Contributions

Nicholas Apergis*, Stephen M. Miller and Effrosyni Alevizopoulou

The bank lending channel and monetary policy rules for Eurozone banks: further extensions

Abstract: The monetary authorities affect macroeconomic activity through various channels of influence. This paper examines the bank lending channel, which considers how central bank actions affect the loan supply through its main indicator of policy, the real short-term interest rate. This paper employs the endogenously determined target interest rate, emanating from the European Central Bank's monetary policy rule, to examine the operation of the bank lending channel. Furthermore, it examines whether different bank-specific characteristics affect how Eurozone banks react to monetary shocks. That is, do sounder banks react more to the monetary policy rule than less-sound banks? The paper finds evidence of an active and statistically and economically significant bank lending channel for the Eurozone between 2000 and 2009.

Keywords: bank lending channel; Eurozone banks; GMM methodology; Monetary policy rules.

JEL classification: G21; E52; C33

DOI 10.1515/bejm-2014-0044

Previously published online June 12, 2014

1 Introduction

The monetary transmission mechanism includes various channels through which the monetary authorities can affect the macroeconomy. Two main channels

***Corresponding author: Nicholas Apergis**, Economics, Curtin University, Western Australia, 6102 Australia, e-mail: Nick.Apergis@curtin.edu.au

Stephen M. Miller: Economics, University of Nevada, Las Vegas, 4505 S Maryland Parkway Box 456005, Las Vegas, Nevada 89164-6005, USA

Effrosyni Alevizopoulou: Banking and Financial Management, University of Piraeus, Piraeus 18534, Greece

include the interest rate (money view) and credit (credit view) channels. In the money view, monetary policy affects aggregate demand through real interest rates, whereas in the credit view, monetary policy facilitates the transmission of policy through the availability of deposits and loans (Hernando and Pages 2001). A sub-channel within the credit view, the bank lending channel, relates to the supply of credit and “stems from financial market incompleteness and relies on imperfect substitutability” (Gambacorta 2005, p. 1737). An alternative sub-channel within the credit view, the balance sheet channel, relates to the balance sheet and income statements and the informational frictions that alter the external finance premium.

Apergis and Alevizopoulou (2012) consider the bank lending channel for a group of six European countries – Austria, Belgium, Finland, France, Germany, and the Netherlands – as well as Denmark and the UK as separate analyses. They specify interest rate policy rules that depend on timing issues – lagged, current, or forecast values to inform the policy rule. They then compare the results across the different policy rules. Their empirical findings show that the bank lending channel operates most robustly to forward-looking monetary policy rules.

Our analysis differs from and extends upon that of Apergis and Alevizopoulou (2012) in several important ways. First, we focus exclusively on Eurozone banks. Second, we include bank specific information to see if differences in bank performance affect how banks respond to changes in monetary policy through the bank lending channel. For example, do sound banks respond more vigorously to a monetary policy change than do less-sound banks? Third, we consider the robustness of our findings by including other variables to control for loan demand – the growth rate of consumption, the ratio of deposits to loans, and the growth rate of deposits. Fourth, for both the interest rate rules and the bank lending channel estimations, our GMM estimation uses up to four lags whereas Apergis and Alevizopoulou (2012) only consider up to two lags. Fifth, one of the three interest rate rules, the forward-looking rule, requires forecasts of the inflation rate and the output gap. Apergis and Alevizopoulou (2012) provide forecasts of inflation, but not the output gap. We provide forecasts of both. In addition, our forecast of the inflation rate includes additional information. That is, we employ a vector-autoregressive (VAR) model to forecast the inflation rate and output gap, which also includes the growth rate of the money stock (M1) and the unemployment rate. Finally, we draw our sample from updated databases, which provide revised bank-specific data.

The empirical findings show that the bank lending channel exists, with differences emerging in the degrees of responsiveness of loan growth to changes in the monetary policy indicator. Moreover, the bank lending channel exerts a stronger effect when target rates are used as indicators, while the strongest effects generally emerge in the models employing the forward-looking rules.

These empirical findings continue to hold through a number of robustness tests, such as a number of idiosyncratic bank characteristics that define the strength of a bank – capitalization, asset size, and liquidity. We also account for additional control variables beyond real GDP growth – the growth rate of real consumption spending, the ratio of total loans to total deposits, and the growth rate of deposits. The new results indicate that large and well-capitalized banks more easily absorb monetary shocks. Moreover, the robustness checks do not alter the initial results; the bank lending channel is the strongest for the forward-looking rule.

We organize the rest of the paper as follows. Section 2 presents and analyses the data. Section 3 outlines the methodologies used, first, to estimate the different monetary policy rules and, second, to estimate the effect of monetary policy on the bank lending channel. Finally, Section 4 reports the findings and Section 5 concludes.

2 Data description

2.1 Interest rate rule data description

We collect quarterly data from the Bloomberg database to estimate interest rate rules for a European group of economies, using the euro as a common currency: Austria, Belgium, Finland, France, Germany, and the Netherlands. We do not consider the remaining Eurozone economies due to an absence of continuous banking data over the sample period considered. For the interest rate rule estimations, we construct Euro-group series for all variables used. That is, we estimate a single interest rate rule that applies to all six economies. For each of the Euro-group variables, we construct weighted averages of these variables as recommended by the International Monetary Fund.¹

¹ In particular, before constructing the country specific bank-related variables, we build appropriate weights, calculated using trade flows and cross-border bank exposure data. These weights capture the importance of country j for the economy of country i . Geographical patterns of trade provide an obvious source of information for this purpose. These aggregation weights use average GDP levels (at Purchasing Power Parity) for the period under consideration. The GDP (at PPP price) data also come from Bloomberg. The weights combine bilateral trade and financial flows. The combined trade and financial weights capture more accurately the trade and financial linkages across the Eurogroup members. The weights are calculated as follows. First, for each country i , we collect bilateral annual trade flows (including both exports and imports) with its trading partners. Then, we collect the financial data, using the external positions of international banks as published in the Bank for International Settlements (BIS) locational banking statistics. We then use the sum of trade flow and foreign exposure positions to derive the weight matrix.

For the Eurozone group, the rate of change in the consumer price index measures inflation, while we measure potential output and the output gap with the detrend real GDP, using the Hodrick-Prescott filter. These data also come from Bloomberg. We use the EONIA interest rate for the European Central Bank (ECB) on main refinancing operation (MRO), which allows the ECB to control the degree of liquidity in the interbank market through short-term open market operation of reverse transactions. The interest rate data come from the IMF International Financial Statistics (IFS) database. We also use bank-specific characteristics in the analysis for the bank lending channel and, therefore, we collect data concerning the financial strength of a bank from BankScope. More specifically, we use bank capitalization measured by equity to total assets, bank size measured by total assets, and bank liquidity measured by the ratio of liquid assets to total assets. Finally, we use two more variables to implement robustness checks – consumption of each country from Datastream and total deposits from BankScope.

2.2 Bank lending channel data description

We collect annual data of total loans as the dependent variable that come from the BankScope database, covering 2000 through 2009.² In particular, we use a sample of 658 Eurozone commercial and savings banks from six countries. The Eurozone countries include Austria (68 banks), Belgium (16), Finland (2), France (94), Germany (475), and the Netherlands (3).

While we use quarterly data for the estimation of our three different interest rate rules (defined below in Section 4), the BankScope data on bank-specific variables only come at the annual frequency. Therefore, we use the interest rate rules estimated with quarterly data to generate annual forecasts (by choosing an average of the four quarter observations) and then to combine them with the analysis of the bank lending channel (in which all variables are set on an annual basis).

3 The econometric specifications

3.1 The interest rate rule

We largely adopt the methodology from Clarida, Gali, and Gertler (1998, 2000) and, therefore, borrow their notation. We estimate the target interest rate as follows:

² The BankScope database does not report quarterly data for the series that we use.

$$i_t^* = \bar{i} + \beta [E(\pi_{t+1} / \Omega_t) - \pi^*] + \gamma E(x_t / \Omega_t), \quad (1)$$

where i^* is the target interest rate, π^* is the target inflation rate, $\bar{i}$ is the long-run equilibrium nominal interest rate, π_{t+1} is the inflation rate between periods t and $t+1$, and x_t is the output gap, the difference between output and its potential. Furthermore, E is the expectation operator and Ω_t is the information set at time t , when the central bank sets the target interest rate. Thus, the target rate depends both on the expected inflation rate gap and expected output gap.

In terms of the ex-ante real interest rate, $r_t \equiv i_t^* - E(\pi_{t+1} / \Omega_t)$, equation (1) becomes the following:

$$r_t^* = \bar{r} + (\beta - 1) [E(\pi_{t+1} / \Omega_t) - \pi^*] + \gamma E(x_t / \Omega_t), \quad (2)$$

where r^* is the target real interest rate and $\bar{r} (= \bar{i} - \pi^*)$ is the long-run equilibrium real interest rate. In an economy with inflation targeting, β plays an important role. Monetary policy proves procyclical when $\beta < 1$. We also incorporate interest rate smoothing, which takes the following form:

$$i_t = (1 - \rho) i_t^* + \rho i_{t-1} + u_t, \quad (3)$$

where the degree of interest rate smoothing is ρ ($0 \leq \rho \leq 1$), and u_t is an exogenous random shock (an *i.i.d.* process).

Additionally, we redefine the constant in equation (1) as follows:

$$\alpha \equiv \bar{i} - \beta \pi^*. \quad (4)$$

Using equation (4), equation (1) becomes:

$$i_t = (1 - \rho) [\alpha + \beta \pi_{t+1} + \gamma x_t] + \rho i_{t-1} + \varepsilon_t, \quad (5)$$

where $\varepsilon_t \equiv -(1 - \rho) [\beta (\pi_{t+1} - E(\pi_{t+1} / \Omega_t)) + \gamma (x_t - E(x_t / \Omega_t))] + u_t$ is a linear combination of the forecast errors of the inflation rate and the output gap as well as the exogenous random shock u_t . Clarida, Gali, and Gertler (1998, 2000) indicate that u_t represents a vector of variables the central bank can use in setting the interest rate target and are orthogonal to ε_t . That is,

$$E(\varepsilon_t / u) = 0 \Rightarrow E(i_t - (1 - \rho) [\alpha + \beta \pi_{t+1} + \gamma x_t] - \rho i_{t-1} / u_t) = 0. \quad (6)$$

We estimate α , β , γ , and ρ , using the Generalized Method of Moments (GMM) methodology. The instrument list contains lagged values of inflation, the output gap, and interest rates.

We can determine the target inflation rate π^* as follows:

$$\pi^* = [(\bar{r} - \alpha) / (\beta - 1)]. \quad (7)$$

Using equation (1) and defining expectations on once-lagged values gives us the backward-looking rule as follows:

$$i_t^* = \bar{i} + \beta(\pi_{t-1} - \pi^*) + \gamma x_{t-1}, \quad (8)$$

where π_{t-1} and x_{t-1} are the lagged values of the inflation rate and output gap, respectively. As with the forward-looking rule, we can rearrange this rule to derive the rule for the real target rate as follows:

$$r_t^* = \bar{r} + (\beta - 1)(\pi_{t-1} - \pi^*) + \gamma x_{t-1}. \quad (9)$$

After incorporating interest rate smoothing, this rule takes the following form:

$$i_t = (1 - \rho)[\alpha + \beta\pi_{t-1} + \gamma x_{t-1}] + \rho i_{t-1} + u_t, \quad (10)$$

using the GMM methodology.

Finally, we adjust the classic Taylor rule to the European data and find the interest rate target, by adding the interest rate smoothing process to the rule and using current data (Taylor-type rule). The estimating equation is as follows:

$$i_t = (1 - \rho)[\alpha + \beta\pi_t + \gamma x_t] + \rho i_{t-1} + u_t, \quad (11)$$

using the GMM methodology.

3.2 Inflation and output gap forecasting: forward-looking rule

To generate out-of-sample forecasts, we use a rolling window of 72 quarters, starting from 1980Q1 to 1997Q4, to identify the best model and to generate the forecasts for the upcoming sample quarter. We compare three alternative approaches for modeling and forecasting the inflation rate and the output gap: autoregressive integrated moving average (ARIMA) models, vector autoregressive (VAR) models, and the Stock and Watson transfer function model. We use the Theil criterion to select the best model, given the out-of-sample forecasts for each method.

First, since both the inflation rate and the output gap are $I(0)$ processes, we consider the $ARMA(p, q)$ model as follows:

$$Y_t = \alpha_1 Y_{t-1} + \alpha_2 Y_{t-2} + \dots + \alpha_p Y_{t-p} + \beta_1 u_{t-1} + \dots + \beta_q u_{t-q}, \quad (12)$$

where Y denotes either the inflation rate or the output gap and p and q vary from 1 to 11. So, we consider the VAR model's forecasts of the inflation rate and the output gap. The four-variable VAR includes the following additional variables: the growth rate of M_1 and the unemployment rate. Finally, we consider the forecasts of the inflation rate and the output gap from Stock and Watson's (1999) transfer function model. It has the form:

$$Y_t = \alpha_1 Y_{t-1} + \alpha_2 Y_{t-2} + \dots + \alpha_p Y_{t-p} + \beta_1 x_{t-1} + \beta_2 x_{t-2} + \dots + \beta_q x_{t-q} + u_t, \quad (13)$$

where Y is the inflation rate (output gap) and x is either the output gap (inflation rate) or the unemployment rate. In all models, we chose the appropriate lag length using the Akaike criterion (AIC). Finally, we choose the Stock-Watson model with the unemployment rate to forecast the inflation rate and the ARIMA model to forecast the output gap.

3.3 The bank lending channel

The econometric method to investigate the bank lending channel estimates the following baseline equation:

$$\Delta \ln L_{mkt} = \phi \Delta \ln L_{mkt-1} + \sum_{j=0}^n \beta_j \Delta i_{t-j} + \sum_{j=0}^n \delta_j \Delta \ln GDP_{kt-j} + \sum_{j=0}^n \omega_j \pi_{kt-j} + u_{mkt}, \quad (14)$$

where $m=1, \dots, 658$ denotes the bank; $k=1, \dots, 6$ denotes the country; $t=2000, \dots, 2009$, L denotes loans, i denotes the monetary policy indicator, π denotes the inflation rate, and u denotes the error term.

We use four different monetary policy indicators: the actual short-term interest rate (not coming from a rule) and short-term interest rates that come from the three central bank interest rate rules. That is, this paper examines how loan growth reacts to the actual short-term interest rate as well as the interest rate target coming out of our forward-looking, backward-looking, and contemporaneous interest rate rules.

In equation (14), we regress the growth rate of lending ($\Delta \ln L$) on the real GDP growth rate ($\Delta \ln GDP$) and on the inflation rate (π) to control for country-specific loan demand changes due to macroeconomic activity. In other words, we isolate shifts in total loans caused by movements in loan demand to identify the supply relationship. The introduction of these two variables also proves important

because it isolates the monetary policy indicator, the short-term interest rate, and the target interest rates from our three policy rules. Additionally, we include lagged values of the dependent variable, because lagged loans affect current loans in an environment where banks establish continuing relationships with their customers. In other words, the bank acquires “informational monopoly over its clients.” We estimate the model using the panel GMM estimator, suggested by Arellano and Bond (1991), where we only include statistically significant lags in the estimation.

3.3.1 Bank-specific characteristics

In addition to the baseline model, we also construct a similar model designed to test whether banks with different characteristics react differently to a monetary shock. This model takes the following form:

$$\begin{aligned} \Delta \ln L_{mkt} = & \varphi \Delta \ln L_{mkt-1} + \sum_{j=0}^n \beta_j \Delta i_{t-j} + \sum_{j=0}^n \delta_j \Delta \ln GDP_{kt-j} \\ & + \eta BS_{mkt-1} + \sum_{j=0}^n \lambda_j \Delta i_{t-j} BS_{mkt-j} + u_{mkt}. \end{aligned} \quad (15)$$

This equation differs from equation (14), because it incorporates two additional terms – a bank-specific characteristic and its interaction with the monetary policy indicator. More specifically, we introduce three separate bank-specific characteristics (BS_{mk}) – bank capitalization, asset size, and liquidity as deviations from their respective means (Gambacorta 2005) – and the interaction terms ($\Delta i_{t-j} BS_{mkt-j}$; $j=1, \dots, n$).

3.3.2 Robustness tests

We also examine the robustness of the results concerning the bank lending channel, excluding the bank-specific characteristics. First, we replace the real GDP growth rate and the inflation rate with the growth rate of real consumption spending. Second, we also replace the inflation rate in equation (14) with, in turn, the ratio of total loans to total deposits and then the growth rate of total deposits. Growth in loan demand may cause banks to issue more insured deposits. Now, equation (14) takes the following three forms:

$$\Delta \ln L_{mkt} = \varphi \Delta \ln L_{mkt-1} + \sum_{j=0}^n \beta_j \Delta i_{t-j} + \sum_{j=0}^n \delta_j \Delta \ln Con_{kt-j} + u_{mkt}, \quad (16)$$

where Con equals real consumption spending with an expected positive coefficient on its growth rate.

$$\begin{aligned}\Delta \ln L_{mkt} = & \varphi \Delta \ln L_{mkt-1} + \sum_{j=0}^n \beta_j \Delta i_{t-j} + \sum_{j=0}^n \delta_j \Delta \ln \text{GDP}_{kt-j} \\ & + \sum_{j=0}^n \gamma_j \ln(L/\text{Dep}_{mkt-j}) + u_{mkt},\end{aligned}\quad (17)$$

where L/Dep equals the ratio of total loans to total deposits with expected positive coefficient.

$$\begin{aligned}\Delta \ln L_{mkt} = & \varphi \Delta \ln L_{mkt-1} + \sum_{j=0}^n \beta_j \Delta i_{t-j} + \sum_{j=0}^n \delta_j \Delta \ln \text{GDP}_{kt-j} \\ & + \sum_{j=0}^n \gamma_j \Delta \ln(\text{Dep}_{mkt-j}) + u_{mkt},\end{aligned}\quad (18)$$

where Dep equals total deposits with an expected positive coefficient on its growth rate.

4 Empirical analysis

4.1 Interest rate rules results

The estimates of the coefficients for the backward-looking, Taylor, and forward-looking rules tell a consistent story within the Eurozone-group (Table 1). Across all rules, the results support an activist policy rule as the coefficient of the inflation gap exceeds one and the coefficient of the output gap exceeds zero, albeit by a small amount. The Eurozone-group responds vigorously to the inflation gap, while interest rate smoothing plays an important role.

More specifically, the inflation gap generates the largest effect on the target rate for the backward-looking rule (the coefficient equals 3.2 versus 2.8 and 1.7 for the Taylor and forward-looking rules, respectively). Therefore, the weight on the inflation receives the lowest value in the forward-looking rule. The small weight on the output gap across all three rules indicates a more ambitious inflation objective. Interest rate smoothing plays an important role. The adjustment in the interest rate takes place more rapidly with almost 60% of the desired change occurring within the quarter for the Taylor rule, whereas only around 25% for the forward-looking rule. For the economy of the Eurozone-group, the ECB seems to

Table 1 Interest rate rule results for Eurozone group.

	α	β	γ	P	Adj. R^2	J-stat	Prob.
Backward	0.0130	3.1828	0.0003	0.5878	0.7545	0.0930	0.2719
Taylor	0.0163	2.7876	0.0005	0.6013	0.8948	0.0000	1.0000
Forward	0.0220	1.6987	0.0009	0.2653	0.7351	0.0000	1.0000

Backward-looking, Taylor-type, and forward-looking rules are given by the following equations, respectively:

$$i_t = (1 - \rho)[\alpha + \beta\pi_{t-1} + \gamma x_{t-1}] + \rho i_{t-1} + u_t$$

$$i_t = (1 - \rho)[\alpha + \beta\pi_t + \gamma x_t] + \rho i_{t-1} + u_t$$

$$i_t = (1 - \rho)[\alpha + \beta E(\pi_{t+1}/\Omega_t) + \gamma E(x_t/\Omega_t)] + \rho i_{t-1} + u_t$$

where α is a constant, reflecting the changes in the inflation target and the equilibrium real interest rate, π =the inflation gap, x =the output gap and ρ =the interest rate smoothing parameter. We estimate the models using the GMM methodology. The J-statistics implies that we cannot reject the null hypothesis of over identifying restrictions.

smooth adjustments in the interest rate to a greater extent, when we use the Taylor-type rules for the estimation of the target rate, whereas in the forward-looking rule, the value of ρ receives the lowest value (i.e., 0.2653). The J-statistics imply that we cannot reject the over identifying restrictions of the models. Our findings show β coefficients that uniformly exceed one and also exceed those reported in Apergis and Alevizopoulou (2012), suggesting a more aggressive anti-inflation and countercyclical central bank policy response.

4.2 Bank lending channel results

Tables 2–5 report the results for the bank lending channel. We estimate the models using the panel GMM estimator and the Sargan test indicates valid instruments in all cases. Table 2 reports the findings when we include the ECB interest rate in the model for the estimation of the bank lending channel (Model I). Then, Tables 3–5 record the results when we include the target interest rate derived from the backward-looking rule (Model II), from the Taylor-type rule (Model III), and from the forward-looking rule (Model IV), respectively. Each Table includes the findings for the various specifications contained in equations (14)–(18). For equation (15), each Table reports three different specifications corresponding to three bank-specific variables – bank capitalization, size, and liquidity.

Table 2 reports the findings for the ECB interest rate. The coefficients of the monetary policy indicator, showing the effects of the decisions of monetary

Table 2 Monetary policy indicator: ECB Rate (Model I).

Dependent variable: Annual growth rate of lending							
	Equa. (14) Coef.	Equa. (15) Coef.	Equa. (15) Coef.	Equa. (15) Coef.	Equa. (16) Coef.	Equa. (17) Coef.	Equa. (18) Coef.
Δi_{kt-1}	-0.5994 (0.0237)	-0.9600 (0.0060)	-0.6260 (0.0392)	-0.5648 (0.0483)	-0.6791 (0.0115)	-0.7855 (0.0151)	-0.5338 (0.0726)
$\Delta \ln \text{GDP}_{kt-1}$	0.1055 (0.0002)	0.3310 (0.0131)	0.9039 (0.0134)	1.0636 (0.0049)		1.1762 (0.0013)	0.7414 (0.0417)
π_{kt-1}	-0.8394 (0.0707)						
Cap_{ikt-1}		0.0261 (0.0000)					
Δi_{kt-1}		4.1960 (0.0129)					
$*\text{Cap}_{ikt-1}$							
Size_{ikt-1}			0.0571 (0.0000)				
Δi_{kt-1}			-1.9926 (0.0438)				
$*\text{Size}_{ikt-1}$							
Liq_{ikt-1}				0.0164 (0.0000)			
Δi_{kt-1}				0.6920 (0.0554)			
$*\text{Liq}_{ikt-1}$							
$\Delta \ln \text{Con}_{kt}$					1.0055 (0.0000)		
$\ln(L/\text{Dep}_{ikt})$						0.0001 (0.0277)	
$\Delta \ln(\text{Dep}_{ikt})$							0.1710 (0.0000)

Coefficient estimates with p-values in parentheses for the group of Eurozone countries, according to the various specifications in equations (14)–(18). Bolded coefficients prove significant at the 5-percent level. The monetary policy indicator takes the actual short-term interest rate (not coming from a rule). We estimate the models using the GMM estimator suggested by Arellano and Bond (1991). Instruments include the second lag for the monetary policy indicator and inflation, whereas the second lag for the real GDP growth rate. Finally, we use the second lag as an instrument for the lagged loans in all cases.

policy on lending, exhibit the expected negative sign and similar magnitudes in all specifications and prove significant at the 5-percent level in four of the seven cases. The remaining three coefficients of the ECB interest rate prove significant at either the 10- or 20-percent levels in two and one cases, respectively. This implies that a higher ECB interest rate induces lower loan growth.

Table 3 Monetary policy indicator: Backward rule (Model II).

	Dependent variable: Annual growth rate of lending						
	Equa. (14)	Equa. (15)	Equa. (15)	Equa. (15)	Equa. (16)	Equa. (17)	Equa. (18)
	Coef.	Coef.	Coef.	Coef.	Coef.	Coef.	Coef.
Δi_{kt-1}	-1.0895 (0.0037)	-3.8256 (0.0011)	-0.8028 (0.0604)		-1.1602 (0.0017)	-1.0080 (0.0418)	-0.8672 (0.0188)
Δi_{kt-2}				-1.5174 (0.0500)			
$\Delta \ln \text{GDP}_{kt}$	0.2806 (0.0357)		0.4803 (0.0016)				0.3571 (0.0062)
$\Delta \ln \text{GDP}_{kt-1}$		0.5238 (0.0002)		0.7404 (0.0001)		1.9991 (0.0000)	
π_{kt-1}	1.2003 (0.0196)						
Cap_{ikt-1}		0.0165 (0.0766)					
$\Delta i_{kt-1} * \text{Cap}_{ikt-1}$		19.5085 (0.0029)					
Size_{ikt-1}			0.0746 (0.0000)				
$\Delta i_{kt-1} * \text{Size}_{ikt-1}$			-17.3960 (0.0000)				
Liq_{ikt-1}				0.0187 (0.0000)			
$\Delta i_{kt-2} * \text{Liq}_{ikt-1}$				12.2259 (0.0111)			
$\Delta \ln \text{Con}_{kt}$					0.8746 (0.0183)		
$\ln(L/\text{Dep}_{ikt-1})$						-0.0002 (0.0568)	
$\Delta \ln(\text{Dep}_{ikt})$							0.1750 (0.0000)

See Table 2. The monetary policy indicator takes the interest rate target coming out of our backward-looking rule. We estimate the models using the GMM estimator suggested by Arellano and Bond (1991). Instruments include the second lag for the monetary policy indicator and inflation, whereas the first lag for the real GDP growth rate. Finally, we use the second lag as an instrument for the lagged loans in all cases.

Tables 3–5 report the findings for the interest rate target from the backward-looking, Taylor and forward-looking rules. Now, the interest rate coefficients exhibit the expected negative sign and similar magnitudes in all specifications and prove significant at the 5-percent level in six of the seven cases in each

Table 4 Monetary policy indicator: Taylor rule (Model III).

Dependent variable: Annual growth rate of lending							
	Equa. (14) Coef.	Equa. (15) Coef.	Equa. (15) Coef.	Equa. (15) Coef.	Equa. (16) Coef.	Equa. (17) Coef.	Equa. (18) Coef.
Δi_{kt}							-0.3802 (0.0093)
Δi_{kt-1}	-0.9710 (0.0010)	-1.7250 (0.0003)	-0.6763 (0.0809)	-1.2088 (0.0198)			
Δi_{kt-2}					-1.6219 (0.0014)	-1.0127 (0.0102)	
$\Delta \ln GDP_{kt}$	0.4712 (0.0004)						0.5917 (0.0000)
$\Delta \ln GDP_{kt-1}$		0.7269 (0.0726)	1.1776 (0.0009)	2.6858 (0.0000)		0.0366 (0.0324)	
π_{kt}	2.1265 (0.0361)						
Cap_{ikt-1}		0.0405 (0.0000)					
$\Delta i_{kt-1} * Cap_{ikt-1}$		5.4612 (0.0001)					
$Size_{ikt-1}$			0.0579 (0.0000)				
$\Delta i_{kt-1} * Size_{ikt-1}$			-1.4896 (0.0120)				
Liq_{ikt-1}				0.0098 (0.0026)			
$\Delta i_{kt-1} * Liq_{ikt-1}$				4.1788 (0.0005)			
$\Delta \ln Con_{kt-1}$					0.7655 (0.0105)		
$\ln(L/Dep_{ikt})$						0.0001 (0.0185)	
$\Delta \ln(Dep_{ikt})$							0.1652 (0.0000)

See Table 2. The monetary policy indicator takes the interest rate target coming out of our Taylor-type rule. We estimate the models using the GMM estimator suggested by Arellano and Bond (1991). Instruments include the first lag for the monetary policy indicator and inflation, whereas the first lag for the real GDP growth rate. Finally, we use the second lag as an instrument for the lagged loans in all cases.

Table. The remaining coefficient of the backward-looking and Taylor rules interest rate targets prove significant at the 10-percent level. The remaining coefficient for equation (16) for the forward-looking rule interest rate target

Table 5 Monetary policy indicator: Forward rule (Model IV).

	Dependent variable: Annual growth rate of lending						
	Equa. (14)	Equa. (15)	Equa. (15)	Equa. (15)	Equa. (16)	Equa. (17)	Equa. (18)
	Coef.	Coef.	Coef.	Coef.	Coef.	Coef.	Coef.
Δi_{kt-1}	-3.3783 (0.0000)	-5.2451 (0.0000)	-0.6907 (0.0016)		-0.3997 (0.0545)	-1.0478 (0.0420)	-1.4239 (0.0000)
Δi_{kt-2}				-1.6044 (0.0289)			
$\Delta \ln \text{GDP}_{kt-1}$	0.2252 (0.0000)	0.6581 (0.0000)	0.7129 (0.0176)	0.9127 (0.0010)		0.8904 (0.0044)	0.8807 (0.0000)
π_{kt-1}	1.9916 (0.0002)						
Cap_{ikt-1}		0.0761 (0.0000)					
Δi_{kt-1}		32.3149 (0.0000)					
*Cap_{ikt-1}							
Size_{ikt-1}			0.0480 (0.0000)				
Δi_{kt-1}			7.3599 (0.0370)				
*Size_{ikt-1}							
Liq_{ikt-1}				0.0444 (0.0001)			
Δi_{kt-2}				22.6709 (0.0000)			
*Liq_{ikt-1}							
$\Delta \ln \text{Con}_{kt}$					0.7907 (0.0000)		
$\Delta \ln \text{Con}_{kt-1}$							
$\ln(L/\text{Dep}_{ikt})$						0.0001 (0.0313)	
$\Delta \ln(\text{Dep}_{ikt})$							0.2388 (0.0000)

See Table 2. The monetary policy indicator takes the interest rate target coming out of our forward-looking rule. We estimate the models using the GMM estimator suggested by Arellano and Bond (1991). Instruments include the second lag for the monetary policy indicator and inflation, whereas the second lag for the real GDP growth rate. Finally, we use the second lag as an instrument for the lagged loans in all cases.

does not prove significant even at the 20-percent level. This implies that higher backward-looking, Taylor, and forward-looking target interest rates induce lower loan growth.

The findings generally show the largest effect for the forward-looking rule and the smallest effect for the actual ECB interest rate. Specifically, for coefficients significant at the 5-percent level, a one-percent increase in the target rate,

specified by the forward-looking rule, reduces bank lending over a range from 0.69 to 5.25%, while the same percentage increase in the ECB interest rate reduces the loan growth over a range of only 0.60–0.79%. The target interest rate coefficients for the backward-looking and Taylor rule tend to fall between the magnitudes for the forward-looking target and ECB interest rates. Finally, the interest rates generally exert their influence with a one-quarter lag.

Tables 2–5 also report the coefficients and their corresponding p-values for the real GDP growth rate and the inflation rate for the four models. The coefficients of real GDP growth exhibit positive and statistically significant effects across nearly all cases. The coefficients in Table 4 that considers the Taylor rule target interest rate reports two instances where the coefficient of real GDP growth proves insignificant at the 5-percent level. In particular, an increase in GDP growth by 1% affects bank lending positively over a range across the four Tables from 0.11 to 2.69%, but most coefficients fall below 1-percent. Across the same tables, the coefficients of the inflation rate generally show a positive effect, when significant.

In sum, the empirical analysis across our seven different specifications indicate that the bank lending channel operates better if the target interest rate comes from the forward-looking rule, if one considers the magnitude of the effect.

4.3 Results with bank-specific characteristics

Tables 2–5 present the results for the bank lending channel from the estimation of equation (15), which, in addition to lagged loans, the monetary policy indicator, and the real GDP growth rate, includes two additional terms – bank-specific characteristics (bank capitalization, size, and liquidity) and the interaction terms between each bank-specific characteristic and the change in the monetary policy indicator. Note, however, that equation (15) excludes the inflation rate.

When controlling for bank specific characteristics and as noted above, monetary policy affects the growth of lending negatively across all model specifications and usually the effect proves significant at the 5-percent level. The bank-specific variables lead to the following outcomes when we consider the effects of BS_{mk} at their mean value. Higher bank capitalization associates with higher lending growth whenever the coefficient is significant. More specifically, a one-percent increase in size leads to a 0.08-percent increase in bank lending for the forward-looking rule, while only a 0.041-percent and 0.026-percent increase for the Taylor and actual rules, respectively. The estimate for the backward-looking rule proves statistically insignificant. Larger banks associate with significantly more bank lending; a one-percent increase in the size of the bank exerts the largest effect on

bank lending for the backward-looking rule (i.e., 0.075%) and the lowest effect for the forward-looking rule (i.e., 0.048%). Finally, more liquid banks associate with significantly more bank lending across all cases, with the strongest effect occurring for the forward-looking rule (i.e., 0.044%) and the weakest effect occurring for the Taylor rule (i.e., 0.010%).

When we consider the interaction terms in conjunction with the interest rate effects, more capitalized banks associate with a stronger bank lending effect (i.e., better capitalized banks can better insulate themselves from adverse monetary policy actions), since all coefficients of the interaction terms prove positive and significant. More specifically, the coefficient for the forward-looking rule exerts the highest effect on bank lending (i.e., a one-percent increase in the interaction term leads to a 32.3-percent increase in bank lending), while the weakest effect comes from the actual policy rule (i.e., 4.2%). This strong result results from the use of a purely forward-looking character of that monetary policy rule in relation to the bank lending mechanism. In particular, the larger response of the banking system to monetary policy decisions in the context of a forward-looking rule indicates that such a monetary policy rule implies that once the central bank adjusts its policy instrument, forward-looking private sector behavior results in an immediate response about the future path of the news upon both current inflation and output. And more importantly, in the presence of a forward-looking monetary policy rule framework, the central bank mainly affects the trends in the banking sector and, consequently, the real economy through changes in expectations about the future path of its instrument in any event; a predictable adjustment of interest rates later, once the disturbances substantially affect inflation and output, should be highly effective in changing private sector's spending and pricing decisions as a preemptive change in overnight interest rates immediately. Therefore, the actual rule is not an explicit instrument rule in the sense of Svensson and Woodford (2004), which poses a feature which is crucial to the effectiveness of the rule to change both the course and the magnitude of its monetary impact on the economy. The findings with respect to the forward rule imply that this particular rule can involve significant adjustments of the short-term nominal interest rate in response to shocks, which cannot be specified in the context of rules that consider only contemporaneous and lagged responses to fluctuations in the target variables.

Furthermore, these findings indicate that the actual rule implemented by the ECB is not totally governed by forward-looking expectations and in case the European monetary authorities wish to change dramatically the course of the European economy, they have to implement a monetary policy course by adopting a purely forward-looking monetary rule.

Larger banks also exhibit a significantly smaller bank lending effect in most cases. The estimates, however, prove statistically significant only for the forward-looking and backward-looking rules. While the forward-looking rule exhibits a positive effect (i.e., a one-percent increase in the interaction term leads to a 7.4-percent increase in bank lending), the backward-looking rule experiences a negative effect (i.e., a one-percent increase in the interaction term leads to a decline in bank lending of 17.4%). Finally, focusing on significant coefficients, more liquid banks associate with a significantly larger bank lending effect. In this case, the strongest effect comes from the forward-looking rule, indicating that a one-percent increase in the interaction term leads to 22.7-percent increase in bank lending activities.

4.4 Robustness tests

Tables 2–5 report the results of using the growth rate of real consumption spending loans to deposits, and the growth rate of deposits in equations (16)–(18), respectively, as robustness checks. Once again, the monetary policy variable exhibits a negative effect. The growth rate of real consumption spending exhibits a significant positive effect on the growth rate of lending, with the strongest effect occurring for the actual rule (i.e., 1.01) and the weakest effect occurring for the Taylor rule (i.e., 0.77). In terms of the intervention interest rate, the strongest effect comes for the Taylor rule (i.e., a one-percent increase in interest rates leads to a 1.62-percent reduction in bank lending activities).

A higher ratio of loans to deposits generally generates a positive effect on the growth rate of lending. In particular, a one-percent increase in the ratio of loans to deposits leads to a significant 0.0001-percent increase in bank lending activities across three of the four monetary rules. In terms of the bank lending channel estimates, the strongest effect comes for the forward-looking rule (a one-percent increase in intervention interest rates leads to 1.05-percent decline in bank lending activities).

A larger growth rate of deposits generates a significant positive effect on the growth rate of lending. More specifically, the strongest effect comes again for the forward-looking rule (i.e., a one-percent increase in the growth rate of deposits generates a 0.24-percent increase in bank lending activities), while the weakest effect comes for the Taylor rule (i.e., 0.17%). Finally, in terms of the bank lending channel, countercyclical monetary policies achieve their strongest effects on bank lending for, once again, the forward-looking rule (i.e., a one-percent increase in the monetary policy interest rate leads to a 1.42-percent decline in bank lending).

5 Conclusions

Interest rate rules now command significant attention amongst economists and policymakers, since they provide a structure within which to analyze the behavior of central banks. The bank lending channel also commands significant attention as well, because its operation provides an alternative channel whereby the monetary authorities' decisions can affect the real economy by altering the supply of bank loans.

The bank lending channel exists in all models examined. This finding suggests that banks across the Eurozone economies play a special role in the transmission of monetary policy, given that monetary policy affected banks' lending decisions. In addition, the comparison between large and small banks also pointed towards a significant difference in the ability of small and large banks to resort to market sources of financing. Our results mostly favor the presence of an operative bank lending channel in the Eurozone-group economies, regardless of the role of liquidity. Although the European banks – particularly, small banks – strive to maintain satisfactory levels of liquid assets sufficient to offset significant shocks to their traditional sources of funds, they remain vulnerable to exogenous shocks originating from changes in monetary policy decisions.

Differences emerge, however, in the degrees of responsiveness of loan growth to changes in the monetary policy indicator. Thus, the bank lending channel exerts a stronger effect when we used target rates as indicators rather than the observed central bank interest rates. Moreover, the strongest effects generally emerge in the models employing the forward-looking rules. Through its actions and announcements, monetary policy guides the private sector's (banks') expectations. Therefore, banking institutions alter their supply of loans according to the rules, making monetary policy decisions more effective.

The forward-looking monetary rule results indicate that given the lags, monetary policy needs to respond to more than contemporaneous levels of inflation. That is, the monetary policy makers can do better by focusing on future inflation. Within such a context, the central bank will design a more efficient monetary reaction to shocks and its response horizon will conform to a wide range of policy horizons, depending on the specification of the coefficients in the monetary policy rule as well as the modeling framework used to express that rule. In this manner, the implementation of a forward-looking monetary rule by the European monetary authorities can further stabilize inflation expectations and increase their credibility. Furthermore, our empirical findings show that although the monetary authorities do not always possess quantitative information on how rational private economic agents (i.e., individuals, firms, and banks) are and on how helpful a central bank's credibility is when it comes to economic

stabilization, forward-looking monetary rules are capable of providing adequate information to the banking sector to modify its lending behavior, given short-run effects of monetary tightening and easing.

The most important lesson we learn from our results is that monetary policy makers need to use their policy to guide expectations. The superiority of the forward-looking monetary rule over the remaining competitive rules indicates that monetary policy needs to respond in a manner that stabilizes expectations. The existing literature shows how to guide the economy (i.e., usually through the workings of the banking system) under extreme threats of either hyperinflation or deflationary spirals. Therefore, appropriate monetary policy design can minimize these risks, especially for the Eurozone-group economies and the recent debt sovereign crisis clearly reveals the inability of fiscal policy to drive the growth processes in a sustainable manner.

This paper also examines whether lending differentials depend on the strength of a bank, characterized by capitalization, asset size, and liquidity. Furthermore, we also accounted for additional variables, in addition to real GDP growth, in the estimation of the bank lending channel. We used the growth rate of real consumption spending, the ratio of total loans to total deposits, and the growth rate of deposits as additional control variables. The results indicate that large and well-capitalized banks more easily absorb monetary shocks. In most of the cases, the bank lending channel strengthens when we used target rates derived from interest rate rules and, specifically, from the forward-looking rule as the monetary policy indicator, a conclusion that strengthened our baseline results.

References

- Apergis, N., and E. Alevizopoulou. 2012. "The Bank Lending Channel and Monetary Policy Rules: Evidence from European Banks." *International Advances in Economic Research* 18: 1–14.
- Arellano, M., and S. Bond. 1991. "Some Tests of Specification for Panel Data: Monte Carlo Evidence and an Application to Employment Equations." *Review of Economic Studies* 58: 277–297.
- Clarida, R., J. Gali, and M. Gertler. 1998. "Monetary Policy Rules in Practice: Some International Evidence." *European Economic Review* 42: 1033–1067.
- Clarida, R., J. Gali, and M. Gertler. 2000. "Monetary Policy Rules and Macroeconomic Stability: Evidence and Some Theory." *Quarterly Journal of Economics* 115: 147–180.
- Gambacorta, L. 2005. "Inside the Bank Lending Channel." *European Economic Review* 49: 1737–1759.
- Hernando, I., and J. M. Pages. 2001. "Is There a Bank Lending Channel of Monetary Policy in Spain?" European Central Bank, Working Paper Series, Working Paper No. 99.

- Stock, H. J., and W. M. Watson. 1999. "Forecasting Inflation." NBER Working Paper Series, Working paper No 7023.
- Svensson, L. E. O., and M. Woodford. 2004. "Implementing Optimal Policy through Inflation-Forecast Targeting." In *Inflation Targeting*, edited by B. S. Bernanke and M. Woodford, Chicago: The University of Chicago Press.