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Financial Cycle Heterogeneity and Monetary Policy in the Eurozone

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Abstract: This work addresses two main issues, first, the quantitative impact of the single regime of monetary policy of the eurozone on the financial cycle variables across eurozone countries and, secondly, cross-country differentials in the characteristics of financial cycles among these countries, which may result from differences in monetary transmission. For each eurozone economy, the main features of average amplitude, duration and slope are measured and the impact of monetary policy in the financial cycle´s indicators is estimated through a Vector Auto-Regression model, the results of which provide the framework for explaining cross-country heterogeneity in the cycle´s characterization. Generally, the results indicate monetary policy does not appear as a significant determinant of the segments the financial cycle across a large majority of eurozone countries' and is thus a poor predictor of significant differentials across these.

JEL codes: E440; E510; E520

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1. Introduction

This work sets out to provide evidence about the impact of the single regime of monetary policy in the eurozone upon some aspects of its constituent countries' financial stability. How does the eurozone´s monetary policy quantitatively affect the financial cycle in the European countries? And to what degree does the eurozone´s monetary policy regime explain cross-country differences in the financial cycle?

A plethora of empirical studies characterize financial cycles, their coherence and volatility in the eurozone, as an emerging literature starts to look at the effects of monetary policy stance on financial variables and credit cycles, however, studies that integrate the analysis of financial cycle heterogeneity among a set of countries belonging to a monetary union, with the analysis of the impact of a single monetary policy stance on the aspects of such cycle in structurally different economies are rare in the literature; the dissertation, therefore, seeks to bridge this gap by integrating both of these issues in a single empirical analysis for the set of European economies belonging to the euro area.

In the aftermath of the 2008 financial crisis, financial conditions have increasingly become recognized to be an important factor in driving macroeconomic conditions in the real economy.

The vanguard of economic modeling has increasingly considered the role of financial intermediaries in contributing to the causation, persistence and propagation of macroeconomic cycles (Gambacorta & Marques-Ibanez, 2011). The last decade, therefore, ushered renewed interest of the literature in issues of financial stability, and central banks likewise have started to incorporate the financial system, its state and particularities in the setting of its policy agenda.

In Europe, the crisis affected particularly a set of peripheric countries within the eurozone which were much more dependent on external financing than those of the core (Lane, 2012), highlighting the fact that despite the union of these countries in a single monetary zone, structural differences among these nations may lead to widely disparate outcomes in the impact of financial conditions.

In the US, , between 2003 and 2006, Leading up to the crisis, it is also notable that USA´s short-term interest rates, between 2003 and 2006, dropped substantially below the trend of the previous twenty years (Taylor, 2007), calling the attention to the mechanisms by which leverage accumulation and undertaking of excess risk on the part of financial institutions can be amplified by extraordinarily expansionary monetary policy, thereby leading to an ensuing debate on the linkages between monetary policy and financial stability (Nair & Anand, 2020).

In the post-2008 crisis era, the study of these developments and the ways by the which financial systems can materially impact the performance of the real economy, even with potentially catastrophic consequences, highlight the relevance of the interactions between monetary policy and financial stability. Such interactions are relevant for the right balance in the use of macroprudential regulation and monetary policy in order to tame financial cycles, and, regarding the cohesion of the eurozone in particular, for the debate around the adequacy of the supranational monetary regime in face of structural asymmetries in financial stability conditions.

While the importance of financial cycles for financial but also for real economic stability increasingly takes a stage of recognition within the economics profession, the possibility that monetary policy can significantly impact the development of these cycles, and the marked cleavages in the outcomes of financial booms and busts within the European Monetary Union, sets out this work´s agenda of understanding differences in the quantitative characteristics of the various constituent´s financial cycles and the extent to which the monetary policy stance of the European Central Bank is determinant to these differentials.

In the following sections, the relevant literature regarding the concept of the financial cycle, its operation in the euro area countries and its interconnection with monetary policy will be reviewed; the main methods employed to address the issues under investigation will be then outlined and explained, following a characterization of the selected financial and economic cycles of the eurozone nations under purview and the various endogenous effects which will serve as an interpretative basis of cross-country differences in the main cycles will be estimated through a vector auto-regression model.

2. Literature Review

The precise nature of a financial cycle is not however consensual, according to Borio (2014) the preferable analytical definition of a financial cycle pertains to self-reinforcing movements in perceptions of value and risk, which are procyclical across the financial system. Requiring empirical indicators to measure a financial cycle under this general definition, Borio (2014) sets out a set of variables that help identify and characterize the financial cycle, which include both credit volumes and property prices as the simplest set of indicators to empirically measure and define a financial cycle.

Claessens, Kose & Terrones (2011) define financial cycles in line with the classic definition of economic cycles of Burns and Mitchell (1946), as a series of deviations from a trend, specifically credit volumes, housing and equity prices, and argue that financial cycles show high correlation to business cycles in credit and housing prices, but lower correlation among these with equity price cycles, which occur at much higher frequency. Additionally, financial cycles exhibit longer durations than business cycles, with upturns being usually longer than downturns; also documented by the authors, financial cycles also tend to exhibit more violent volatility and higher amplitude variations than business cycles, the severity of downturns being generally proportional to the amplitude of the upturn and vice-versa.

Following the same line, Claessens, Kose & Terrones (2012) document further empirical regularities that characterize financial cycles, namely, that recessions that coincide with financial downturns are typically longer and more severe, and recoveries associated with financial upswings stronger; those financial cycles have higher duration and amplitude, and conversely lower frequency than business cycles, and in line with Claessens, Kose & Terrones (2011); also exhibiting higher volatility in emerging economies.

The more prevailing strategy of modelling the financial cycles and their relation to the macroeconomy makes use of the notion of financial frictions as the main features through which these cycles form, within the standard DSGE equilibrium framework (Borio, 2014). In the most baseline New Keynesian models however, the conditions of the financial system are thought to be negligible for real economic performance and thus it is argued that within modern more efficient financial markets, the predictive dynamics of real output and its relation to interest-rates can be modelled through a frictionless financial market framework, implying further that optimal monetary policy can disregard financial developments themselves (Woodford, 2003), the links between the financial cycle, real output and monetary policy are not thought of as macroeconomically relevant.

These financial frictions can take various forms; Bernanke & Gertler (1989), emphasize the role of information asymmetry between borrowers and lenders, that is, monitoring of credit risk of borrower´s is costly, and therefore the Modigliani-Miller theorem does not hold, meaning, at the firm level, that strict separation between financial and real factors is broken. The difference between the cost of external borrowing and internal financing, originated in the presence of such frictions, is therefore decreasing with the net worth value of borrowers, and by consequence the level of transacted credit is increasing with net wealth.

Kiyotaki & Moore (1997) on another hand, introduce a different form of financial frictions, although much to the same effect as in Bernanke & Gertler (1989). In what comes to be termed the costly enforcement approach, after an incident of default on credit, lenders acquire a given asset pledged as collateral from defaulting borrowers, which after the default event, its value decreases, either due to bankruptcy costs or lower efficiency of use by the lender. In the presence of such additional costs in the enforcement of collateral recuperation, credit is rationed to borrowers as a function of the market value of the underlying collateral asset, i.e., the market value of pledged collateral drives the amount of transacted credit when the recovery of collateral value after a default incident is costly.

Gertler & Kiyotaki (2010), alternatively, focus the incidence of financial frictions on the side of the lender. In this approach, the flow of credit between the lender and borrowers occurs efficiently, however, the main constraint is imposed by agency costs between depositors and financial intermediaries which act as the lending agents on the other side of the market, that is, banks, financing loans through deposits see their ability to raise funds constrained by the asymmetric information depositors face. The degree of deposit ration therefore, becomes limited by the balance sheet value of the lender (i.e., financial intermediary) which in turn limits the supply of credit from banks to borrowers.

A seminal example of modelling financial cycles through the augmentation of standard models with financial frictions is found in Bernanke, Gertler & Gilchrist (1996), coining one of the main mechanisms of propagation of financial cycles, expressed as the financial accelerator mechanism, through which small shocks can create wide fluctuations in real and financial conditions, whereby firms and households who bear higher external financing premiums, due to informational frictions of financial and credit markets, experience a lowering of financial constraints when their net worth improves, such that higher spending and investment are obtainable, in turn eliciting a positive impact on overall economic activity and further endogenous propagation of the process, holding symmetrically in case of a decline in net worth of credit constrained agents generating further deleveraging.

In an empirical assessment of real and financial cycles in Europe, Rünstler et. al (2018), establish some stylized facts regarding the synchronicity and characteristics of these cycles across the different EU economies. More importantly, according to the authors, there is much higher mismatch in cycles of financial variables between European economies than observed in cycles of real GDP, with evidence of a divide between southern and northern Europe. The amplitude of financial cycles also varies substantially across EU countries, with certain countries experiencing very low amplitude cycles on one hand and others experiencing high amplitude cycles, thus setting a precedent that financial cycles and conditions of financial stability can exhibit wide variability across the eurozone.

In a similar vein, the results of Samarina, Zhang & Bezemer (2017) confirm the existence of high heterogeneity between eurozone countries' financial cycles, both in terms of synchronicity and amplitude. These authors also empirically test the impact of the introduction of the European monetary union on the coherence of financial cycles across the member states; according to these findings, the impact of the introduction of the euro seems to reduce coherence overall, however the effect runs through multiple channels with differing impacts, with the reduction in currency risk as the main propeller of cycle heterogeneity, amplified by financial deregulation, but with overall lower real interest rates having an increasing impact in cycle coherence.

Facing a common policy stance and exhibiting differential and asynchronous cycles across the whole area, the relationship between monetary decisions and financial variables across the eurozone becomes a natural question. A background theoretical basis which outlines the multiple channels which mediate this relationship is therefore needed, and the following strands of the literature, offer some insight into the main links typically considered.

The credit channel of monetary transmission (Bernanke and Gertler, 1995) is one of the principal channels by which the main variables of the financial cycle are more readily affected by monetary policy decisions. In particular, the balance sheet channel, postulates that through a change in interest-rates, borrower´s net worth value is indirectly impacted by their effect upon aggregate demand in a procyclical manner with real economic activity, but also through a direct revaluation of balance sheet´s illiquid assets at the new rates; thus, the net worth revaluation amplifies the policy effects upon credit extension and overall economic activity through the financial accelerator mechanism. Alternatively, the credit channel can also operate through a bank lending channel, a change in monetary policy stance leads to a change in the loan supply of banking institutions, which can also be mediated by the mediated by the financial accelerator through induced changes in banking capital (Van den Heuvel, 2009)

Borio & Zhu (2008) set out another possibility, that monetary policy can affect the overall level of risk and, consequently, leverage in the economy by a "risk-taking" channel. This channel, according to the authors, can work through different effects; on one hand, a reduction of short-term interest rates can boost asset prices and increase cash flows, which can lower the perceptions of underlying portfolio risk and incentivize the undertaking of further risk; on another hand, the downward pressure on profit margins through lower interest rates, can in the presence of large fixed costs incentivize the increase in portfolio risk in order to improve margins of return, known commonly as *search for yield*; additionally, policy may have a signaling effect, whereby commitment on part of Central Banks to absorb downside risks may reduce risk premia on interest-rates. This mechanism can be of particular importance for the propagation of financial cycles, such that a policy target that does not regard the state of the financial system can further amplify an increase in leverage and the build-up of risk during upswings or increasing the likelihood of occurrence of financial crises during financial down-turns.

Ciccarelli, Maddaloni & Peydró (2010) empirically attest to strong evidence of an active credit channel in the eurozone operating through household, firm and bank´s balance sheet, and to the hypothesis that the impact of monetary-policy shocks on output and inflation are further amplified by its effects on the overall demand and supply of credit and the value of firms and household´s balance sheets, linking together the state of real and financial sectors in respect to policy. Moreover, the evidence advanced by these authors also suggests that the bank lending component (credit-supply effect) more prominently impacts the behavior of firms, while for the household sector, the balance sheet channel accounts for the predominant effects.

Furthermore, Altunbas, Gambacorta & Marqués-Ibáñez (2009), in a large sample of European banks, confirm the presence of a risk-taking mechanism and a bank lending channel for the credit supply behavior of banks, namely that banks are incentivized to insulate returns from monetary policy shocks that significantly lower nominal interest-rates by increasing the risk exposure of loan portfolios, and thus potentially amplifying the volatility of financial cycles.

Badarau & Popescu (2014) simulate through a DSGE model the case where the Central Bank´s Taylor rule incorporates a target of financial stability along the objectives of price stability, by targeting the variability of credit, and a standard Taylor rule that takes into account price stability only. According to this analysis, monetary policy can be *too expansionary,* by increasing variability of the credit cycle through the risk-taking channel, however, the comparison of both models also suggests that the prospect of stabilizing credit cycle variability through nominal interest-rate targeting is limited.

Empirically, Juselius, Borio, Disyatat & Drehmann (2016), analyze through a VAR system, the impact of financial factors in long-run output and interest-rates. More interestingly, by comparing the main model to one where the policy rule function incorporates financial factors such as a debt service gap, defined as the deviation of the ratio of interest payments and amortizations of households and non-financial companies to income, and find that during financial booms, an optimal policy requires raising nominal rates above the baseline of the standard rule, and conversely the disregard for the financial cycle in the setting of target policy rates can lead to wider financial variability and medium-to-long run losses in potential output.

Nonetheless, the economic environment in the post-2008 crisis became increasingly characterized by persistently, low real rates of interest, thereby limiting the scope of monetary policy through the use of conventional instruments, and unconventional measures of monetary policy have therefore taken a more pronounced role; in order to check the robustness of our analysis in light of such a change in the policy framework; the ECB´s balance sheet value, having increased substantially in consequence (Pattipeilohy et al., 2013) and can therefore be taken as an indicator of unconventional monetary policy stance.

From these strands of the literature therefore, some preliminary foundations can be taken for our purposes. Firstly, some understanding of the measurement and nature of financial cycles is set out, such that the preferential indicators used will be the volume of outstanding credit in the economy and housing property prices, while in line with Borio (2014), equity prices are not utilized as a potential indicator due to the lower correlation with the set of other potential financial cycle indicators and higher frequency volatility compared to standard measures of financial cycle duration. The empirical literature that characterizes financial cycles across the eurozone also allows the setting of some relevant expectations, namely, synchronization of amplitude and duration of financial cycles is relatively low across eurozone countries, and such features seem to be related to individual structural differences across countries. Finally, some evidence points to inflation-targeting monetary policy as a factor which can amplify financial cycles in a pro-cyclical manner, such that through the credit, balance sheet and risk-taking channels, leverage can be endogenously increased during financial upturns, and the risk of severe crises amplified during downturns.

Based on this literature, and the expectations that can be drawn from it, the strategy of approach to the main questions, the eurozone´s monetary policy impact in the financial cycle of the different countries and whether such an impact increases or decreases cyclical heterogeneity, can be constructed as follows in the proceeding sections.

3. Data and Methodology

The dataset under analysis consists of 19 countries composing the euro area, sharing a common currency and by extension a common monetary policy regime under the direction of the European Central Bank.

The cyclical variables measuring both the financial and the business cycles, are transformed into their natural logarithms, such that in order to extract the cyclical components of the main variables, the Hodrick - Prescott filter is applied. The application of the filter assumes that the measured series (y_t) of credit volume, property prices, and GDP to be decomposable into a long-run trend component (τ_t) and a cyclical component (c_t) such that the cyclical component, $c_t = y_t - \tau_t$, can be extracted. This assumption implies a level of trend Credit, Housing prices and GDP consistent with finance neutral sustainable levels of output and interest-rates, thus bringing it closer to the framework advanced in Borio et. al. (2017), which defines the natural rates of output and interest as those simultaneously consistent with both stable inflation and sustainable financial conditions. The trend component is computed such that it minimizes the loss function:

$$(1) \quad min_{\tau}[\sum_{t=1}^{T}(y_t - \tau_t)^2 + \lambda \sum_{t=2}^{T-1}[(\tau_{t+1} - \tau_t) - (\tau_t - \tau_{t-1})]^2]$$

The solution to the trend requires the setting of an appropriate positive value for the parameter λ, which requires proper adjustment to the frequency of observation, and determines the smoothness of the trend, by penalizing period-to-period changes in trend growth rate (Hodrick, 2020) such that higher values have implicit higher amplitude and duration of cycles. Following Hodrick & Prescott (1997), the typical parameter value set for quarterly data when applied to business cycle analysis, corresponding to the mean cycle duration of 5 years in the OECD, is λ = 1600, which for the purposes of this work is used in order to identify the cyclical component of GDP in the Eurozone sample.

Ravn and Uhlig (2002), however, derive an optimal rule of adjustment to the data of different frequency from typical business cycle duration in developed countries, as the product of the standard quarterly value of λ = 1600, with the fourth power of the ratio of the frequency of the standard cycle to that of the observed series. Bearing, on average, approximately 3 to 4 times the duration of the mean business cycle in developed countries, Drehmann et al. (2010), approximate the optimal parameter for the filtering of credit cycles as $\lambda = 4^4.(1600) \approx 400\,000$.

Most notably, the parameter λ= 400 000, is used to generate credit cycle components that underlie credit-to-GDP gap measures specified by the Basel Committee for Banking Supervision as a target indicator for the setting of counter-cyclical capital buffers under the Basel III framework. In order to parcel out the cyclical component of financial indicators included in this work, therefore, the smoothing parameter in the application of the HP-filter will be preferentially set to λ= 400 000.

Filtered series by the application of the HP filter notably suffer from a problem of end-point bias (Hamilton, 2017), which causes terminal data points of the series to have a disproportional impact in the estimation of the trend and therefore may bias the extracted cycle component with spurious dynamics. The correction of end-point bias is dependent on the objectives to which the filtered series is employed (Ekinci, Kabaş & Sunel, 2013), namely, when the analysis is primarily concerned with the characteristics of the cycle over the historical period of the sample, end-point bias may be overcome by extending the original series by forecasting the end points into additional periods and omitting these observations after the filter is applied; however, when the terminal point is of particular interest in order to carry out forecasts of the series into future periods this method may be problematic. Given that this study is primarily concerned with the first objective, the main cyclical variables will be forecasted at each end-point on both tails of the corresponding time series for an extension of 4 additional quarters by an ARIMA (1,1,1) process, and the additional observations are then promptly omitted after the series is decomposed.

A preliminary characterization of financial cycles across the eurozone nations will be undertaken in order to compare cyclical amplitude, duration and slope, across countries and sub-areas of the eurozone. For the effect, the growth cycle of the series is identified through the filter, in order that the turning points in the series of credit, property prices and GDP can be ascertained.

Analysis of the cycles defined as deviation cycles also entail a different interpretation of turning points of the cycle. While the classical definition of cycles, deriving from Burns and Mitchell (1946), characterizes cycles in terms of expansion and contraction phases, marked by the periods between turning points, such as peaks and throughs, constituting the local maxima and minima of the series within a set defined time intervals, in the level of the time-series of the cyclical variable. By characterizing our cyclical variables according to their Deviation cycle, the turning points are defined as the points where the series reverts from either above-trend to below trend growth (downturn) and from below-trend to above-trend growth (upturn).

Similarly, to classic business cycle dating procedures, the dating criteria are adapted from the Bry-Boschan Quarterly algorithm, and candidate turning points are identified by the conditions of Expansion Terminating Sequences and Recession Terminating Sequences:

ETS in t: $\Delta_2(c_t) > 0, \Delta(c_t) > 0, \Delta(c_{t+1}) < 0, \dots, \Delta_k(c_{t+k}) < 0$

RTS in t: $\Delta_2(c_t) < 0, \Delta(c_t) < 0, \Delta(c_{t+1}) > 0, \dots, \Delta_k(c_{t+k}) > 0$

Where k equals the window length over which the criteria that identifies candidate turning points must hold, typically set as k=2 quarters.

Due to the typical longer duration purported by financial cycles relative to standard business cycles (typically 3 to 4 times higher), in order to assure the minimum length of financial cycles, given the usual minimum duration parameters, of 5 quarters for minimal cycle length and 2 quarters for minimal phase length (Harding and Pagan, 2002), the minimum cycle duration is multiplied by a factor of 4, yielding a minimal of 20, in line with the average difference between business and financial cycle durations and therefore with the factor of transformation assumed by which the HP-filter is calibrated here for trend-decomposition of financial indicators.

Additional censoring conditions are also applied, such that peaks and troughs alternate successively, and the higher (lower) of two successive troughs (peaks) is not identified, and that a trough has to be lower than the preceding peak, or a peak higher than the preceding trough.

The main features analyzed will be average cycle amplitude and duration, defined respectively as the average absolute change in the cyclical variable´s level from each peak to through, and the average number of quarters necessary for its value to return to the value of a given peak from a given trough.

The average slope of the cycle is then computed as the ratio of average amplitude to average duration, serving as an indicator of how widely a financial cycle fluctuates for every unit of time.

After the identification, characterization and comparison of financial cycles in eurozone countries, the impact of the stance of monetary policy, on the indicative variables of the financial cycle, for the whole of the euro countries can then be estimated through a Vector Autoregression (VAR) model, for the set of series referent to each country within the eurozone.

The VAR model specifies the simultaneous evolution of multiple time series aggregated in a vector matrix. The variables constituting the vector are modelled as the linear combination of their path of past values of a given order p which indicates the maximum lag which is modelled to be predictive of the contemporaneous values for each autoregressive process in each series.

Reminding the VAR model from Lütkepohl (2005), a generic structure can be construed as follows, where the set of endogenous series, Y_t , is a $k \times p$ matrix and a linear combination of the respective lags up to order p and an error term U_t.

In its matrixial form:

(2) $Y_t = \Phi_1 Y_{t-1} + \Phi_2 Y_{t-2} + \cdots + \Phi_p Y_{t-p} + U_t$

Where:

$$(3)\quad Y_t = \begin{bmatrix} y_{1,t} \\ y_{2,t} \\ \vdots \\ y_{k,t} \end{bmatrix}; \quad \Phi_{t-p} = \begin{bmatrix} \beta_{1,1} & \beta_{1,2} & \cdots & \beta_{1,p} \\ \beta_{2,1} & \beta_{2,2} & & \beta_{2,p} \\ \vdots & & \ddots & \vdots \\ \beta_{k,1} & \beta_{k,2} & \cdots & \beta_{p,k} \end{bmatrix}; \quad U_t = \begin{bmatrix} u_t \\ 0 \\ \vdots \\ 0 \end{bmatrix}$$

The set of endogenous variables $Y_{k,t}$, therefore, are modelled as dependent not only on the evolution path of its own past values, but also the of past evolution of every each other time series determined within the system, parameterized by the coefficients $\beta_{k,t-p}$ which are estimated by multivariate least squares estimation.

The fundamental assumptions of the VAR(p) model require the vector of error components of the system U_t to meet a set of classical conditions such as a zero mean expectation, $E(U_t) = 0$, at every value of t, and the absence of serial autocorrelation of the errors across t, $E\left(U_t U_{t-n}^{'}\right) = 0$, which requires a proper selection for the order p of lagged values of each series in the estimated model in order to preform reliable statistical inference.

The selection of optimal order of lags included in the model is carried out by selecting the number of lagged values that minimize the appropriate information criteria. The selection therefore, will constitute the setting of optimal lag length yielded by the minimization of one of four inspected criteria, the Akaike Information Criterion, the Hannan-Quinn Criterion, the Schwarz Information Criterion and the Final Prediction Error Criterion.

Because each of the k endogenous variables depend on $k \times p$ regressors, VAR(p) models tend to become heavily parameterized, and thus implies an extensive loss in degrees of freedom relative to a limited sample size. For this reason, parsimony in the construction of the model is of particular consideration, such that the lowest optimal lag length among the set of four criteria will be selected.

The lag selection by minimization of information criteria, minimizes prediction error, and seeks to optimize the trade-off between quality of fit, which reduces the incidence of autocorrelation, and complexity of the model, which increases the risk of overfitting and the loss of degrees of freedom, the first of which generally increasing as p increases while the second being decreasing in p.

Additionally, consistent estimation of the VAR(p) process requires stationarity of the time-series constituting the vector of endogenous variables. Stationary implies that the statistical moments of the series to remain invariant across the time dimension.

If the VAR(p) process is stable, the matrix of endogenous variables, Y_t is inferred to be stationary (Lütkepohl, 2005, pag. 27), although the reverse is not necessarily true as non-stable models are not necessarily non-stationary. Moreover, Stability of the VAR(p) process requires the verification of the condition that the eigenvalues of the matrix of coefficients $\Phi_{k\times p}$ must lie inside the unit circle and be lower than one in absolute value.

Alternatively, stability of the model can be ascertained by whether it possesses no unit roots in the characteristic equation, and these lie outside the unit circle in absolute value.

More formally, the stability condition implies:

$$\text{(4)} \quad \det\left(I_k - \Phi_1 z - \cdots - \Phi_p z\right) \neq 0\,,\ |z| \leq 0$$

Failure to verify stationarity in the matrix of endogenous regressors requires transformation of the series into stationary processes. Non-stationary processes can be made stationary by differencing the series a number of times given as the series' order of integration, a process however, that entails the loss of observations at each consecutive differentiation.

Nonetheless, a non-stationary series in levels may be trend-stationary, that is, it can be decomposed into the linear combination of a stationary process and a deterministic trend function strictly dependent on time. Model stability, then, will be tested with both trend and non-trend constant components. Given that stability is achieved through the introduction of a linear trend,

4. Characterizing business and financial cycles (Euro area countries, 1999 – 2021)

In this section, the main statistical properties and characteristics of the time series of interest are analyzed. The set of variables under study are drawn from the ECB´s Statistical Data Warehouse (https://sdw.ecb.europa.eu/).

Additionally, a preliminary characterization and dating of financial and business cycles in the sample of eurozone constituent countries is carried out.

4.1 Descriptive Statistics

For each of the eurozone countries a dataset is construed, comprising the quarterly values, ranging from the first quarter of 1999 (1999-Q1) to the third quarter of 2021 (2021-Q3), for the set of variables measuring the financial cycle, total credit volume, measured as the sum of the stocks of total loans and debt securities extended to non-financial corporations, households and non-profit institutions serving households; residential property prices, measured by the index of transaction value of new and existing dwellings, the set of variables measuring the business cycle, namely GDP level, indexed to a base of 100 in reference to the first observation of the first quarter of 1999, measured at market prices, calendar and seasonally adjusted in chain linked volume, and the inflation rate, measured as the relative percent change in the quarterly average of the monthly harmonized consumer price index. Changes in monetary policy will be measured through the change in the short-term money market interest rate prevailing in the eurozone, coined as the Euribor (Euro Interbank Offered Rate), which acts as the main reference rate to which a much broader plethora of interest rates are indexed; additionally, with the increased relevance of unconventional monetary policy strategies of the ECB, the total balance sheet value of the central bank will be utilized as an indicator of unconventional policy stance.

From Tables .1 through .4, the main descriptive statistics for the cyclical components of Credit Volume, House Prices Index, GDP and Money-market Interest Rate are shown for the set of countries. Descriptive statistics for additional non-core variables are shown in annex.

Table.1 Descriptive Statistics - Total Credit Volume (Cycle – Log difference from trend)

	Mean	Median	Min.	Max.	St. Dev.
Austria	-0.05392	0.00495	-0.05392	0.07647	0.027888
Belgium	-0.08456	0.00568	-0.08456	0.12553	0.051034
Germany	-0.06973	0.00467	-0.06973	0.09546	0.046487
Estonia	-0.12955	0.00098	-0.12955	0.26353	0.100947
Finland	-0.11638	0.01727	-0.11638	0.13971	0.074443
France	-0.05569	-0.00294	-0.05569	0.08105	0.036529
Greece	-0.32080	0.00097	-0.32080	0.43080	0.223811
Ireland	-0.29658	0.01874	-0.29658	0.29557	0.157553
Italy	-0.14283	0.01126	-0.14283	0.21168	0.099787
Lithuania	-0.34734	-0.10450	-0.34734	0.74166	0.284761
Luxemburg	-0.18728	0.00476	-0.18728	0.36272	0.137023
Latvia	-0.58969	-0.02865	-0.58969	0.65780	0.336686
Malta	-0.04571	0.00218	-0.04571	0.03017	0,001186
Netherlands	-0.08930	0.02760	-0.08930	0.08791	0.042763
Portugal	-0.19687	0.04689	-0.19687	0.21936	0.117407
Slovenia	-0.30405	-0.07151	-0.30405	0.35114	0.204565
Slovakia	-0.06702	-0.00043	-0.06702	0.09281	0,002907
Spain	0.00000	-0.05470	-0.49503	0.37109	0.224342

Notably, as shown in, Table.1 the cyclical series of total credit shows a highly asymmetric distribution for almost the whole of the sampled countries. The ratio of mean to median value of the distribution shows that while the mean of the cycle of credit is generally below trend for all countries in the sample, the median value of the credit cycle across time is generally above trend, which might indicate a negative skewedness in the evolution of the credit cycle across the time span.

This particular skewedness in the distribution of credit cycles suggests a possibly longer tail in the downturn range of the cycle, which may reflect, simultaneously, a general longer duration of the upturn phase of the credit cycle, and shorter but more pronounced downturns. This pattern may also be influenced by extreme episodes of sharp declines in credit, namely, the impact of the 2008 financial crisis, which is encompassed by the span of time covered by the data and may require additional care as a potentially influential outlier.

Table.2 Descriptive Statistics – Housing Price Index (Cycle – Log difference from trend)

	Mean	Median	Min.	Max.	St. Dev.
Austria	-0.01824	-0.01330	-0.12036	0.09688	0.0472981
Belgium	0.00258	-0.03162	-0.08808	0.14951	0.0725369
Germany	-0.02111	-0.02133	-0.09685	0.12280	0.0531641
Estonia	-0.02721	-0.01202	-0.45483	0.54762	0.2235069
Finland	-0.00322	-0.00396	-0.09009	0.06196	0.0364444
France	0.00983	-0.02637	-0.14277	0.24693	0.1176306
Greece	-0.01174	-0.03087	-0.19381	0.21217	0.1209532
Ireland	-0.00551	-0.00380	-0.08732	0.06547	0.0419171
Italy	0.00937	-0.00672	-0.12800	0.17472	0.1015516
Lithuania	-0.02155	-0.05442	-0.17155	0.36597	0.1286834
Luxemburg	-0.02774	-0.05909	-0.11031	0.15667	0.0669132
Latvia	-0.02828	-0.05761	-0.38118	0.54327	0.2045930
Malta	-0.00010	0.00067	-0.08349	0.09704	0,0330923
Netherlands	-0.02910	-0.00689	-0.20819	0.16299	0.0961112
Portugal	-0.02058	0.02585	-0.21790	0.16517	0.0984424
Slovenia	-0.02021	-0.00812	-0.20544	0.14929	0.0847516
Slovakia	-0.00003	-0.00673	-0.06092	0.07705	0.0235396
Spain	0.00000	-0.00549	-0.20915	0.23522	0.1242628

Conversely, the house price index statistics shows a lower skew in the distribution symmetry, given that the mean to median ratio of the distribution tends to be lower for a majority of countries.

More notably still, cross-country differences in the range of financial cycle indictors show a particular pattern; namely, a set of countries within the eurozone tend to experience higher maximum amplitudes in both segments of the financial cycle on average, and moreover, these same countries tend experience the lowest average minimum amplitudes of the financial cycle. This set of countries encompasses those belonging to both eastern and central Europe and southern Europe, such as Estonia, Latvia, Lithuania, Slovenia Greece, Portugal and Spain, composing what's commonly termed the European "periphery".

Table.3 Descriptive Statistics – Gross Domestic Product (Cycle – Log difference from trend)

	Mean	Median	Min.	Max.	St. Dev.
Austria	-0.000290	0.000233	-0.125209	0.035970	0.0207737
Belgium	-0.000283	-0.000043	-0.130100	0.029890	0.0177710
Germany	0.000068	0.000650	-0.105200	0.036680	0.0200544
Estonia	-0.000358	0.000757	-0.110699	0.096465	0.0392298
Finland	-0.000155	0.000321	-0.066022	0.052415	0.0203844
France	-0.001084	-0.001286	-0.176443	0.033690	0.0226578
Greece	-0.001436	0.000912	-0.139920	0.049723	0.0296097
Ireland	0.001152	0.000988	-0.071118	0.118617	0.0357803
Italy	-0.000333	-0.000204	-0.036182	0.007099	0.0052993
Lithuania	-0.000929	-0.000927	-0.085096	0.100353	0.0344546
Luxemburg	0.000227	-0.000037	-0.070100	0.069110	0.0181122
Latvia	-0.000109	0.001165	-0.083731	0.047236	0.0202214
Malta	-0.000172	0.000191	-0.149297	0.053799	0.0236565
Netherlands	0.000174	-0.000497	-0.089636	0.033689	0.0171638
Portugal	-0.000173	-0.001409	-0.156826	0.054327	0.0245039
Slovenia	0.000153	-0.004107	-0.120956	0.072364	0.0249797
Slovakia	-0.000995	0.004199	-0.150314	0.124047	0.0649308
Spain	-0.000290	0.000233	-0.125209	0.035976	0.0273699

Overall, GDP cycles across the eurozone tend to show on average lower amplitudes in deviation from trend, both in terms of the downturn and the upturn, although the same group of countries which experience the largest downturns in financial cycles also tend to experience the largest GDP downturns of the sample.

4.2 Cycle Characterization

A more precise dating and measurement of amplitude of the filtered cycle series, however, is achieved by applying the BBQ algorithm.

A total of 43 upturns is identified in medium-term cycles of credit, while the overall number of downturns are identified as 41, in the period of 91 quarters of the sample.

Property price cycles, additionally, show a similar total of 45 upturns and a total of 43 downturns, possibly suggesting similarity in the occurrence of episodes of either expansion or recession between credit and housing price cycles. This similarity in the frequency of financial indicators can be partially due to the calibration of the HP-filter to eliminate higher frequency oscillations, however, past this minimum threshold it is suggestive that, overall, oscillations in medium-term cycles in financial variables tend to occur with close frequency across the eurozone between different indicators.

Additionally, 68 expansions and a total of 61 recessions are identified in the sample across the eurozone in the GDP cycle. The higher count of cyclical phases across eurozone countries in the same sampled span of time accounts for the higher frequency of the business cycle relative to that of financial cycles although it is expected given the lower filtering of higher frequencies of complete cycle durations applied to GDP, relative to other cyclical indicators, in order to capture the frequency of cyclical movements which are most materially relevant.

Having identified the appropriate turning points, the main characteristics of the cycle can be measured for both upturns and downturns. Table 4. summarize the across-time average of each cycle´s features such as amplitude, duration and slope for each of the eurozone´s countries under purview, respectively for upturns and downturns of each cycle.

Overall, credit cycles across the eurozone achieve on average an amplitude of approximately, 22.1 % relative to trend, while downturns can reach an average amplitude of 25.6%. Moreover, cycles in property prices reach an average amplitude of approximately 19.2 % during upturns and approximately 19.6 % during downturns, across the aggregate of the eurozone.

In the standard business cycle, however, amplitude tends to be more contained, reaching about 6.9 %, during expansions, and approximately 8.2 % during recessions, on average across the whole eurozone, contrasting starkly against the deeper reach of financial cycles both.

The wider-ranging amplitude of financial cycles on the eurozone is can be partially derived again by the filtering of higher frequency cycles, which is itself justified by the natural protraction and longer-term momentum typically found in financial cycles relative to business cycles in advanced countries, and thus can be naturally expected for single phases to show higher and more pronounced amplitudes over a longer duration.

The duration of the average eurozone credit cycle upturn lasts about 16 and a half quarters while downturns last about 18 quarters, while on average, housing prices have a duration of about 16 quarters in both upturns and downturns for the whole of the eurozone.

Table.4 Descriptive Statistics – Characterization of Upturns (1999 Q1 – 2021 Q3)

	Credit			Housing Prices			GDP		
	Amplitude (%)	Duration (Q)	Slope	Amplitude (%)	Duration (Q)	Slope	Amplitude (%)	Duration (Q)	Slope
Austria	2.5	14	0.18	7.5	14	0.54	4.1	16	0,26
Belgium	12.9	16.5	0.78	21.9	22	1	3.3	19.3	0,17
Germany	1.9	12	0.16	3.6	6	0.6	4.6	18	0,26
Estonia	7.3	15	0.49	64.3	19	3.38	9.2	9.8	0,94
Finland	13.3	13	1.02	6.5	11.3	0.58	5.5	18.3	0,30
France	7.7	16.3	0.47	13	14	0.93	9.3	5.7	1,63
Greece	68.1	46	1.48	27.5	22	1.25	8.2	24	0,34
Ireland	33.5	9.7	3.45	9.7	17	0.57	1.4	8.7	0,16
Italy	11.8	13.5	0.87	15.5	18.5	0.84	1.2	29.5	0,04
Lithuania	57.7	17	3.39	28.1	12.5	2.2	8.6	21.3	0,40
Luxemburg	22.1	11.3	1.96	5.1	31	0.16	6.5	23.5	0,28
Latvia	64.6	14.5	4.46	59.6	27	2.21	8.6	15	0,57
Malta	6.2	17	0.36	13.9	7	1.99	7.8	24.5	0,32
Netherlands	-	-	-	13.1	21	0.62	4.1	14.5	0,28
Portugal	-	-	-	3.7	4	0.93	5.9	23	0,26
Slovenia	33.4	13.5	2.47	11.4	9.5	1.2	9.7	25	0,39
Slovakia	8.1	19.5	0.42	6.6	22.7	0.29	20.5	4.3	4,77
Spain	3.6	5	0.72	35.3	16	2.21	5.1	16.7	0,31

Surprisingly, the average eurozone business cycle in the sample is only very moderately shorter relative to cycles in credit and property prices, with expansions that last approximately 17 and half quarters and around 11 and half quarters in recessions.

Naturally, this divergence between financial and business cycle's amplitudes but closer similarity in terms of duration reflects itself in a stark difference in the slope of each category of cycles.

Measuring the average amplitude range of a phase in a single quarter constituting that phase´s duration, the average slope indicates that financial cycles are on average more volatile with more violent and wider changes over a singular period of time, relative to underlying cyclical changes in GDP over the same period.

Table.5 Descriptive Statistics – Characterization of Downturns (1999 Q1 – 2021 Q3)

	Credit			Housing Prices			GDP		
	Amplitude (%)	Duration (Q)	Slope	Amplitude (%)	Duration (Q)	Slope	Amplitude (%)	Duration (Q)	Slope
Austria	6,4	17	0,38	4,1	7	0,59	6,7	7,5	0,89
Belgium	10,1	13.5	0,75	14,5	28,5	0,51	6,1	5	1,22
Germany	7,5	17	0,44	5,8	19	0,31	6,8	4,3	1,58
Estonia	11,8	12	0,98	42,9	6,5	6,60	9,7	11,2	0,87
Finland	15,2	18.5	0,82	10,2	26	0,39	6,7	5,8	1,16
France	7,6	9	0,84	19,5	14	1,39	4,6	30	0,15
Greece	75,1	38	1,98	40,6	29	1,40	13,9	6	2,32
Ireland	36,7	20	1,84	10,3	34	0,30	1,4	19,3	0,07
Italy	16,5	25.5	0,65	14,4	20	0,72	2,1	6	0,35
Lithuania	49,6	17.5	2,83	28,4	11,5	2,47	10,5	8,5	1,24
Luxemburg	24,5	22	1,11	1,5	2	0,75	8	11,3	0,71
Latvia	71,9	29	2,48	40	6	6,67	10,9	22,5	0,48
Malta	5,8	9	0,64	15,3	11,3	1,35	11,5	10,3	1,12
Netherlands	17,7	34	0,52	19,3	20	0,97	6,5	16,3	0,40
Portugal	34,6	43	0,80	14,7	19,5	0,75	5,7	9,3	0,61
Slovenia	26,8	22	1,22	19,5	13	1,50	5,6	2,7	2,07
Slovakia	11,3	11.5	0,98	7,5	5	1,50	22,8	24	0,95
Spain	58,1	47	1,24	44,4	26	1,71	8,7	6,8	1,28

The bulk of higher amplitude downturns are patterned in a set of countries, as previously foreshadowed by the standard descriptive statistics of the cycles, primarily focusing on countries from the southern and eastern sections of Europe, which additionally fall under the same pattern of the most affected during the sovereign debt crisis.

The deepest financial downturns of the eurozone over the sample time is found for Greece, reaching approximately 75 % for overall credit and 40 % for the housing property price index, supporting however particularly long phase durations, and thus the extreme depth of amplitude of the downturn is supported by the long extension over which it occurs and the height of the preceding upturn, reaching a peaking of approximately 43 % and 21 % relative to trend.

Other similar countries also present extreme amplitudes such as Spain which proports an average downturn of 58 % in credit and 44 % in housing prices, although once again partly attributable to the extreme amplitude of the peak of about 39 in credit and 23 in property prices relative to trend at the start of the downturn. Moreover, Latvia also reaches an extreme downturn amplitude of about 71.9 % in credit making it the second largest of the sample, although it contrasts with an upturn of approximately 64.4 %.

The lower amplitudes in the financial cycle can be found however in the core of the eurozone, such as Germany, Austria and Belgium, notoriously more resilient during the onset of the sovereign debt crisis, purporting also particularly low slopes and thus much more stable and tame financial cycles.

In countries with singularly longer phase durations such as Portugal, the Netherlands, Spain and Greece, a portion of a long phase of the cycle might lie outside of the sample while another significant portion of this phase may cover a significant proportion of the time sample. For this reason, the measurement of the complete average phase amplitude of large portions of a countries' cycles can be distorted, while in other cases due to a characteristically long single expansion period where the trough lies out of sample, the average amplitude of the credit cycle upturn cannot be fully determined in-sample for both Portugal and the Netherlands.

Additionally, countries with pronounced financial cycles tend to also have more pronounced GDP cycles, although the latter are relatively tamer in terms of both duration and amplitude.

The highest amplitude in the sample across the GDP cycle is achieved by Slovakia reaching around 22.8 % and 20.5 %, respectively during recessions and expansions, nonetheless, countries located in the southern and Baltic sections of the eurozone such as Greece, Spain, Latvia, Lithuania and Estonia also tend to cluster in the upper bounds of higher amplitude business cycles.

Expectedly, however, the deeper and longer downturns across a bulk of countries in the sample tend to occur within the time range of the 2008 financial crisis and the ensuing sovereign debt crisis, especially in countries with exceptionally long financial cycles.

Recessions in the sample also tend to be larger than expansions relative to the trend for the majority of nations under study, although by a narrow margin.

Overall, some general conclusions can be drawn; namely, for every category of the cyclical variables average amplitude and duration tend to be proportional, while deeper amplitude and duration of a phase tends to be associated with deeper amplitudes and duration in the other.

Southern and Eastern European countries belonging to the eurozone, especially those that came historically to be most affected by the sovereign debt crisis tend to have longer lasting and deeper amplitude financial cycles.

5. Relating Business and financial cycles: the implicit model

The empirical model is developed within a set of assumptions and theoretical frameworks which inform simultaneously the selection of variables, the specification and the overall interpretation given to the estimates.

The model specifies the simultaneous endogenous relationships between the main variable of the financial and business cycles, and moreover it specifies a lagged impact of each of the cyclical variables on every other cycle.

This specification implied by the structure of VAR, is underlined by the mutual build-up of the various cyclical variables across periods, such that, a mechanism where the build-up of credit reinforces the build-up of property prices, while another is presupposed where property price changes across multiple periods affect the supply of overall credit across time.

A third chain of causality must also incorporate by which the components of the financial cycle are thought to affect the business cycle, while, conversely, the cycle in GDP is supposed to impact both the value of housing and the supply of credit. This assumption, however, violates strictest assumptions of financial neutrality, such as present in the benchmark DSGE models of either Real Business Cycle or New Keynesian strands, at least in the long-run, and rests on the assumption that financial frictions at the micro-level are of sufficient scale to materially create a connection between the state of the real and financial sectors of the economy.

Additionally, the model must be interpreted in light of a full specification of the set of transmission channels, direct and indirect, by which monetary policy instruments impact the financial cycle through either credit and housing prices, and more commonly the standard GDP cycle.

The complete specification of the model for each of the Euro area countries, i, is construed as:

$$\begin{bmatrix} CRD^{c}{}_{i,t} \\ HPI^{c}{}_{i,t} \\ Y^{c}{}_{i,t} \\ G_{i,t} \\ r_{i,t} \end{bmatrix} = \alpha_t + \Phi_{t-1,k} \begin{bmatrix} CRD^{c}{}_{i,t-1} \\ HPI^{c}{}_{i,t-1} \\ Y^{c}{}_{i,t-1} \\ G_{i,t-1} \\ r_{i,t-1} \end{bmatrix} + \cdots + \Phi_{t-p,k} \begin{bmatrix} CRD_{i,t-p} \\ HPI_{i,t-p} \\ Y_{i,t-p} \\ G_{i,t-p} \\ r_{i,t-p} \end{bmatrix} + \theta_1\, ECB_{BS_t} + \theta_2\, Crisis_i + \theta_3\, PreCrisis_i + \varepsilon_t$$

Belonging to the vector of endogenous variables, the cycle component of total credit is noted as $CRD^{c}{}_{i,t}$, while the cycle in housing property prices is noted as $HPI^{c}{}_{i,t}$, and $Y^{c}{}_{i,t}$, denotes the standard business cycle as the cyclical component in GDP. Additionally, the outstanding value of public debt included in the endogenous vector, is denoted as $G_{i,t}$, and the short-term money market interest-rate as, $r_{i,t}$. Moreover, some variables included are assumed to be strictly exogenous; these include, value of the volume of assets that constitute the ECB´s balance sheet, noted as ECB_{bs_t}, which can be reasonably conceived as independent from the macroeconomic state of any one of the individual countries under analysis; the other set of exogenous variables constitute two dummy variables $Crisis_i$ and $PreCrisis_i$,one capturing time specific effects of the period encompassing the duration of the impact the Great Financial Crisis, here set between 2008-Q3 and 2011-Q4 and another, capturing the time specific structural effects present during the first half of the sample over up until the onset of the crisis, which covers the period between 1999-Q1 to 2008-Q2.

This specification implies a tripartite separation of the time frame of the datasets which allows the separate study of the relationships among the endogenous regressors within different macroeconomic and financial environments prevailing in each time window. The first part of the period under consideration (1999 Q1 – 2008 Q2) in Europe, is typically characterized by a larger efficacy of monetary policy, accompanied by a macroeconomic environment of relatively on-target inflation and low business cycle volatility, and a financial environment of relative integration and consequential liberalization in financial and banking regulatory frameworks for most countries which compose the eurozone. With the eruption of the crisis (2008 Q2 – 2011 Q4), the macroeconomic and financial environment changed dramatically, suffering large contagion effects and causing disruptions to European financial markets, slowing liquidity provision under tighter money market conditions and higher spreads, an in which a large subsection of eurozone saw a reversal of capital inflows and as a consequence late in 2009, debt to GDP ratios of peripheric countries saw signs of increasing instability of public debt dynamics and a sharp increase in sovereign debt spreads (Lane, 2012).

Moreover, the post-crisis period (2011 Q4 – 2021 Q3) required significant changes in the European economic environment, for one, the conventional instruments of monetary policy became constrained by the zero lower bound restriction, and thus limiting the efficacy of monetary policy; this meant however, a substantial increase in the prevalence of unconventional instruments in the conduction of monetary policy, accompanied by a corresponding expansion of the ECB´s balance sheet and an accumulation of risky assets by the central bank. The post-crisis regulatory framework also changed significantly, as with the establishment of the Single Supervisory Mechanism Regulation, conferring to the ECB powers to conduct macroprudential policies and extended oversight over credit institutions across-the board rather than focusing on the specific regulation of a set of individual banks of higher prominence.

For these reasons the inclusion of the period-specific dummy variables, allows for the capture of particular interactions which may be differentiated among periods.

As mentioned in section 2, the financial accelerator mechanism is fundamental in understanding the interaction between the components of the financial and the business cycle. Through this mechanism, credit and real economic activity are mutually reinforcing, with a given positive shock to economic activity, for instance, balance sheet value of economic agents tends to increase, mainly, through the increase in the present value of cash-flows originating from positive correlation in its assets with increases in overall income; although other effects are possible, such as downstream spillovers in inflation, increasing at lower unemployment levels through standard Philips curve dynamics, in final goods markets to asset markets; which assuming the prevalence of aforementioned financial frictions and a general endemic ubiquity of asymmetric information in credit markets, implies a reduction in credit constraints and therefore an overall increase in extended credit in the economy. Conversely, because a portion of productive investment applications with positive net present value can go unfinanced for credit constrained agents, the overall increase in extended credit to these particular segments of agents implies a corresponding increase in previously foregone investment with positive returns, which feeds back once again into aggregate income.

The effects of the financial accelerator also provide a link between housing prices, credit and economic activity. As in Aoki, Proudman & Vlieghe (2004), the prevalence of asymmetric information between households and financial intermediaries imposes borrowing constraints, and therefore credit to households becomes a function of net worth. Because the majority of household assets constitute housing property and therefore the most frequent form of household collateral, housing prices can cause changes in extended credit to the household sector, e.g., a positive shock to economic activity and consequently property prices, increases borrowing and leverage of the household sector; however, since the primary object of investment in this sector occurs primarily in housing property, the higher level of borrowing feeds back into demand for these assets, which further drive increases in housing prices.

Through this channel of the financial accelerator, therefore, a positive and mutually reinforcing relationship between the property price cycle, the credit cycle and the GDP cycle is expected.

In diagram. 1, the relationships mediated by the financial accelerator between the three studied cycles are systematized.

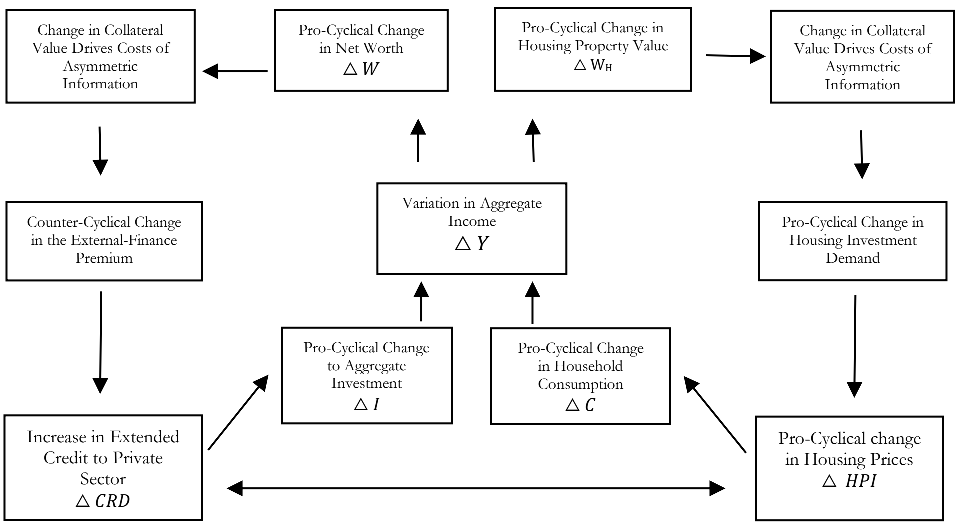

Diagram.1: Financial Accelerator Mechanism

A similar mechanism underpins the impact of monetary policy through financial and credit markets and the impacts of monetary policy decisions on the financial cycle.

As described above, the credit channel of monetary policy can transmit changes in the monetary policy instrument to the overall level of credit being extended to different sectors of the economy, and by extension to both property prices and income.

The credit channel can be sub-divided in two individual channels; the balance sheet channel is most closely propagated by a financial accelerator-like mechanism, whereby changes in net worth of credit constrained borrowers are of particular importance to the transmission of monetary policy.

A change in the level of interest-rates brought about by a change in monetary policy stance, directly changes the preponderance of interest expenses of debtor economic agents, and thus elicits a contrary change in cash-flows, e.g., a tightening of monetary policy rates simultaneously reduces the cash-flow prospects of borrowers and decreases asset assets prices of underlying assets, further weakening balance sheet value of credit constrained agents. Because balance sheet value largely determines the amount of pledgeable collateral, it is intrinsically linked with borrowers' access to credit, and therefore a monetary tightening in the manner described, will further increase constraints on financial funds. Therefore, financially constrained firms, with lower ability to increase short-term borrowing will require a curtailment of output and employment (Gertler & Gilchrist, 1993).

Moreover, the same process applies in the case of housing investment, whereby a change in monetary policy stance tends to affect housing property prices in inverse relation to the change in interest-rates. Facing this change, households in particular, which bear the highest preponderance of housing property value in its balance sheets marketable collateral, are the most affected sector, becoming either more highly, or less, credit constrained depending on the change in the policy rate. As exemplified above, a monetary tightening therefore decreases access to funds which are predominantly applied in housing investment on part of households, implying a reduction in demand which further depresses housing prices.

Alternatively, the bank lending channel focuses primarily in the financial constraints of the banking system and how these constraints can mediate the transmission of monetary policy decisions.

In the bank lending channel, changes in monetary policy elicit changes in banks reserves mainly through the conduction of open market operations, more specifically, the selling/buying of Central Bank securities to the banking system decreases/increases the amount of held reserves in the same proportion, which in turn either constrains or expands the lending capacity of the banking institutions through a corresponding change in deposits which preserves the bank`s balance sheet identity. This channel impacts the flow of credit and consequently investment and production, through a reduction in loan supply due to funding constraints of the banks rather than the borrowers.

Moreover, monetary policy works to simultaneously affect both real and financial sectors through the risk-taking channel (Borio & Zhu, 2008). This channel is thought to function by altering the pricing of risk by economic agents, that is, through a change in policy interest rates, changes the flow of returns, cash-flows and asset prices, thus boosting net worth value as in the workings of the credit channel and the underlying financial accelerator mechanism; however, the sequence of this particular channel assumes then an inverse relation between agents risk calculation and net worth, which can induce firms to rebalance the overall composition of finance, for example, towards riskier levels of indebtedness due to a reduction in interest rates. Moreover, this particular channel can operate through the wedge between the prevailing market rates of return and target rates of return (Rajan, 2005), inducing a search for yield, that is, agents set fixed targets of return which incentivizes the undertaking of increased leverage when the wedge between market and target rates increase.

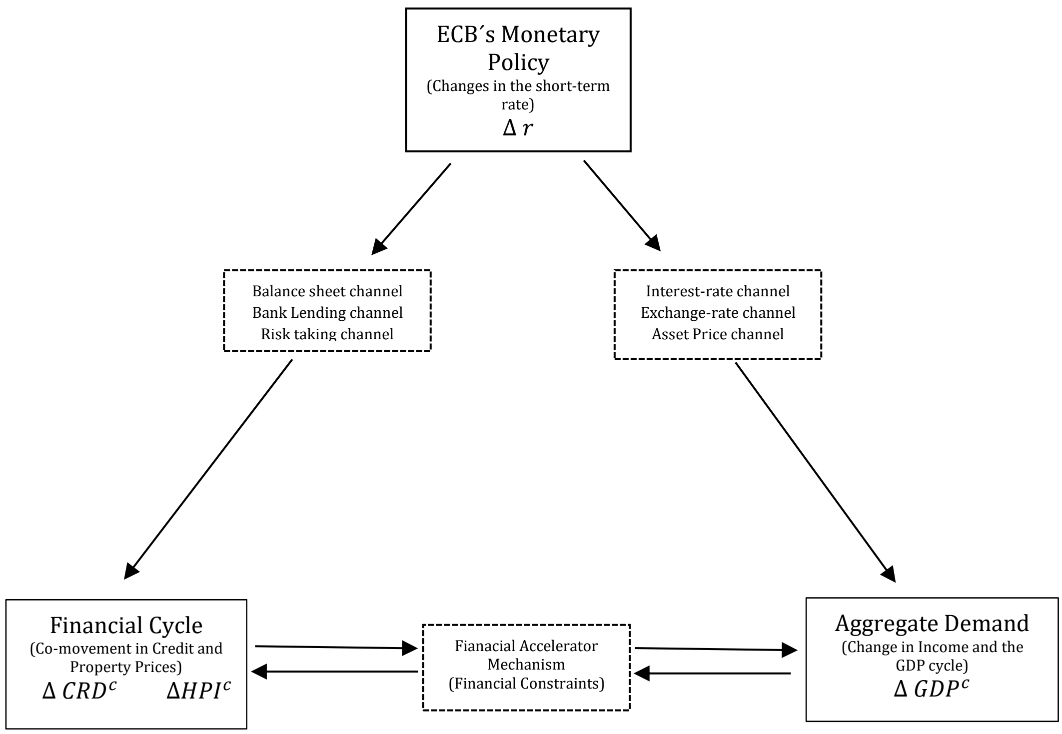

Diagram.2: Endogenous Relationships between Financial and Business cycles and Monetary Policy

6. VAR Results

In this section the main resulting estimates of the VAR estimator parameters are presented along with their respective impulse response functions. Moreover, the relationship among cycles and monetary policy decisions will be interpreted through Granger causality, defined as the joint significance of the lagged coefficients of a given variable relative to another within the system.

Generally, even with the specification of a long-term trend variable, a large proportion of the models contain at least one unit root in the characteristic equation or extremely proximal to unity, confirming that model instability does not stem from trend-stationary processes. Because of this, the set of variables constituting each model are transformed into its first differences and a single constant non-trend term is included, assuring model stability for all models of each country. As a cost of ensuring stationarity within the vector of endogenous variables by differencing each variable, however, the first observation of each series is lost as a result of its differentiation relative to the second observation, shortening each differenced series to the span between 1999-Q2 and 2021-Q3.

Additionally, the Johansen test for cointegration for all 18 models fails to reject the null hypothesis that the number of cointegrated relationships among the endogenous variables is inferior to the number q of these variables. Therefore, the Vector Error Correction Model (VECM) specification is rejected in favor of the VAR-in-differences.

Under the VAR-in-differences specification every model corresponding to each of the countries under analysis becomes stable as given by the roots of the characteristic equation shown in annex. Moreover, for each model, there is at least one of the inspected information criteria (section 3.) yielding $k = 1$ as the optimal lag length, with exception of Slovenia´s, given its outlier positioning in this respect however, the risk of higher than necessary autocorrelation is traded-off with the need to assure model comparability across countries, $k=1$ is therefore ubiquitously selected in order to preserve a maximum of degrees of freedom and assure comparability across models. Under these assumptions, the t-statistic associated to each estimated coefficient has the same interpretation as a Granger-causality test.

The results are summarized under tables (6), (7), (8) each corresponding to an endogenous variable within the VAR system, namely the three main cycles, for which the coefficient estimates associated to the lagged values of each variable are displayed for each country for which the model is applied.

Table.5 Results of VAR Regression (1999 Q2 – 2021 Q3) – Credit Cycle: $y = CRD^C$ (Log - First Differences)

$t-1$	CRD^C	HPI^C	GDP^c	r	G	ECB_{bs}	$crisis_d$	$Pre\ Crisis_d$
Austria	-0.247**	0.005	-0.001	0.009***	-0.029	0.005	0.0002	0.005**
Belgium	0.045	-0.192	0.032	0.0436	0.004	0.032	-0.0006	0.010**
Germany	0.275***	-0.036	-0.034	0.0032	-0.129**	0.021*	-0.0024	-0.001
Estonia	0.198**	0.039	-0.267**	-0.0008	0.0247	-0.016	-0.003	0.0096**
Finland	0.082	-0.046	-0.195	-0.004	0.025	0.024	0.003	0.0087**
France	0.412***	-0.027	0.371***	-0.0078	-0.157	-0.022	0.0008	0.0017
Greece	-0.597***	0.086	0.0074	0.003	-0.003	-0.0149	-0.0042	0.003
Ireland	0.208	0.240	-0.235	0.0043	-0.1064	0.064	-0.004	0.0108
Italy	-0.167	0.043	-0.216	0.002	0.092	-0.0085	0.0047	0.018***
Lithuania	0.313***	0.421***	-0.048	-0.002	0.185***	-0.052	-0.0173	0.024***
Luxemburg	0.4998***	0.2003	-0.196*	0.0015	-0.004	-0.051	0.0035	0.0109
Latvia	-0.381***	-0.025	0.0018	-0.0028	0.018	-0.014	-0.0078	-0.001
Malta	-0.293***	0.0261	-0.0502	-0.001	0.0537	0.0116	0.0023	0.0003
Netherlands	-0.0069	-0.034	-0.0759	0.0034	0.0016	-0.0001	0.0084**	0.008***
Portugal	0.386***	0.086	-0.0176	0.0046*	-0.035	-0.0123	0.0056	0.012***
Slovenia	0.649***	0.157*	-0.040	0.003***	-0.015	-0.0014	0.0035	0.008**
Slovakia	-0.589***	-0.032	-0.071*	-0.0046	-0.080	0.0447	-0.006	0.0009
Spain	0.1648	0.222***	0.004	0.002	0.0739	-0.003	0.0004	0.0603

The notations," *";" **";" ***", signify that the coefficient estimates are respectively statistically significant at 10%, 5% and 1%.

Unexpectedly, the coefficient associated to the short-term interest rate tends to show across a plurality of countries a positive association between the one period lagged quarterly change in the short-term rate and the quarterly change in the credit cycle. The theory underlying the credit channel suggests, rather, that a positive change in the interest rate leads to a contraction in both credit supply through the banking sector and credit demand through the household and firm´s sectors.

In terms of absolute magnitude, the coefficient range varies between 4,36 % for the in the Belgium model and 0,08 % for Estonia, for each percent point change quarter-to-quarter; across most countries, however, the modulus of impact of the short-term rate is lower than

1%. Interestingly, the countries where the expected acceleration of the credit cycle through expansionary monetary policy tends to cluster towards the balkanic and eastern nations such as Slovakia, Malta, Lithuania, Latvia and Estonia, although Finland and France also proport this relationship. Only Austria and Slovenia show significant results at $p< 5\%$, although purporting a positive coefficient on the impact of the interest rate

However, the VAR estimates across the generality of eurozone countries does not show the impact of monetary policy on credit volume cycle to be statistically significant, that is, the test statistic associated with the short-term interest rate lag coefficient, for a generality of the eurozone countries does not exceed the 95% confidence interval, and thus, the wedge between the theoretically expected and measured coefficients may result from low sample accuracy.

The strongest determinant of the credit cycle found across the multiplicity of countries is its own quarterly autoregressive process, that is, there is a tendency for credit expansion to accelerate across time proportional to the magnitude of previous expansions. This relationship is to be highly expected within the framework of the financial accelerator, whereby changes in credit across the cycle, further reinforces, through changes in income, the change in credit in the same direction at each posterior period, if lending constraints are binding over a significant proportion of economic agents.

The second indicator of the financial cycle, the property price cycle, shows, for a proportion of countries (10 out of 18), a reinforcing influence of property prices on credit. As set out in section 5., a positive impact of the housing price cycle on the credit cycle can be interpreted through household´s balance sheet, i.e., a rise in housing wealth provides the necessary collateral at which banks are willing to increase lending to credit constrained households, other factors constant. In the estimates, however, the majority of coefficients pertaining to this channel are not statistically significant, with notable exceptions for the case of Lithuania and Spain which show a high positive and significant impact of the change in housing price cycle on the growth of the credit cycle.

Moreover, the pre-crisis period dummy variable is also a significant determinant of the credit cycle in 9 out of 18 countries, and the associated positive coefficients generally imply a higher build-up of credit in upturns of the cycle during this period, as similarly suggested in section 4.

Table 6. summarizes the coefficient estimates associated with the lagged variables that are determinant of the housing price cycle in each of the analyzed countries.

As with the credit cycle estimates above, a similar pattern can be noted in the property price cycle, namely the short-run interest rate does not appear to be a significant granger cause of the housing property price cycle, that is, changes in the target interest rate do not generally precede changes in the housing price cycle within a 95% confidence interval for the great majority of countries of the eurozone.

Table.6 Results of VAR Regression (1999 Q2 – 2021 Q3) – Housing Price Cycle: $y = HPI^C$ (Log - First Differences)

$t-1$	CRD^C	HPI^C	GDP^c	r	G	ECB_{bs}	$crisis_d$	$Pre\ Crisis_d$
Austria	-0.213	-0.439***	-0.0799	0.005	0.089	0.047	-0.0056	-0.014***
Belgium	-0.063	0.006	0.095	0.007*	0.054	-0.020	0.0009	0.0074*
Germany	0.026	0.048	0.0768	0.003	0.071	0.0192*	-0.0115***	-0.0105***
Estonia	-0.072	0.562***	0.851***	0.003	0.082*	-0.165**	0.005	0.0002
Finland	0.0932	0.2137*	0.116	-0.0029	0.022	-0.021*	0.0052	-0.0008
France	-0.142	0.408***	-0.015	0.0022	-0.395***	0.014	0.014***	0.009***
Greece	-0.094	0.696***	-0.029	0.0004	-0.014	-0.026*	-0.005	0.0013
Ireland	0.039*	0.300**	-0.0054	-0.039*	-0.0034	-0.019	0.009**	-0.0003
Italy	0.2054*	0.3469***	0.5539**	-0.0032	0.081	0.0199	-0.0007	0.0040
Lithuania	0.258**	0.511***	-0.139	-0.004**	0.0302	-0.0535	-0.0099	-0.0114
Luxemburg	0.0332	-0.194	-0.076	0.006	-0.012	-0.002	-0.005	-0.0126***
Latvia	0.192	-0.414***	0.091	0.0006	-0.115	-0.106**	0.0269*	-0.002
Malta	0.136	-0.67***	-0.119	0.0018	0.352	-0.033	0.00238	-0.0004
Netherlands	-0.126	0.648***	0.051	0.006	0.020	-0.021	-0.0048	-0.0029
Portugal	0.064	0.391***	0.098**	-0.0044	-0.067	-0.014	-0.01**	-0.0078*
Slovenia	0.124	0.337**	0.153	-0.0023	-0.0714	-0.0268	-0.0037	-0.0056
Slovakia	0.0189	-0.305***	0.0012	-0.00388	-0.0164	-0.037*	0.004	-0.0029
Spain	0.2056*	0.635***	-0.0008	-0.006	-0.1114	-0.0224	-0.0067	-0.0089*

The notations," *";" **";" ***", signify that the coefficient estimates are respectively statistically significant at 10%, 5% and 1%.

Across 10 out of 18 models, the estimated impact of the monetary policy indicator again suggests a positive impact of higher interest-rates on the change in the cycle of housing prices, whereas through the household balance sheet channel, an increase in interest-rates is assumed to decrease property asset value and by extension, a negative relationship between interest-rates and changes in the housing price cycle. Although, since the positive estimated coefficients are not significant within the 95 % interval for virtually all of the estimated models, this paradoxical result in light of the theoretical framework which underlies it may result once again from low power of the study.

Another common pattern is also found, namely, the best predictor of changes to the housing price cycle is its own quarterly lagged difference, and thus consistent with the financial accelerator mechanism, 13 countries report a positive self-reinforcing relationship between current cyclical housing prices and their own past values, 10 of which being. Notable exceptions however include countries such as Austria, Latvia and Slovakia which show a significant inverse relationship between the present and lagged quarterly difference, suggesting thus that for these countries, rather than acceleration, the property price cycle tends to experience reversion trend quarter to quarter.

It should be noted, both the credit and housing price cycle proport consistently across the majority of countries, small non-significant effect of monetary policy on each cycle, and in cases where significant coefficients are found, these do not tend to be consistent with the theoretical channels through which policy is thought to influence financial variables.

Table 7. shows the regression coefficients which in each countries' model determines the estimated impact of each of the system´s variables on the business cycle.

GDP cycle growth is very weakly dependent on the growth of the credit cycle at the 95% confidence interval, with notable exceptions being France and Slovakia, reporting highly significant ($p < 0,01$) but contradicting results, while in the case of Slovakia the acceleration in the credit cycle precedes an acceleration of the business cycle, as expected through the financial accelerator mechanism, the French case shows a limiting impact of accelerated growth in the credit cycle on the French business cycle.

Across 7 out of the 18 eurozone countries, however, the housing property cycle constitutes a significant preceding determinant of the growth in business cycle, and proport with exception of Portugal, a positive reinforcing impact upon it, i.e., a positive change in the quarter-to-quarter difference in housing prices predict a positive change in the quarterly difference of the GDP cycle. These countries include Estonia, Finland, Lithuania, Netherlands, Portugal, Slovenia, Slovakia and generally belong to a group of nations not constituent of the core of the eurozone

Table.7 Results of VAR Regression (1999 Q2 – 2021 Q3) – Business Cycle: $y = GDP^C$ (Log - First Differences)

$t-1$	CRD^C	HPI^C	GDP^c	r	G	ECB_{bs}	$crisis_d$	$Pre\ Crisis_d$
Austria	-0.0743	0.0275	-0.274**	0.009	-0.14**	-0.033	0.004	0.0004
Belgium	0.098	0.116	-0.313**	0.0055	-0.026	-0.054**	0.0035	-0.0018
Germany	0.129	-0.058	-0.193*	0.0124**	0.256**	-0.0434**	-0.0002	-0.00106
Estonia	-0.159*	0.121***	0.151	0.0028	0.045**	-0.099***	0.015**	0.0041
Finland	-0.149*	0.532***	-0.271**	0.0153***	-0.0304	-0.0149	-0.0149	0.0006
France	-0.558***	0.1099	-0.400***	0.0125	-0.092	-0.024	0.0048	0.0012
Greece	0.07	-0.117	-0.0926	-0.0003	0.074	-0.0626**	-0.011	-0.0008
Ireland	0.112	0.011	-0.493***	0.005	-0.0663	-0.0304	0.0059	-0.002
Italy	0.048	0.0242	-0.421***	0.0012	0.0477	-0.0064	0.0001	-0.0012
Lithuania	0.016	0.267***	-0.192	-0.0017	0.0327	-0.019	0.0026	0.0014
Luxemburg	-0.050	0.1065	-0.563***	-0.563	0.0365	0.0197	-0.0012	0.0007
Latvia	-0.0646	0.0776	-0.526***	-0.0006	-0.019	0.02306	0.00864	-0.0003
Malta	0.192	0.084	-0.492***	0.0095	0.142	-0.0201	0.0028	-0.00077
Netherlands	0.1663	0.269**	-0.331***	0.0072	-0.058	-0.038**	0.0047	0.0007
Portugal	0.415	-0.441**	-0.254**	0.0096	0.036	-0.068**	-0.006	-0.0125
Slovenia	-0.0564	0.293**	-0.173	0.0004	0.0227	-0.0427	-0.0048	0.0061
Slovakia	0.7729***	1.573***	-0.238**	0.004	-0.264	-0.0488	0.0099	-0.0035
Spain	0.381	0.0146	-0.253**	0.007	0.033	-0.0514	0.0005	-0.0112

The notations," *";" **";" ***", signify that the coefficient estimates are respectively statistically significant at 10%, 5% and 1%.

Monetary policy only reports a significant impact on the GDP cycle for Germany and Finland, although it again shows a puzzling relationship on both accounts. A positive change on the quarterly difference of the short-term interest rate, is shown to precede a positive change in the growth of the business cycle, although by most commonly accepted channels of monetary policy transmission the reverse relationship is expected. For all other individual countries of the eurozone monetary policies' impact on the GDP cycle is not statistically significant at the 95% interval.

More interestingly, the model does not detect statistically significant structural differences in the business cycle in none of the analyzed countries, that is no time specific fixed effects is found between periods across the whole of the eurozone.

Interaction terms between the three major cycles and period specific dummies are additionally tested, however, these are reported generally to be non-significant, except for the cases as reported in annex, and without clear patterns among these. Therefore, cycle and period dummy interaction terms are omitted and the respective models re-estimated without these in order to preserve model parsimony.

The quarterly growth of public debt does generally not show itself as a significant predictor of the financial cycles across the eurozone countries under consideration; nonetheless, exceptions include Germany and Lithuania, where it shows a significant impact on the growth of cyclical credit in posterior quarters. In both countries however, different relationships are found; while in Germany the quarterly growth in public debt is associated with a posterior deceleration of the credit cycle, and may thus result from the dominance of a trade-off within the distribution of debt where private financial debt is partially absorbed by the public sector, in Lithuania a co-evolving effect of public debt and the credit cycle.

Additionally, public debt growth seems to precede a taming of the cycle in property prices particularly in France where a negative coefficient is significantly associated to the relationship between the quarterly change in public debt. All other estimated coefficients measuring the impact of public debt on financial cycle indicators are non-significant in the statistical sense.

Overall, the instruments of monetary policy are poor predictors of future changes in the indicators of the financial cycle and thus differences across eurozone countries relative to a baseline counterfactual cannot be with any high degree of confidence be said to result from the influence of monetary transmission to that particular region. In general, the estimated coefficients are not significant within the 95 % confidence interval save particular exceptions such as Austria, Slovenia and Lithuania, in the first two being found a significant impact of the short-term rate on the growth of credit and the latter supporting a significant impact on the housing property price cycle. The estimated sign of the effect however, is for all statistically significant relationships and a majority of on non-significant coefficients fond to be contrary to that which is expected within the theoretical transmission channels outlined in section 5., showing a positive rather than inverse relationship between total credit, housing prices and the short-term rate.

The impulse response functions of each cycle to a monetary shock in each of the modeled countries, as displayed in annex, graph.1 through .18, confirm a general tendency, i.e., the impulse introduced by a change in the growth of the short-term interest rate, for each countries model shows only a small effect size across a number of 10 quarters. Moreover, the bootstrapped 95% confidence bands are shown along with the average effect size, a set of 100 resampled iterations construct the bands within which the estimated coefficients fluctuate at 95% confidence from each replacement sample, thus confirming the non-significance of the majority of estimates since for these the associated confidence interval can intercept both sides of a null impulse line.

7. Conclusion and Discussion

Bringing together the analysis of the characteristics of the financial cycle in each eurozone country and the effect magnitudes drawn from the estimated VAR system, financial cycle differences across countries are generally hardly explainable through the variables within the system save for the magnitude of the quarterly lagged difference of each cycle which is statistically significant in 12 out of 18 in the case of the credit cycle, and 14 in the case of the housing price cycle.

Countries such as Greece, Latvia, Malta and Slovakia, however, report a deceleration effect in the credit cycle, which does not seem to explain the behavior of the identified cycles of these respective countries in section 5.. Latvia and Greece report exceptionally long average credit cycle phases, but a self-limiting effect on the quarter-to-quarter growth of that cycle, and thus a self-reinforcing perpetuation of the credit cycle as postulated by the financial accelerator mechanism does not necessarily explain the high duration and amplitude in a cycle´s phase for these. Conversely, nations where a significant self-acceleration effect is identified in the credit cycle are in its totality, not necessarily those which suffer from particularly long phase amplitude or duration, as some where this relationship is found rather report particularly tame credit cycles such as Germany, France; the cases of Portugal, Slovenia, Lithuania and Luxemburg, however, coincide with long and large average phases of the cycle.

Similarly, across a majority of the eurozone the housing price cycle tends to accelerate across quarters such as in Estonia, France, Ireland, Italy, Greece, Lithuania, Portugal, Netherlands and Spain. These countries expectedly have relatively higher phase amplitude and durations which the self-accelerating effect of the cycle can explain in line with the postulates of the financial accelerator effect.

The main effect under consideration, that of monetary policy decisions on the individual financial cycles of each economy, does not bear explanatory power in the vast majority of the eurozone. The coefficient associated with the quarterly lagged difference of the short-term interest Euribor rate relative to the credit cycle is not significant at the conventional 95% confidence interval in 16 out of 18 countries and where it shows a significant effect, an unexpected relationship is reported, namely rather than a reduction in the interest-rate promoting the growth in credit, the inverse is found for Austria and Slovenia.

Based on the estimates the direct cumulative impact of the quarterly growth in the short-term interest-rate across the sample period in Austria is of approximately - 3.27 %, implying overall a relatively taming in of the growth in the credit cycle. Moreover, the cumulative impact in Slovenia is approximately - 0.55 %, again implying a relative dampening in the growth of the credit cycle through monetary policy across the period. In both countries a relatively small cumulative magnitude of effect is reported and thus it is unlikely that changes in monetary policy can account for any large differences between these countries and the rest of the eurozone, which without aligning with theoretical framework that can explain the mechanisms involved, such interpretation is not in any case advisable.

Only in the case of Lithuania does monetary policy show a significant effect on the property price cycle, showing an expectable inverse relationship. The cumulative effect of the quarterly change in the short-term rate on the growth of the housing cycle is approximately 8,5 %, and therefore monetary policy has an accelerating effect of the property price cycle from 1999 Q1 to 2021 Q3. This effect can be interpreted through the standard balance sheet channel outlined above, which is further reinforced by a further self-acceleration of the housing cycle by a coefficient of 0.511 across quarters, thus propagating the initial monetary shock further through the financial accelerator mechanism. The housing price cycle in Lithuania sits among the fourth highest in terms of average amplitude with average downturns of 28.4 % and upturns of 28.1 %, of which monetary policy accelerates cumulatively in 8.5 %. Additionally, because of the self-accelerating factor in the housing cycle, a further increase in the growth of the cycle accounts for a further increase in both amplitude and duration.

Generally monetary policy does not show itself as a significant preceding determinant of the financial cycle across a majority of eurozone countries and is, save specific exceptions, a poor predictor of cross-country differences in the main cycles under consideration. Because of this, moreover, the use of monetary policy as a primary instrument to stabilize the financial cycle can prove to be ineffective.

Across multiple eurozone countries, the low and generally non-significant effects of the short-term interest rate relative to both segments of the financial cycle suggest that it may not be a fit instrument in order to control the growth of financial cycles and assure financial stability. In the standing debate about the optimal policy framework to address financial stability, between macroprudential and monetary policies, the prominence of monetary policy has been challenged mainly through the trade-off it faces in pursuing stability of the financial and real economy simultaneously when these face asynchronous cycles (Badarau & Popescu , 2014), however to be confirmed, the results outlined above suggest an alternative justification for the preferential use of a macro-prudential framework.

The extent of non-significance of monetary policy across the vast majority of the surveyed countries may not however be entirely reflective of the neutrality of policy in relation to the cycle, but rather arise from some natural limitations to the study, namely, where statistical power is concerned. Defined as the likelihood of rejecting a false null hypothesis, i.e., to detect a significant effect when one is present, the studies´ power is directly proportional to sample size. Since the single regime of monetary policy in the eurozone, established with the creation of the euro in 1998, is a primary object of this analysis, the sample size constituting the multiple time series is intrinsically limited, even when the data units are analyzed at the quarterly frequency.

Problems of statistical power may also be compounded with the use of vector autoregression modelling which the present study makes use of in order to avoid a more pernicious risk of endogeneity bias, heavy parameterization arises with the specification of most relationships as endogenous and most to all variables as co-dependent within the model. High parameterization therefore logically implies a loss in degrees of freedom, leaving a lower number of independent points of data from the initial sample size which care informative to estimation of the model´s parameters.

Through this work, model parsimony has been a guiding principle in the specification of variables and respective lag determinant within the VAR structure in order to mitigate the impact which loss in degrees of freedom may entail. However, under particularly small effect sizes which are reported in virtually all countries analyzed for the relation of the short-term interest rate to each cycle, and thus, low statistical power may be at the root of a general non-statistical significance of the estimated parameters and especially those associated with the impact of monetary policy changes.

Aside from issues of precision in the measurement, the generally low magnitude of impact of the interest-rate on the financial cycle, even when a significant effect is found, indicates that differentials in monetary transmission are not a prominent driver of financial cycle outcomes across the eurozone, and therefore, the standard targets of price stability can be pursued without ponderous considerations for the stability of financial conditions and its distribution across the eurozone, while the latter objective may be better addressed by macroprudential policy instruments, which the results suggest, its objectives can reasonably be carried out independently of the monetary policy stance.

Nonetheless, future research might be needed in order to address the alternative determinants of such marked differences in the characteristics of financial cycles across the eurozone as documented here and in various seminal reports outlined in the literature. Since positive results were not found within this study regarding the explanatory power of the ECB´s policy stance of the various constituent countries' cycle characteristics, it becomes worthwhile to investigate the causes which can explain disparate outcomes within the monetary union.

Moreover, as it becomes increasingly adopted further research on whether macro-prudential regulation can alternatively best tackle heterogeneity in the state and development of financial stability in the eurozone may complement the research agenda outlined in this study, and further the understanding of what best policy tools can contribute to the cohesion of the monetary union across its financial and monetary dimensions.

Finally, while inherent to the object of research, the aforementioned limitations regarding statistical power can in future research naturally be overcome as new data becomes available and the relevant time series increase in extension across time, and thus allowing in the future for a more precise estimation of the relationships between monetary policy and cross-country heterogeneity in financial cycles.

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9. Annex

Table.8 Database Description

Country List
Austria, Belgium, Germany, Estonia, Finland, France, Greece, Ireland, Italy, Lithuania, Luxemburg, Latvia, Malta, Netherlands, Portugal, Slovenia, Slovakia, Spain

Variables	Description	Source
Total Outstanding Credit	Total economy net incurrence of loans and debt securities by non-financial corporations and households.	ECB´s statistical data warehouse: https://sdw.ecb.europa.eu/home.do
Housing Price Index	Index of residential property prices at transaction value.	ECB´s statistical data warehouse: https://sdw.ecb.europa.eu/home.do
Gross Domestic Product	Total value of domestic goods and services at market value in chain linked volume, seasonally adjusted.	ECB´s statistical data warehouse: https://sdw.ecb.europa.eu/home.do
Government Debt	Net incurrence of debt liabilities by general government sector.	ECB´s statistical data warehouse: https://sdw.ecb.europa.eu/home.do
Short-term interest rate	3-Month Euribor eurozone´s money market reference interest-rate.	ECB´s statistical data warehouse: https://sdw.ecb.europa.eu/home.do
Central Bank´s Balance Sheet Value	Total value of European Central Bank´s assets and liabilities, quarterly average over monthly end of period reporting.	ECB´s statistical data warehouse: https://sdw.ecb.europa.eu/home.do

Table.9 Descriptive Statistics – Public Debt (Log – Level)

	Mean	Median	Min.	Max.	St. Dev.
Austria	12.31	12.41	11.86	12.72	0.27
Belgium	12.82	12.81	12.54	13.21	0.21
Germany	14.39	14.43	14.03	14.70	0.22
Estonia	6.92	6.91	5.73	8.66	0.83
Finland	11.39	11.34	10.93	12.03	0.38
France	14.24	14.34	13.61	14.86	0.38
Greece	12.44	12.62	11.85	12.79	0.30
Ireland	11.52	11.73	10.55	12.37	0.74
Italy	14.44	14.46	14.05	14.81	0.21
Lithuania	8.94	9.12	8.05	10.09	0.72
Luxemburg	8.58	9.00	7.39	9.82	0.86
Latvia	8.30	8.97	6.70	9.54	1.03
Malta	8.35	8.37	7.80	8.99	0.32
Netherlands	12.74	12.83	12.37	13.05	0.24
Portugal	11.93	12.03	11.13	12.53	0.48
Slovenia	9.53	9.51	8.31	10.60	0.75
Slovakia	10.21	10.16	9.53	10.98	0.46
Spain	13.38	13.32	12.77	14.17	0.52

Table.10 Descriptive Statistics – Shor-term interest-rate (Level)

	Mean	Median	Min.	Max.	St. Dev.
Austria	1.5764	1.0931	-0.5458	5.0242	1,78
Belgium	1.5764	1.0931	-0.5458	5.0242	1,78
Germany	4.719	4.600	0.210	7.680	1,78
Estonia	1.5764	1.0931	-0.5458	5.0242	2,70
Finland	2.3275	1.6433	-0.5458	12.7067	1,78
France	1.5764	1.0931	-0.5458	5.0242	1,78
Greece	1.5764	1.0931	-0.5458	5.0242	2,78
Ireland	2.0529	1.0931	-0.5458	10.8016	1,78
Italy	1.5764	1.0931	-0.5458	5.0242	1,78
Lithuania	1.5764	1.0931	-0.5458	5.0242	3,69
Luxemburg	2.8457	1.8424	-0.5458	20.7864	1,78
Latvia	1.5764	1.0931	-0.5458	5.0242	3,83
Malta	3.1921	2.1633	-0.5458	15.6967	1,93
Netherlands	3.6138	4.3467	0.3069	6.2700	1,78
Portugal	1.5764	1.0931	-0.5458	5.0242	1,78
Slovenia	1.5764	1.0931	-0.5458	5.0242	1,08
Slovakia	1.9397	0.6960	-0.5458	8.6333	3,82
Spain	2.8621	1.0931	-0.5458	16.0700	1,78

Table.11 Optimal Lag Length according to four information criteria (VAR-In-Differences)

	AIC	HQ	SC	FPE
Austria	10	1	1	1
Belgium	10	2	1	5
Germany	1	1	1	1
Estonia	10	1	1	4
Finland	10	1	1	3
France	10	1	1	6
Greece	10	1	1	2
Ireland	10	1	1	1
Italy	10	2	1	6
Lithuania	9	1	1	4
Luxemburg	10	1	1	5
Latvia	10	3	1	3
Malta	10	3	1	4
Netherlands	10	1	1	2
Portugal	10	1	1	1
Slovenia	10	3	1	3
Slovakia	10	3	3	6
Spain	10	1	1	5

Table.12 Roots of the Characteristic Equation: VAR-in-Levels

	X_1	X_2	X_3	X_4	X_5
Austria	0.8902805	0.8289485	0.8289485	0.3659044	0.3659044
Belgium	0.9624968	0.9424423	0.9424423	0.4259601	0.4259601
Germany	1.0400204	0.9072255	0.8753982	0.8753982	0.5316762
Estonia	1.0701539	0.8859225	0.8534441	0.8534441	0.8096535
Finland	0.9841085	0.8699991	0.7694571	0.7694571	0.5505204
France	1.0326948	0.9703370	0.8464054	0.8464054	0.4159322
Greece	1.0154027	0.9038540	0.9038540	0.6661263	0.0033467
Ireland	1.0103537	0.9683040	0.9683040	0.7009997	0.5206683
Italy	0.9313347	0.9313347	0.9223251	0.6728913	0.1815271
Lithuania	1.0177169	1.0177169	0.6932096	0.6932096	0.5122468
Luxemburg	1.0300055	0.9753787	0.7785276	0.7785276	0.2114381
Latvia	0.9514537	0.9514537	0.5537422	0.4373254	0.3170560
Malta	0.9533858	0.8960317	0.3770858	0.2201499	0.2201499
Netherlands	1.0398893	0.8878223	0.8331581	0.8331581	0.5526174
Portugal	1.0210060	1.0210060	0.9047075	0.9047075	0.3946490
Slovenia	1.0319863	0.9745576	0.9745576	0.6254117	0.2499140
Slovakia	0.8571228	0.8571228	0.7244526	0.2508403	0.2508403
Spain	0.9685311	0.9685311	0.9566317	0.8490900	0.4428593

Table.13 Roots of the Characteristic Equation: VAR-in-Differences

	X_1	X_2	X_3	X_4	X_5
Austria	0.5669718	0.4961875	0.4075497	0.2386798	0.2386798
Belgium	0.5708791	0.3678157	0.3678157	0.1363076	0.1087246
Germany	0.4652551	0.4652551	0.3156650	0.3156650	0.1335217
Estonia	0.7307401	0.33729477	0.1423128	0.0779393	0.0779393
Finland	0.4701313	0.4701313	0.4190037	0.4190037	0.0743879
France	0.4496480	0.4070045	0.4070045	0.2704740	0.0677732
Greece	0.6913052	0.5725631	0.5089830	0.3406236	0.0621999
Ireland	0.4663156	0.4641063	0.2548513	0.2548513	0.0761436
Italy	0.5912782	0.4005575	0.2869941	0.2617211	0.2617211
Lithuania	0.6634197	0.3399620	0.3399620	0.2723878	0.1705113
Luxemburg	0.6321717	0.5978198	0.4743202	0.2166819	0.1893931
Latvia	0.5608688	0.4674179	0.3193972	0.1273459	0.1273459
Malta	0.6169326	0.3663570	0.3663570	0.2864602	0.0309156
Netherlands	0.7491817	0.3395270	0.3095673	0.0943077	0.0943077
Portugal	0.6607115	0.3514406	0.2110908	0.2046315	0.1569031
Slovenia	0.7400585	0.6618803	0.4265646	0.2911440	0.2911440
Slovakia	0.4109289	0.4109289	0.3915316	0.2045025	0.2045025
Spain	0.6881516	0.5908531	0.2673986	0.1984092	0.1984092

Table.14 Results of VAR Regression (1999 Q2 – 2021 Q3) – Government Debt: $y = G$ (Log - First Differences)

$t-1$	CRD^C	HPI^C	GDP^c	r	G	ECB_{bs}	$crisis_d$	$Pre\ Crisis_d$
Austria	-0.950^{**}	-0.056	0.0023	0.0026	-0.302^{***}	0.0611	0.012	0.0061
Belgium	-0.0753	-0.833^{***}	-0.1268	-0.0005	-0.441^{***}	0.0376	0.0063	-0.00068
Germany	-0.1274	0.2432	-0.255^{*}	-0.0027	0.0302	0.0083	0.017^{***}	0.0067
Estonia	0.814	-0.023	-0.896	-0.0024	-0.0618	0.17006	-0.033	-0.034
Finland	0.383	-1.184^{***}	0.287	0.004	-0.489^{***}	-0.0129	0.038^{***}	-0.024^{***}
France	0.0609	0.367^{***}	-0.041	-0.0147	-0.013^{**}	0.018	0.005	-0.0004
Greece	0.277	0.4245^{*}	0.079	-0.312	-0.0134	-0.0328	0.035^{***}	0.0181^{**}
Ireland	0.0425	0.4988	-0.0913	-0.028	-0.152	0.163^{**}	0.064^{***}	0.0094
Italy	0.485^{***}	-0.486^{***}	-1.18^{***}	-0.0041	-0.086	0.0227	0.00094	-0.0026
Lithuania	-0.071	0.391	-1.313^{***}	0.00097	-0.280**	0.0626	0.075^{***}	-0.0089
Luxemburg	-0.276	0.7609	0.146	-0.0186	-0.1769^{*}	0.375^{***}	0.007	0.0191
Latvia	-0.524^{*}	0.1350	0.308	0.012^{**}	0.0323	0.291^{***}	0.0362	0.0263
Malta	-0.0978	-0.1133	-0.109	-0.0023	0.1568	0.0353	0.0049	-0.0013
Netherlands	-0.2738	-0.2609	-0.136	0.0016	0.0885	0.134^{***}	-0.0005	0.0044
Portugal	-0.490^{**}	0.0106	-0.1418*	-0.0105^{*}	-0.209^{*}	-0.0038	0.032^{***}	0.024^{***}
Slovenia	-0.392	-0.633^{**}	-0.310	-0.00027	-0.204^{*}	-0.0366	0.0393	0.0055
Slovakia	0.189^{*}	0.101	0.117^{**}	-0.0132^{*}	0.052	0.1029^{*}	0.0155	-0.012
Spain	-0.259	-0.290^{**}	-0.062	-0.0066	0.224^{**}	0.017	0.013^{*}	0.0020

The notations,” *”;” **”;” ***”, signify that the coefficient estimates are respectively statistically significant at 10%, 5% and 1%.

Table.15 Results of VAR Regression (1999 Q2 – 2021 Q3) – Short-term interest rate: $y = r$ (First Differences)

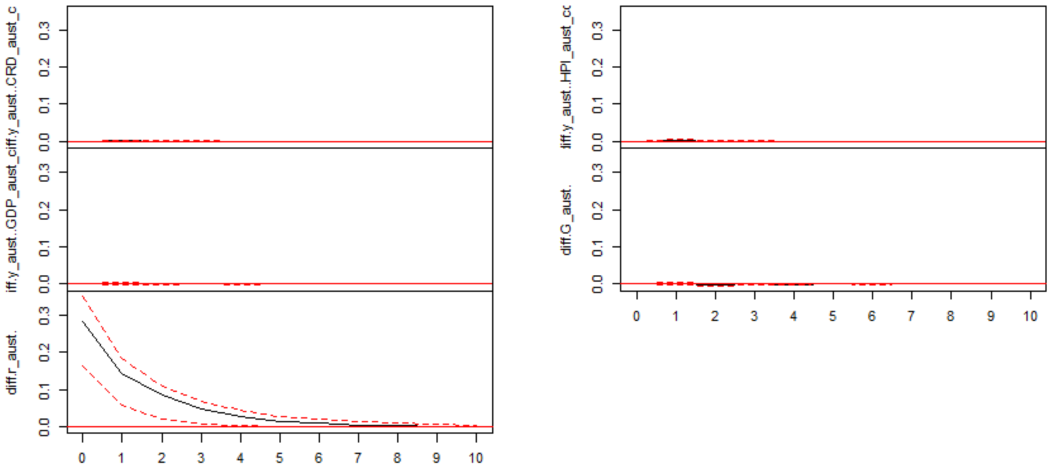
$t-1$	CRD^C	HPI^C	GDP^c	r	G	ECB_{bs}	$crisis_d$	$Pre\ Crisis_d$
Austria	1.265	-0.673	3.140*	0.511***	-0.493	-0.609	-0.0273	0.0388
Belgium	-0.942	3.3117	3.019*	0.525***	1.659	-0.570	-0.040	0.0407
Germany	-6.494*	1.962	2.766	0.541***	0.279	-0.733**	-0.051	0.0658
Estonia	-1.549	1.587*	0.221	0.206***	-0.141	0.808*	-0.302**	0.0814
Finland	-1.691	14.448***	2.888	0.443***	-0.363	-0.426	-0.100	0.0556
France	1.782	-1.638	0.002	0.534***	0.1539	-0.4679	-0.022	0.0646
Greece	-5.211**	2.711	0.601	0.531***	-0.0162	-0.9039	-0.004	-0.0394
Ireland	-0.754	0.147***	1.004	0.513***	-3.52	-0.4076	-0.089	0.0599
Italy	3.895	3.684	9.419	0.602***	5.09**	-0.548	-0.048	-0.0757
Lithuania	12.70**	8.031	-20.66*	-0.269**	-0.909	0.217	0.157	-0.469
Luxemburg	0.298	-0.689	-3.299***	0.537***	-1.68***	-0.801*	0.073	0.038
Latvia	-17.98***	0.748	1.224	0.1305	-0.618	1.813	-0.811	0.109
Malta	-0.047	0.0577	-0.643	0.276**	-0.884	-0.222	0.0849	0.0398
Netherlands	4.599	3.444	-1.783	0.411***	-4.83***	-0.652**	0.082	0.042
Portugal	3.296	5.128**	1.543	0.548***	-0.542	-0.476	0.032	0.026
Slovenia	8.915	2.791	1.472	-0.639***	7.44***	-0.450	-0.184	-0.306
Slovakia	-0.732	1.723	0.537	0.415***	0.553	0.709	-0.0799	-0.148
Spain	-1.051	3.462*	0.556	0.472***	-1.755	-0.582	0.061	0.060

The notations," *";" **";" ***", signify that the coefficient estimates are respectively statistically significant at 10%, 5% and 1%.

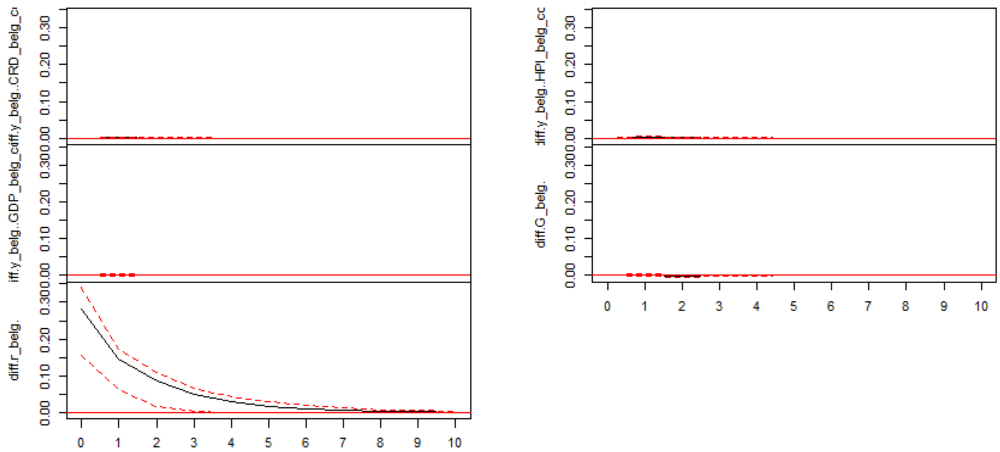
Table.16 Johansen Cointegration Test

Coint. Rel.		0	1	2	3	4
Austria	5% crit. val.	34.40	28.14	22.00	15.67	9.24
	Test statistic	28.70	28.59	21.69	12.06	7.64
Belgium	5% crit. val.	34.40	28.14	22.00	15.67	9.24
	Test statistic	54.96	35.53	23.91	16.11	1.92
Germany	5% crit. val.	34.40	28.14	22.00	15.67	9.24
	Test statistic	50.45	35.43	27.23	17.95	8.57
Estonia	5% crit. val.	34.40	28.14	22.00	15.67	9.24
	Test statistic	52.46	34.32	22.77	9.70	2.45
Finland	5% crit. val.	34.40	28.14	22.00	15.67	9.24
	Test statistic	66.97	21.65	15.08	7.13	3.73
France	5% crit. val.	34.40	28.14	22.00	15.67	9.24
	Test statistic	65.17	27.38	14.83	8.71	4.03
Greece	5% crit. val.	34.40	28.14	22.00	15.67	9.24
	Test statistic	34.93	25.92	18.45	10.65	2.62
Ireland	5% crit. val.	34.40	28.14	22.00	15.67	9.24
	Test statistic	37.61	22.95	17.33	12.94	1.92
Italy	5% crit. val.	34.40	28.14	22.00	15.67	9.24
	Test statistic	76.81	66.10	29.00	16.20	4.05
Lithuania	5% crit. val.	34.40	28.14	22.00	15.67	9.24
	Test statistic	59.02	30.90	20.29	14.06	3.13
	5% crit. val.	34.40	28.14	22.00	15.67	9.24
Luxemburg	Test statistic	55.59	34.62	22.71	17.43	9.63
Latvia	5% crit. val.	34.40	28.14	22.00	15.67	9.24
	Test statistic	70.21	62.66	32.37	8.39	4.45
Malta	5% crit. val.	34.40	28.14	22.00	15.67	9.24
	Test statistic	70.58	50.20	38.24	10.72	3.68
Netherlands	5% crit. val.	34.40	28.14	22.00	15.67	9.24
	Test statistic	32.28	23.53	12.35	11.57	5.51
Portugal	5% crit. val.	34.40	28.14	22.00	15.67	9.24
	Test statistic	54.41	46.69	26.96	19.00	11.66
Slovenia	5% crit. val.	34.40	28.14	22.00	15.67	9.24
	Test statistic	67.43	36.0	34.50	13.59	7.20
Slovakia	5% crit. val.	34.40	28.14	22.00	15.67	9.24
	Test statistic	140.48	32.45	22.11	16.10	4.77
Spain	5% crit. val.	34.40	28.14	22.00	15.67	9.24
	Test statistic	79.57	40.69	22.82	16.82	2.26

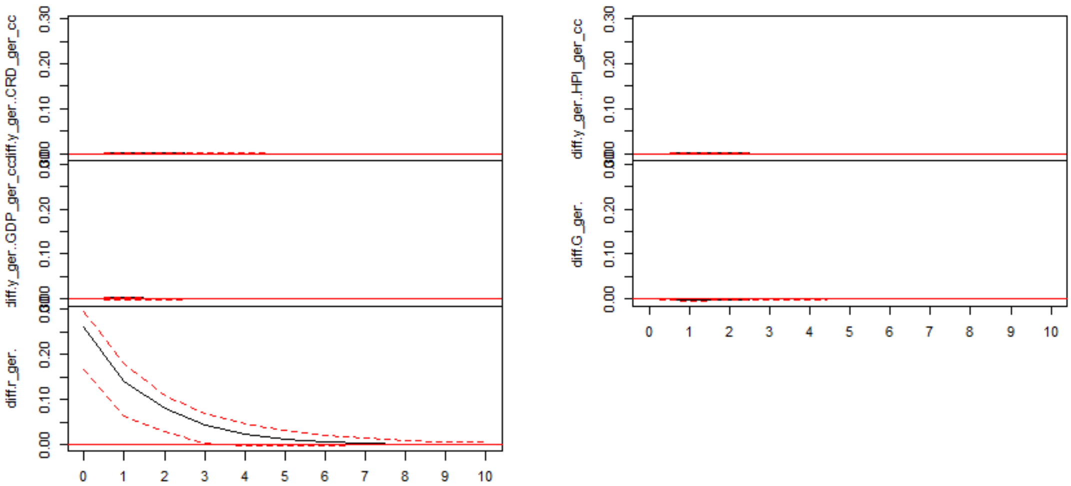
Graph 1. Impulse Response Functions– Impulse: Short-term interest rate (Austria)



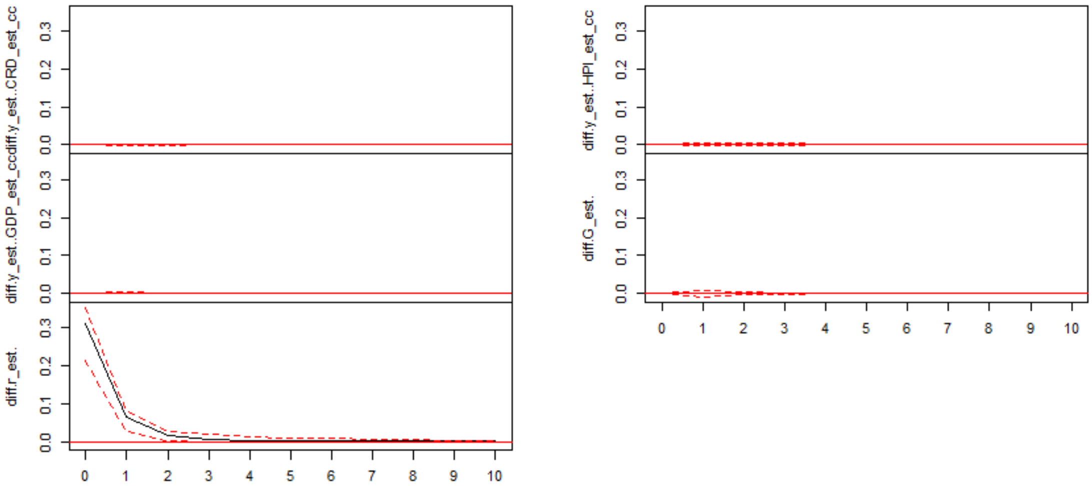
Graph 2. Impulse Response Functions– Impulse: Short-term interest rate (Belgium)



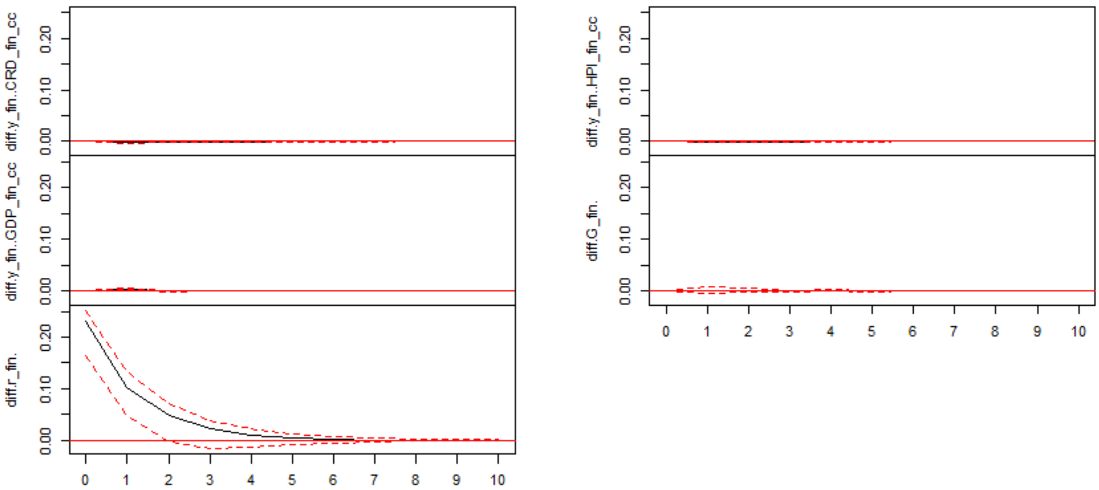
Graph 3. Impulse Response Functions– Impulse: Short-term interest rate (Germany)



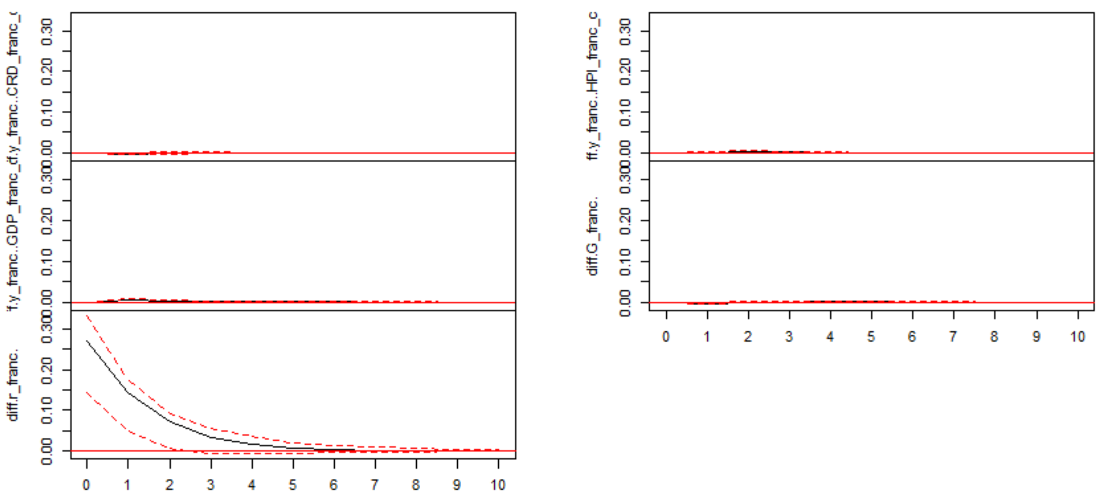
Graph 4. Impulse Response Functions– Impulse: Short-term interest rate (Estonia)



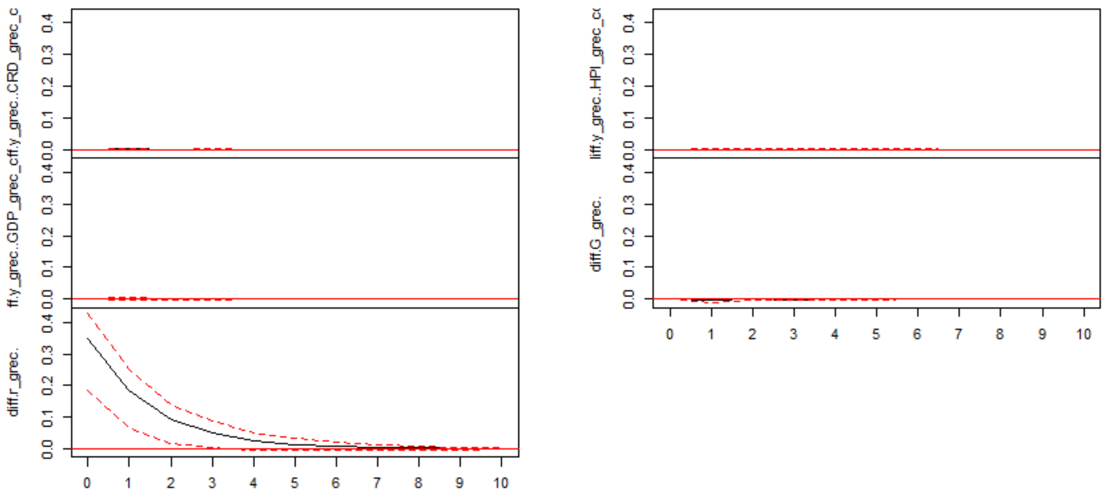
Graph 5. Impulse Response Functions– Impulse: Short-term interest rate (Finland)



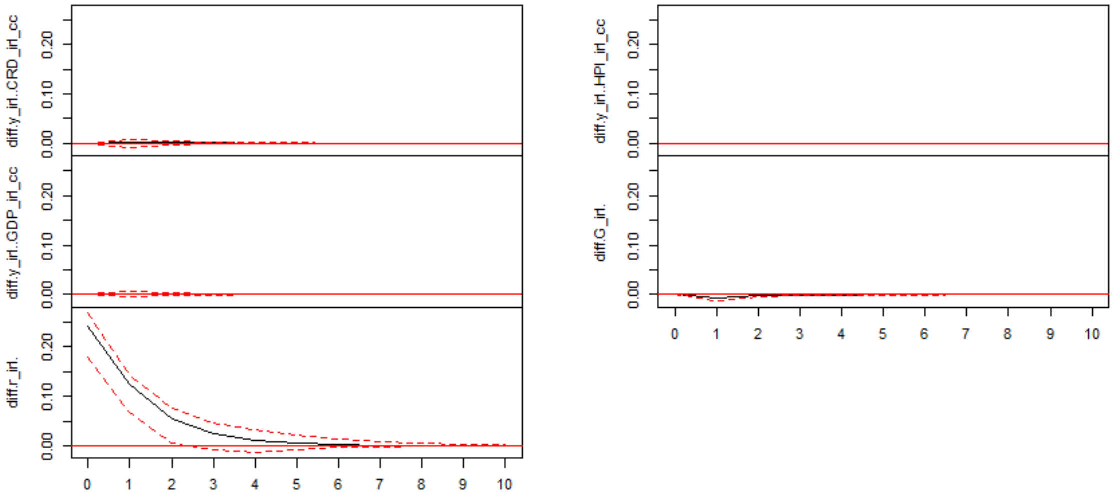
Graph 6. Impulse Response Functions– Impulse: Short-term interest rate (France)



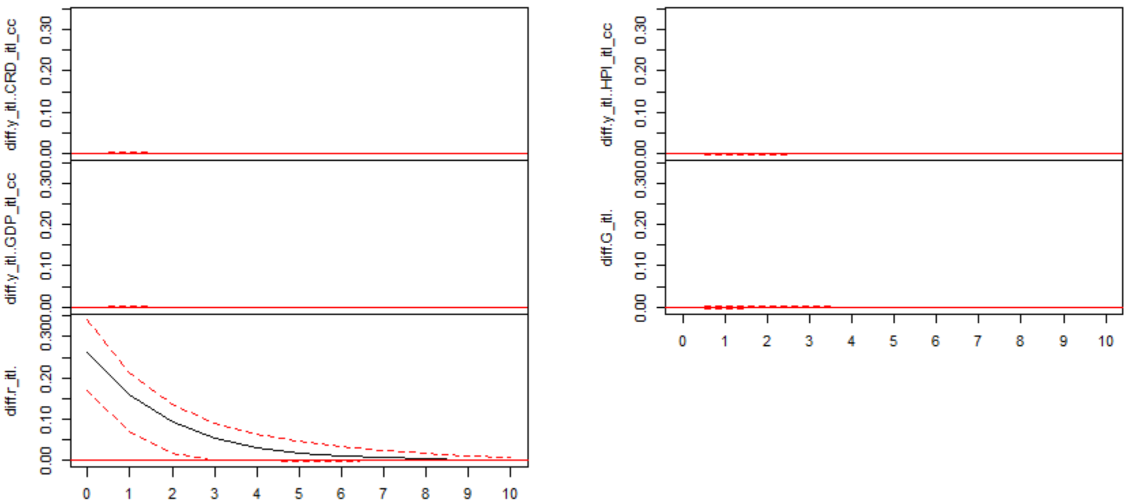
Graph 7. Impulse Response Functions– Impulse: Short-term interest rate (Greece)



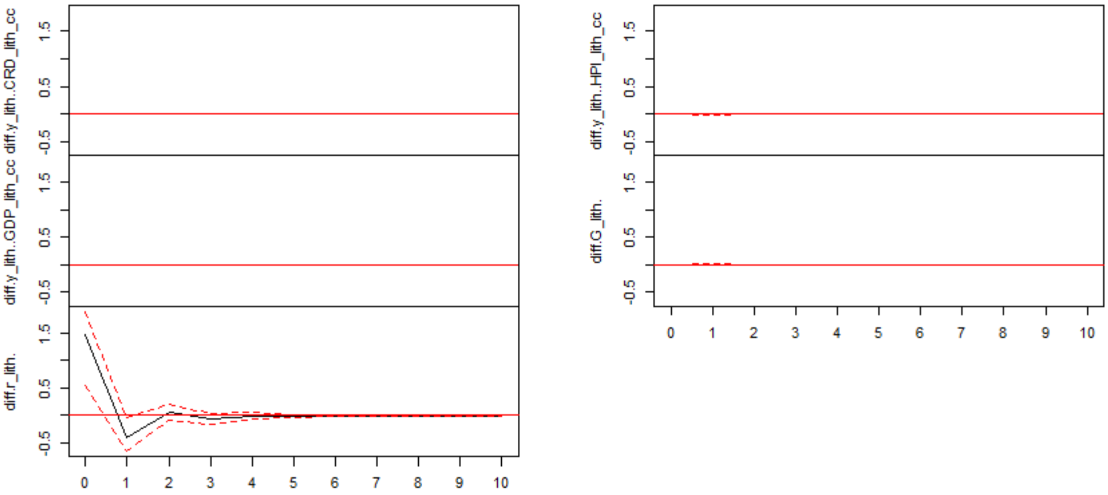
Graph 8. Impulse Response Functions– Impulse: Short-term interest rate (Ireland)



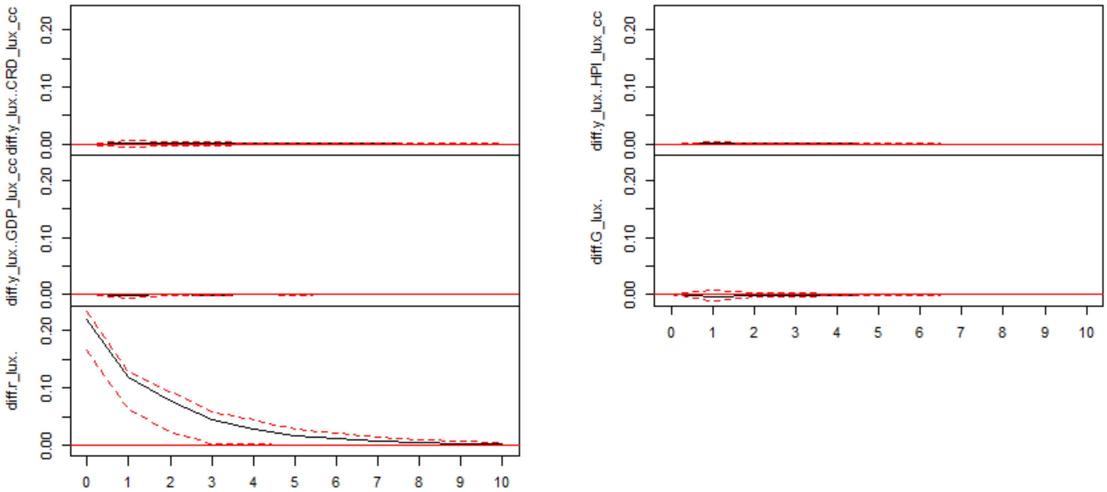
Graph 9. Impulse Response Functions– Impulse: Short-term interest rate (Italy)



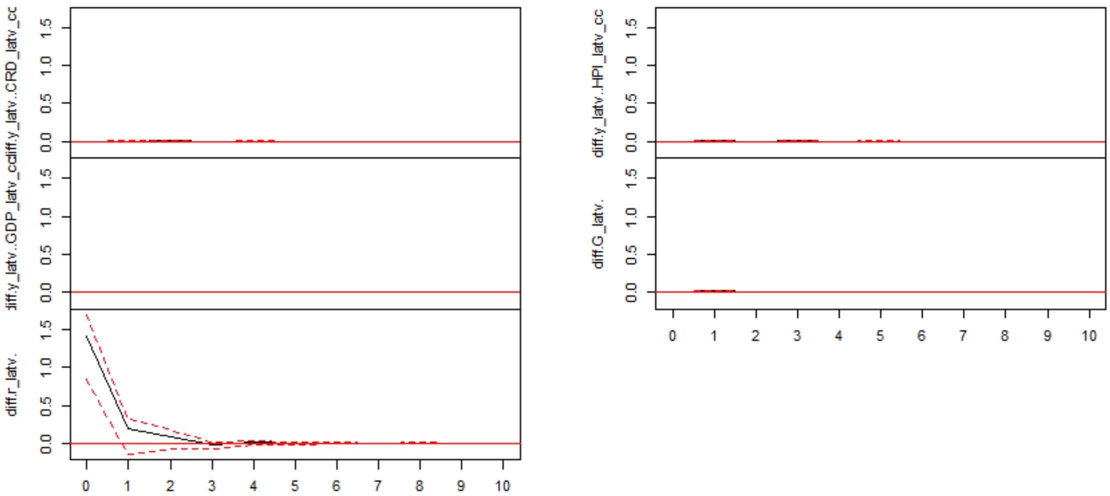
Graph 10. Impulse Response Functions– Impulse: Short-term interest rate (Lithuania)



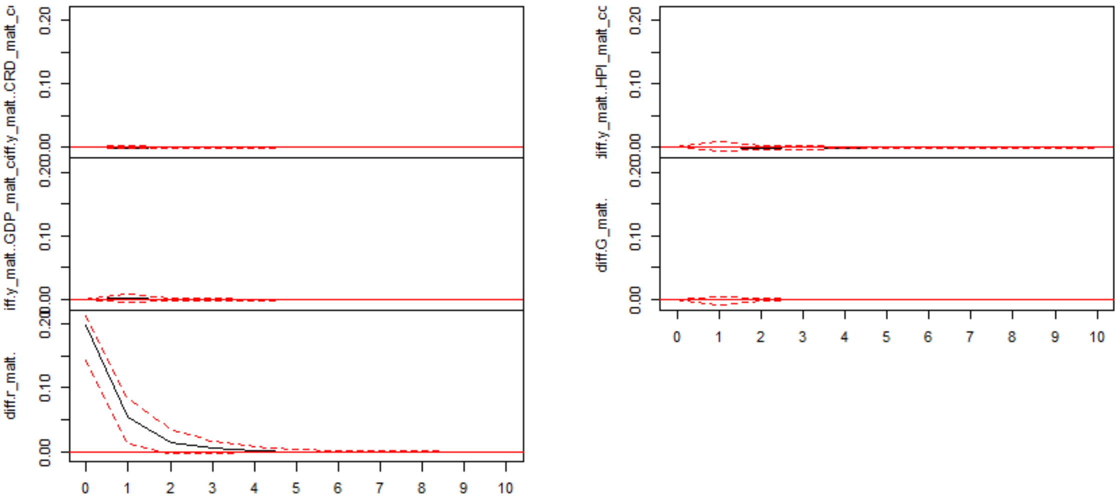
Graph 11. Impulse Response Functions– Impulse: Short-term interest rate (Lithuania)



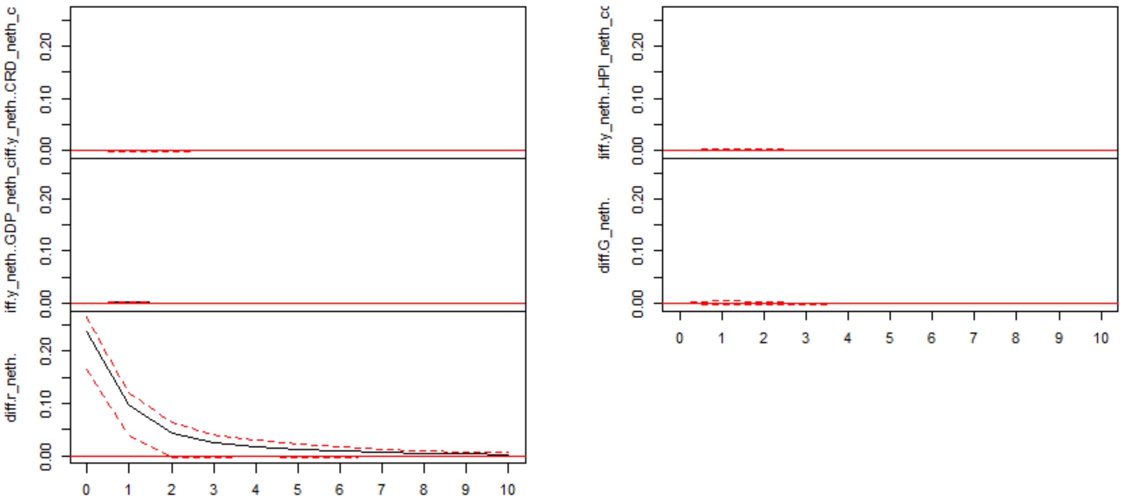
Graph 12. Impulse Response Functions– Impulse: Short-term interest rate (Latvia)



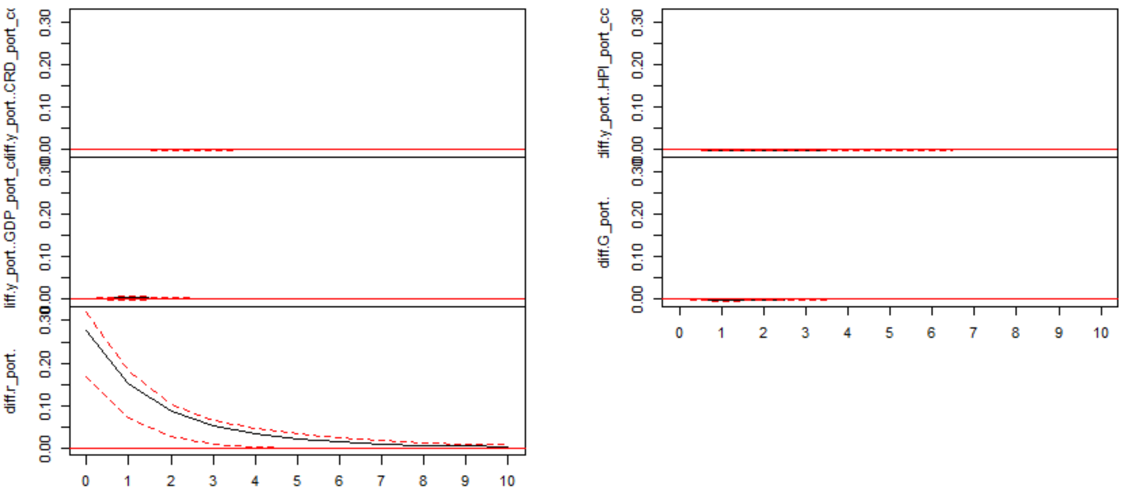
Graph 13. Impulse Response Functions– Impulse: Short-term interest rate (Malta)



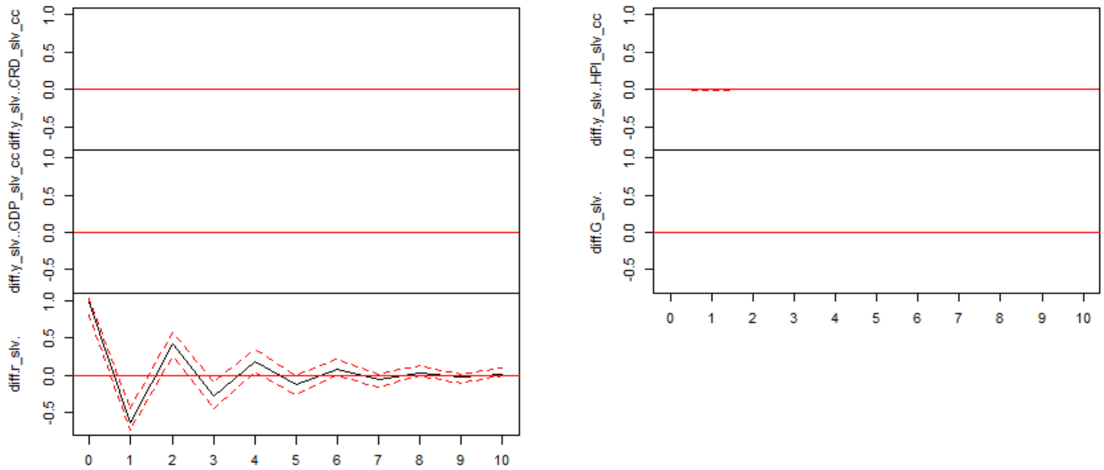
Graph 14. Impulse Response Functions– Impulse: Short-term interest rate (Netherlands)



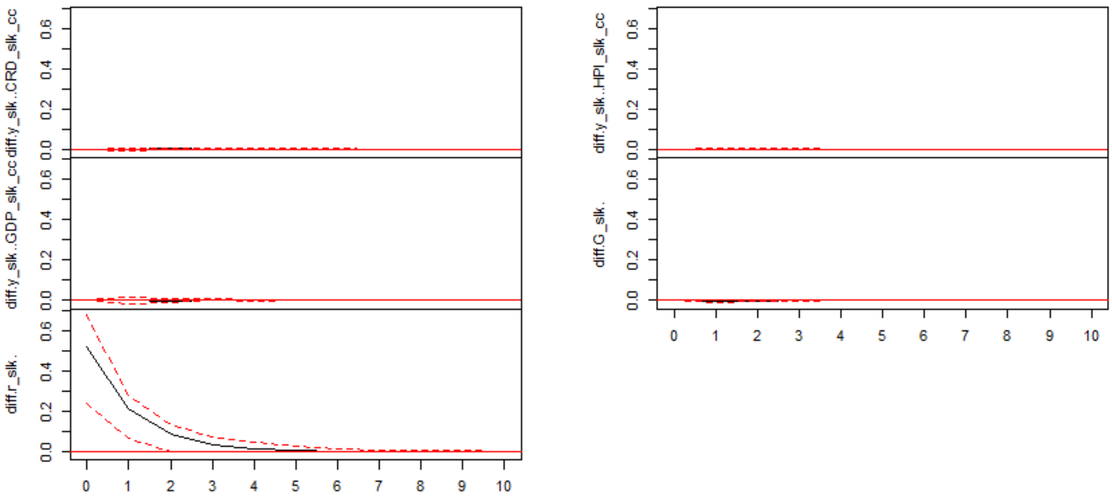
Graph 15. Impulse Response Functions– Impulse: Short-term interest rate (Portugal)



Graph 16. Impulse Response Functions– Impulse: Short-term interest rate (Slovenia)



Graph 17. Impulse Response Functions– Impulse: Short-term interest rate (Slovakia)



Graph 18. Impulse Response Functions– Impulse: Short-term interest rate (Spain)