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What is the linkage between real growth in the Euro area and global financial market conditions?

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Abstract

This paper deals with transitiontransmission mechanisms through which world financial market conditions indicators affect real economic growth in the Euro area. The informational content of financial variables for predicting real economic growth is assessed, allowing for asymmetric responses to shocks. A nonlinear framework is developed based on a smooth transition model for which the effects of shocks can vary across business cycles when financial indicators modify both the endogenous and state variables. Global financial variables are shown to significantly affect real growth in the Euro area, particularly during periods of recession. Changes in stock market index and yield slope have asymmetric effects on real growth. In recessionary periods, the slope of the US yield curve does not have a significant impact on growth in the Euro area.

Please receive the final draft. Yours Sincerely, Jean-Michel Sahut
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1. Introduction

The role played by financial markets in the real economic shock transmission process has been a matter of renewed interest in the literature since the subprime mortgage crisis in the United States in July 2007. Several studies have examined real growth synchronization through trade channels across country blocs including within the Euro area, with inconclusive results.[1] Only a few have explored the impact of global financial variables; here too, little consensus exists in the literature (see e.g. Giannone, Lenza, and Reichlin; 2010). The purpose of this paper is to provide new evidence on how the real economy in the Euro area adjusts to financial perturbations that mainly originate in the US economy. We use a nonlinear approach which is robust to alternative characterizations of behaviour of agents. We delineate two separate regimes in the economic cycle for which the effects of shocks can differ. The transition from one regime to another is smooth, implying that changes in economic aggregates are influenced by changes in the behaviour of many different agents who do not react fully in tandem to a given economic signal. According to Peters (1994), a smooth transition or a continuum of states between the extremes appears more realistic in financial markets with a large number of investors, each switching at different times, as a consequence of heterogeneous objectives.

The remainder of this paper is organized as follows. Section 1 examines the nonlinear relationship between financial development and economic growth. Section 2 presents nonlinear LSTR model for real growth in the Euro area. Section 3 shows empirical results and discusses them. The paper concludes in section 4.

2. Linkage between financial development and real economic growth a nonlinear consideration

The linkages between financial markets and the real economy have posed a major theoretical challenge for economists working in the fields of macroeconomics and finance. Improved understanding of these linkages is also crucial for EU policy-makers.

Several economic studies have identified channels through which financial market variables significantly affect real business cycles (e.g. Fama (1990), Schwert (1990), Estrella and Mishkin (1998), Hamilton and Kim (2000), Hassapis and Kalyvitis (2002)). Other results have been more contradictory. Avouyi-Dovi and Matheron (2003), among others, indicate that there does not seem to be a strong dependency link between stock prices and the level of real activity relating to business cycle frequencies except in the United States.

The relationship between financial variables and output growth rate is typically examined by testing for Granger causality where the output growth is explained via vector autoregressive models (VAR) with lagged changes of the financial variable. Hassapis and Kalyvitis (2002) and Caporale, Hassapis, and Pittis (1998) test for Granger causality between financial variables and output. Lutkepohl and Poskitt (1996) discuss the problems that can arise in causality testing by fitting finite VAR models to infinite order processes. They find that

[1] It is widely acknowledged in the economic literature that global shocks play an important role in explaining output fluctuations. Recently, Dées and Vanstenkiste (2007) used a global VAR model to validate this hypothesis for several regions including the Euro area and the US. They found the linkage between the Euro area and the US appeared to be stronger than suggested by pure bilateral trade channels. However, co-movement between US and Euro area growth is difficult to explain in terms of trade linkage alone. Moreover, Bayoni and Swiwtam (2007) found that channel transmission of cycles through commodity prices were insufficient to explain further observed linkage. Other researchers such as Giannone and Reichni (2004), Gianone *et al*. (2008), and Favero and Giavazzi (2008) have argued that real trade volume only partially explains the real activity statistics due to third country effects.

approximating general stationary processes by finite order VARs can lead to relatively misleading results in samples of common size.

Over the past few decades, many financial variables, such as stock prices, interest rates, interest rate spreads, and monetary aggregates, have been widely used to forecast future economic activity. Beckett (1961), Goldsmith (1969), Bosworth (1975), Hall (1978), Fama (1981), Geske and Roll (1983), and more recent studies by Barro (1990), Fama (1990), Schwert (1990), Lee (1992), Atta-Mensah and Tkacz (1998), Estrella and Mishkin (1998), and Hassapis and Kalyvitis (2002) are among the many studies that provide cogent arguments that the stock market index can lead to changes in real economic growth. These studies identify a high correlation between stock returns and future real activity.

Another financial variable for predicting economic growth that has attracted considerable attention of monetary policy makers is the yield spread. Several researchers have recently argued that there is a significant correlation between the yield spread and increased business activity (Black *et al.*; 2000, Galbraith and Tkacz; 2000, Hassapis; 2003). In general, a positive yield differential implies economic expansion, while a negative difference implies economic recession. Hassapis (2003) suggests that the economic growth rate is linked to the magnitude of the yield spread. A large body of literature has confirmed the significant relationship between yield spread and real economic activity.

Such findings confirm that financial variables are associated with future economic activity, and that they should be included as explanatory variables in macroeconomic models explaining real growth. Estrella and Mishkin (1998) argue that even though large-scale macroeconomic models are very useful for forecasting future economic activity, policy makers and market participants could benefit from looking at a few well-chosen financial indicators. They suggest firstly that these indicators can be used to double check econometric and judgmental predictions. For example, a quick look at a financial indicator can be used to flag potential problems in more involved approaches. If the model and the indicator agree, then our confidence in the model's results is enhanced. If, however, the indicator gives a different signal, this may lead to a review of the assumptions and relationships of the more complicated model that led to the prediction. The second reason that one should look at simple financial indicators is the potential for overfitting econometric models. Carefully chosen financial indicators could help us to avoid this problem. Thirdly, financial indicators provide quick and simple signs of future economic activity (Harvey, 1997).

3. Nonlinear LSTR model for real growth in the Euro area

In this study, we make use of recent advances in threshold models to develop a nonlinear model to explain the relationship between real growth in the Euro area and financial variables and real growth in the United States. We also look for a particular specification that explains shock transmission asymmetry between different economic blocks. In the latter context, we develop a dynamic model with a logistic function, related to Granger and Tearasvirta (1993) and Teasvirta (1994).

The smooth transition regression (STR) model is a non-linear time series model introduced by Bacon and Watts (1971) as a generalization of the Quandt (1958) threshold regression model. (see also Granger and Teraesvirta (1993), Teraesvirta (1998) and Franses and van Dijk (2003)). In its most basic form, it is equivalent to a linear model with stochastically time-varying coefficients. Furthermore, contrary to the Markov-switching model, the STR model allows for endogenous regime switches, and therefore provides economic intuition for the non-linear behaviour.

We consider the following two-regime STR model:

$$y_t = \pi' x_t + \lambda z_{t-1} F(z_t, \gamma, c) + \mu_t \quad (1)$$

with y_t the dependent variable measured by the logarithm of real growth rate in the Euro area, $X_t = (1, y_{t-1}, \ldots, y_{t-n}, x_1, \ldots, x_n)$, where $y_{t-1}, \ldots, y_{t-n}$ are the lagged real growth rate in the Euro area and $(x_1, \ldots, x_n)$ the independent variables that will be considered in the model.
μ_t is *i.i.d.* $\sim N[0, \Omega]$. $F(.)$ is the transition function. $F(.) \in [0;1]$, and it is continuous in the threshold transition variable z.
Following Granger and Teräsvirta (1993), Teräsvirta (1994) and Jansen and Teräsvirta (1996), we consider a logistic Transition function as follows:

$$F(z_t; \gamma, c) = \frac{1}{1 + \exp(-\gamma \prod_{j=1}^{m} (z_t - c_j))} \qquad with\ c_1 \leq \ldots \leq c_m \quad (2)$$

where z_t is the transition variable. In this study, we consider that z_t is a lagged endogenous variable $z_t = y_{t-d}$ for certain integer d > 0. The vector $c = (c_1, \ldots, c_m)$ is an m-dimension vector of location parameters. γ is a transition parameter that determines the speed of transition between the two extreme regimes, with lower absolute values of γ implying slower transition. The values taken by the transition variable and the transition parameter γ determine the speed of transition from lower to upper regime.
$\gamma > 0$ and $c_1 \leq \ldots \leq c_m$ are identifying restrictions. Empirically, it is enough to consider $m=1$ or $m=2$, since these two orders capture principal parameter variations. For $m=1$, the model implies that the two extreme regimes are associated with low and high values of z_t. If $\gamma \to \infty$, $F(z_t; \gamma, c)$ becomes an indicator function $I_{[Z_t > c_1]}$ defined by: $I[A]=1$ if event A occurs, and 0 otherwise. In this case, the LSTR model in (1) is reduced to a two-regime threshold model of Hansen (1999). In case of $m=2$, the transition function has $(c_1+c_2)/2$ as a minimum and attains value 1 both at low and high values of z_t. Finally, for each order m, the transition function (2) will be constant when $\gamma \to 0$.

Applied to economic growth, logistic models provide a good economic interpretation. If the transition function F is zero, then the baseline model becomes a linear model (1) with parameters X. In this case, model (1) is interpreted as the linear path which models extreme recessionary periods. If $\underset{z_t \to -\infty}{Lim} F(z_t; \gamma, c)$, the function F(.) will be in the lower regime and the model (1) becomes a standard linear regression of the form:

$$y_t = \pi' x_t + \mu_t \quad (3)$$

On the other hand, if F is one, then the STR model becomes another linear model (2). Model (2) can be seen as the linear model associated with great expansion. Note that in extreme contractions (expansions), the transition variable is lower (higher) than the threshold in LSTR models, and the actual GDP is less (greater) than a linear path in LSTR-D models to keep the transition function close to zero (one). On the other hand, in extreme expansions the transition variable is higher than the threshold in LSTR models, and actual GDP is greater than a linear path in LSTR-D models to keep the transition function close to zero (one). Hence, F may be interpreted as a filtering rule that locates the model between these two extreme regimes. If $\underset{z_t \to +\infty}{Lim} F(z_t; \gamma, c)$, the function F(.) will be in the upper regime and the model in equation (1) becomes a different linear regression:

$$y_t = (\pi' + \theta') x_t + \mu_t \quad (4)$$

In order to generalize the STR model to allow for more than two different regimes, we consider the following additive model:

$$IF\,(z,\gamma,c) = \sum_{j=1}^{r} \beta x F_j\,(Z_t^{(j)};\gamma_j,c_j) + u_t \qquad (5)$$

where $F_j(z_t;\gamma,c)$ are logistic functions for *(j=1,…,r)*. If *m=1*, $Z_t^{(j)} = Z_t$ and $\gamma_j \to \infty$ for *j=1, …,r,* the model (11) becomes an LSTR with *r+1* regimes. So, the additive generalization can be seen as the generalization of the multi-regime threshold model of Hansen (1999). Even if the largest, generally considered model is a two-regime model (with *r=1* and *m=1* or *m=2*), the additive model has an important role in evaluating the estimated model. In particular, the multi-regime model (5) provides an alternative to test remaining nonlinearity.

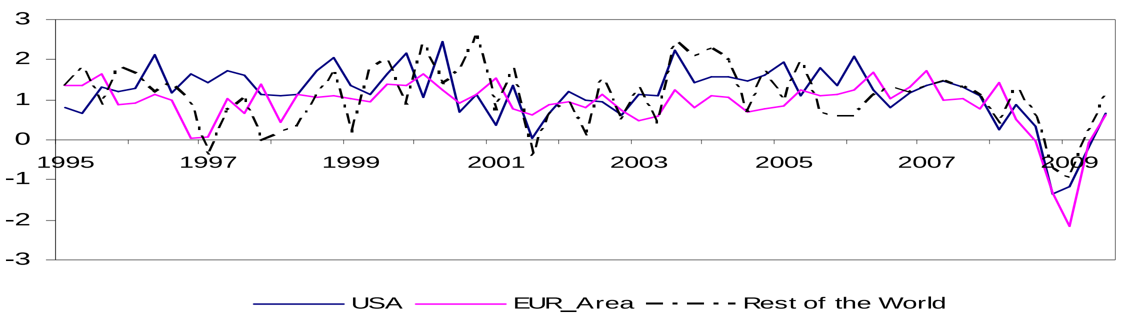
Building an LTR model requires a careful and systematic modelling strategy. An LSTR model is set up in three stages: i.e. specification, estimation and evaluation. The specification step includes linearity tests and the selection of the transition variable zt. The evaluation step comprises parameter stability tests and no remaining linearity. Finally, we must choose the number of regimes to consider in the model, which means selecting r in equation (2).

4. Data description and empirical results

We model the relationship between the real growth rate of output in the Euro area (GDP_EUR) and the real growth rate of output in the United States (GDP_US), the real growth rate of output in the rest of the world (GDP_RW), the Stock market index volatility in the Euro area (SMI_EUR), the United States stock market index volatility's (SMI_US), the slope of the yield curve in the Euro area (Slope_EUR) and the slope in the United States yield curve (Slope_US). In our model we avoid integrating index of consumer prices to avoid problems of collinearity between variables, as this indicator is often highly correlated with delays indicators of economic growth[2].

Our study uses seasonally adjusted quarterly real GDP data from the Euro area and the United States over the period Q1 1995 to Q3 2009. Our model is constructed using the full sample, as well as for a hold back period for out of sample forecasting To characterize a global shock we aggregate real GDP from seven countries[3] (Australia, Canada, Denmark, Norway, New Zealand, Sweden and Switzerland). These countries were chosen to represent very different economies, so that any shock affecting all of them may be interpreted as a global shock.

Figure 1. Real GDP growth rates in the three economic areas



2 Gafar J.(2003): "From State Control to Free Markets". Nova Science Publisher, Inc.

3 The seven countries considered here are the same as those chosen by Espinoza, Fornari and Lombardi (2009) for comparison purposes. .

The financial variables used in this paper consist of time-varying stock market volatilities and the yield curve for all the countries in the sample. Time-varying stock market volatilities are obtained as the estimated dynamic volatilities from GARCH (1,1) processes for the stock market indices of all the countries. The slope of the yield curve is calculated from the difference between the 10-year government bond yield and the 3-month T-bill rate for all countries.

Now, we examine the implications of our LSTR model to capture real growth asymmetry in the Euro area. In a first step we test for linearity by using the lagged dependent variable as transition variables.[4] The results of the Fisher version of the LM test for *m=1, 2* and *3* are presented in Table 1. The table 1 shows that the LM-F statistics are not significantly different from zero. These results strongly reject the null hypothesis of linearity against the alternative non linear LSTR model.

In the next step, we apply the sequence of tests proposed by Granger and Teräsvirta (1993) and Teräsvirta (1994) to select the order *m* of the logistic function between *m=1* and *m=2*. The results are reported in table 2. The H^*_{02} hypothesis is the most strongly rejected, and hence the order *m=1* is used to specify our transition function.
In order to test whether equation (8) is an adequate characterization of the nonlinear features rendered by the data we also analyzing the remaining linearity in order to choose the number of regimes *r*. Table 3 reports the results of no remaining linearity and parameter constancy tests. Our results do not reject the null hypothesis of no remaining linearity. We selected the order *r=1* that specifies a smoothed transition model with two extreme regimes. The results of the parameter constancy test reported in the same table do not reject the null hypothesis of constant parameters with time.

Our modelling strategy is based on that proposed by Öcal and Obsorn (2000) and Sensier *et al.* (2002). We begin with a linear specification, followed by a general-to-specific strategy to get a parsimonious model, using the minimum AIC criterion for the model specification choice. At the outset, the maximum number of GDP_EUR, GDP_US and GDP_RW lags is set at ten. Iterative ordinary least squares (OLS) regressions are performed, deleting variables with the smallest t-statistic until the AIC minimum is achieved. Based on this process, the fourth lag of real GDP is chosen for the EURO, while the first lag is used for the US. To capture the impact of financial variables on leading real business cycles, we estimate two models. In the first model, real GDP is explained by European and world macroeconomic variables. The second model incorporates the financial variables (stock market volatility and yield curve). Results from the estimation are shown in Table 4.
The empirical results strongly reject the hypothesis linearity in the relationship between European real growth and the explanatory variables. In fact, for both models the transition parameter γ appears significantly different from zero. Parameters γ and c show that the transition from low to upper regimes is smooth but relatively more rapid when financial variables are included in the estimation. Parameter γ is noticeably larger for the second model. This finding shows that information contained in financial markets increases the speed of transition of the real activity from the lower to the upper regime. As is shown in Table 4, real economic growth in Europe is significantly affected by lags of up to four quarters. It is also significantly affected by economic growth in the US and less affected by the growth in the

[4] Lagged dependent variables are used as transition variables similar to Dufrénota, Mignonb, and Péguin-Feissolle (2003).

rest of the world. Theses results are consistent with Dées and Vanstenkiste (2007) who argue that this is partially explained by the importance of the bilateral trade volume between Europe and the US relative to the rest of the world.

The second model that includes financial variables outperforms its restricted counterpart.. This indicates a serious loss of information for the prediction of real growth in the Euro area when financial variables are ignored. Higher values founded for LR and R^2 measurements indicate that adding financial variables enhances the explanatory power of the model.
The estimated results imply that both stock market variables and yield slope affect economic growth in the Euro area. Stock market volatilities appear to have a larger impact on real activity than the US or Euro yield curve slope.. Real growth in the Euro area appears to be more affected by volatilities in the Euro-market than by those in the US markets. The fact that stock market index volatilities are significantly positive is consistent with Fama (1990) These results contrast with Stock and Watson (2003) who argue that financial variables do not help to forecast real activity.

To get a deeper understanding of the role of financial variables in the transmission of shocks, we plot in Graphs 2-3 the transition functions against ΔEUR_Growth of the two models. The shapes of the transition functions depend on the values of the estimated parameters γ that indicate the speed of transition from recession regime to expansion regime. Interestingly, the transition shown for the pure economic model occurs for c= -0.02, while the transition of the financial model occurs at c=0.04. The two figures show different dynamics around the threshold parameters. The switch from a recession regime to an expansion regime is less steep for the model including financial variables compared to the pure economic model.

Figure 2. Transition function of real growth adjustment dynamics: pure economic model

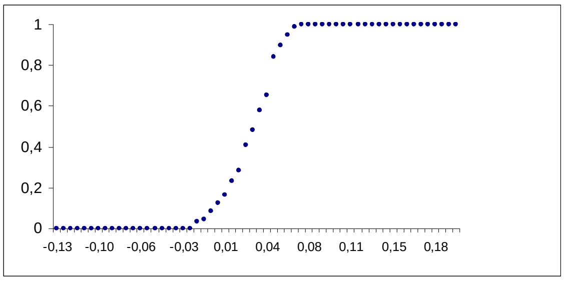
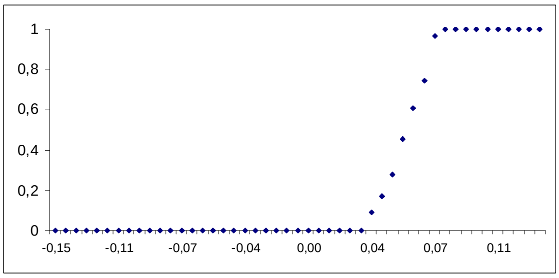


Figure 3. Transition function of real growth adjustment dynamics: financial model



The LSTR specification allows us to identify two extreme regimes. We identify a recession regime when F=0 and an expansion regime when F=1. In other words, there appear to be asymmetrical dynamics of output growth depending on the business cycle phase, which is reflected both in its own dynamic and in its relation with other variables. To gain a better understanding of the role of financial variables in extreme regimes, we test two additional models associated with extreme regimes, where F(.)=0 and F(.)=1. The results are reported in Table 5. The domestic stock market has a positive influence on the prediction of depreciation for the economy. In recession periods, US yield curve slopes do not significantly affect growth in the Euro area. On the contrary, stock market volatilities continue to be significant in affecting real growth during recession periods. According to Model 2, the European slope curve significantly affects real growth only during a recession. These finding are in line with those of Rudebusch (1995) and Haubrich and Dombrosky (1996) who suggest that the public anticipates that short-term interest rates will gradually decline in a recession until the economy's performance improves. These reductions in short-term interest rates may stem from countercyclical monetary policy designed to stimulate the economy, or they may simply reflect low real rates of return during the recession. In either case, the anticipated severity and duration of the recession will strongly influence the expected path of short-term interest rates, which will show up in the shape of the yield curve.

Increases and decreases in stock market index and yield slope have asymmetric effects on real growth. The LSTR specification implies that the US stock market initiates asymmetries in the European real growth process. In particular, the interaction term between the transition function and GDP_EUR_{t-1} has a positive coefficient of 0.324, indicating that increases in real growth have a more significant impact than decreases.

In expansionary periods, both stock market volatilities and slope curve significantly affect real growth in Europe which implies that market liquidity and volume transaction favour the increase of real growth.

5. Forecasting accuracy

The quality of the model including financial variables can be assessed by its out-of-sample performance compared to its restricted counterpart (the economic model that only includes the GDP data). In line with Stock and Watson (2005), the results founded for in-sample data need to be complemented by a full-fledged out-of-sample forecasting exercise.

To test the forecasting accuracy of the model that includes financial variables, we consider the last four years of our data as an out-of-sample period. Our evaluation of predictive ability is based on two main statistics: the Root Mean Square Error (RMSE) and the mean absolute error (MAE). Table 6 shows the results of the forecast comparison.

The computed RMSE of the second model, 0.0341, is about 12.54% higher than the RMSE for the pure economic model, 0.0303. The results show that taking into account the financial variables provides a forecast gain compared to the corresponding pure economic model. This implies that the financial variables contain valuable informational content. Globalization of financial markets also plays a fundamental role in transmitting economic shocks. The predictive power of the model that incorporates financial variables increases by 39%, as measured by the MAE estimates.

6. Conclusion

The existence of transition mechanisms through which financial indicators affect real economic growth have been widely discussed in the economic literature. This paper develops a nonlinear model of the business cycle for the Euro area that incorporates both Euro area and US financial variables for predicting economic growth. We show that real economic growth forecasts need to be interpreted within a nonlinear framework. We used a Logistic Smooth Transition Model that identifies two distinct extreme regimes in the economic cycle, a recession regime and an expansion regime.

Our results show that financial variables play a significant role in forecasting economic growth. Our framework allowed us to reproduce some stylized facts, notably the asymmetry of the responses of real GDP to its determinants.. In periods of recession, the slope of the US yield curve does not have a significant impact on growth in the Euro area. This finding suggests that EU policymakers do not need to be overly concerned about its direct impact on the business cycle.

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Table 1. Test of Linearity against STR model

	GDP_EUR	
	LM	P-Value
M		
1	18.921	0.000
2	35.740	0.000
3	22.655	0.000

Table 2. Test sequence for selection of *m*

	GDP_EUR_t	
	LM	P-Value
$H^*_{03} : \beta^*_3 = 0$	14.281	0.483
$H^*_{02} : \beta^*_2 = 0 / \beta^*_3 = 0$	21.664	0.000
$H^*_{01} : \beta^*_1 / \beta^*_2 = \beta^*_3 = 0$	52.145	17×10^{-8}

Table 3. Test of no remaining linearity and test of no constancy parameters

	GDP_EUR_t	
	LM	P-Value
Test of no remaining linearity		
m		
1	0.468	0.156
2	0.699	0.108
3	0.991	0.421
Test of no constancy parameters		
m		
1	0.369	0.201
2	1.671	0.644
3	1.033	0.230

Table 4. Estimation results of a two-regime LSTR model

	GDP_EUR_t	GDP_EUR_t
Intercept	-0.0685	-0.1946
	(0.0010)	(0.0000)
Y_{t-1}	0.0082	0.0256
	(0.0000)	(0.0000)
Y_{t-2}	-0.0288	-0.3455
	(0.0000)	(0.0000)
Y_{t-3}	0.2490	0.0087
	(1.8300)	(0.0955)
Y_{t-4}	6.8640	0.3499
	(1.0881)	(3.5022)
GDP_US_t	1.3630	2.4501
	(0.000)	(0.0000)
GDP_US_{t-1}	0.9581	0.4972
	(0.000)	(0.0000)
$GDP\text{-}RW_t$	0.3988	0.9758
	(0.0000)	(0.0000)
$GDP\text{-}RW_{t-1}$	0.1381	0.3711
	(0.0026)	(0.0000)
SMI_EUR_t		1.8774
		(0.0001)
SMI_US_t		0.8544
		(0.0000)
$Slope\_EUR_t$		0.9005
		(0.0025)
$Slope\_US_t$		0.3590
		(0.9951)
λ	0.2019	0.2771
	(0.0028)	(0.0012)
γ	0.0105	0.0459
	(0.00003)	(0.0000)
c	0.0051	0.03046
	(0.0008)	(0.0000)
R^2	0.7211	0.8911
LR	0.8127	0.8909

Table 5. Estimation results of two extreme regime LSTR models

	GDP_EUR$_t$	
	F(.)=0	**F(.)=1**
Intercept	-0.0345	-0.0410
	(0.0976)	(0.0074)
Y_{t-1}	0.0381	0.0324
	(0.0000)	(0.0000)
Y_{t-2}	3.9860	0.0121
	(11.0895)	(0.0000)
Y_{t-3}	0.9110	-0.9087
	(13.1190)	(0.6311)
Y_{t-4}	22.1008	-20.8751
	(4..9931)	(13.4491)
GDP_US_t	0.98134	-5.8499
	(0.000)	(0.0000)
GDP_US_{t-1}	0.4330	4.1031
	(0.000)	(0.0000)
$GDP\text{-}RW_t$	6.1355	-4.5820
	(0.0000)	(0.0000)
$GDP\text{-}RW_{t-1}$	1.1355	-1.6211
	(0.0319)	(0.7531)
SMI_EUR_t	0.9244	-0.1355
	(0.0000)	(0.0000)
SMI_US_t	0.2341	-0.4578
	(0.0000)	(0.0000)
$Slope\_EUR_t$	16.1445	-3.2516
	(0.4670)	(0.0000)
$Slope\_US_t$	0.9345	-0.4568
	(6..3151)	(3..5355)
λ		
γ	0.0135	0.0636
	(0.00003)	(0.0000)
c	0.0051	0.03046
	(0.0008)	(0.0000)
LR	0.8399	0.7161

Table 6. Out-of-sample performance measurements

	RMSE	MAE
Pure Economic model	0.0303	0.0356
Model with financial variables	0.0341	0.0461