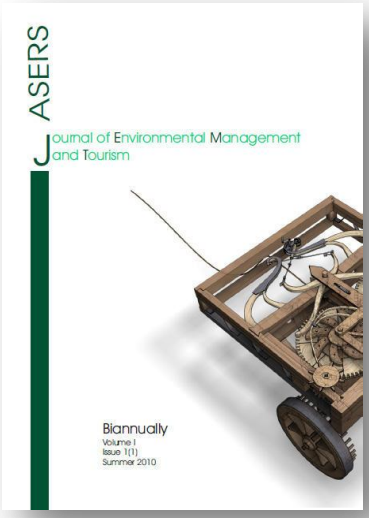

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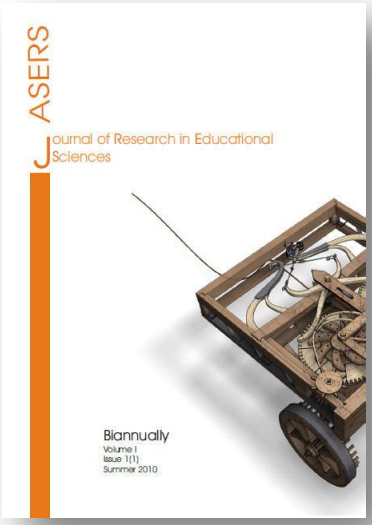

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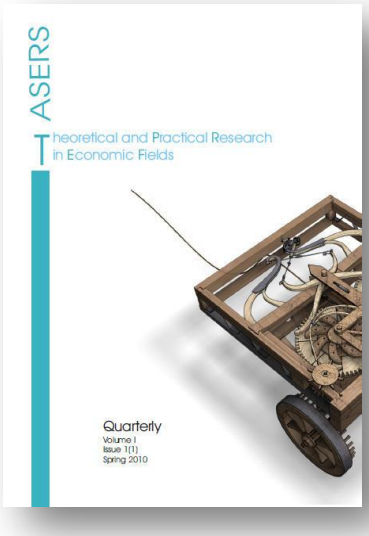

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