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THE EFFECT OF FINANCIAL REGULATION MANDATE ON INFLATION BIAS: A DYNAMIC PANEL APPROACH

By

Diana Lima,
(Central Bank of Portugal)

Ioannis Lazopoulos
(University of Surrey)
&
Vasco Gabriel
(University of Surrey)

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The Effect of Financial Regulation Mandate on Inflation Bias: A Dynamic Panel Approach[*]

D. Lima [†]   I. Lazopoulos [‡]   V. Gabriel [§]

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Abstract

Central banks in charge of banking regulation are less aggressive in their inflation mandate since tight monetary policy conditions could have an adverse effect on the stability of the banking system. Due to the conflict between the two mandates, it has been argued that banking supervisory powers should be assigned to an independent authority to avoid inflation bias and enhance social welfare. The first part of the paper develops a theoretical model that assesses the interaction between different policy transmission channels, namely the credit channel and the banks' balance sheet channel. Focusing on a mandate where central banks are also responsible for banking supervision, cases where the price and financial stabilisation objectives are complementary or conflicting are identified, highlighting the role of policy instruments and types of macroeconomic shocks on welfare. The second part of the paper empirically assesses whether central banks' combined mandates lead to an inflation bias problem using panel data for 25 industrialised countries from 1975 to 2012. The estimation results show that, once we control for relevant policy and institutional factors (such as the presence of inflation targeting and deposit insurance schemes), the separation of banking supervision and monetary policy does not have a significant effect on inflation outcomes.

Key words: Monetary policy, banking regulation, institutional mandates.

1 Introduction

It is now well documented that many macroeconomic variables in several economies have gone through the so-called 'Great Moderation' period, which broadly corresponded to lower levels and volatility of inflations rates, coupled with stable growth and low unemployment. Until recently, financial regulation did not feature prominently as a macroeconomic policy tool, but, nevertheless, recent decades have seen substantial changes in the institutional architecture of monetary policy and banking regulation across many countries. It seems, therefore, relevant to assess how these changes have contributed to macroeconomic outcomes and, in particular, inflation.

Historically, the institutional arrangements concerning the monetary policy and banking regulation were mainly influenced by two distinct traditions; the Anglo-Saxon influence, where monetary policy and banking supervision are combined under the central bank, and a German-influenced approach, where these functions are separated.[1] According to Haubrich (1996), the origin of these different traditions is related to the evolution of the payment system. Countries that adopted the Anglo-Saxon tradition experienced a rapid expansion of credit through the introduction of alternative forms of money, where the central banks naturally became the guarantors of the smooth functioning of the payment system and the regulators in these market-based financial systems. In contrast, countries that experienced a slow expansion of credit developed a bank-based financial system of well-capitalised banks that were regulated by an independent authority following the German tradition.

However, in the late nineties there was a tendency for the separation of these functions following the German-style framework.[2] Indeed, over the period from 1986 to 2006 for a sample of 91 countries, Masciandaro (2009) demonstrates that 94% chose to reform their financial supervisory architecture and unify the financial system regulators within the same agency, but different from the central bank. In particular, it is shown that the degree of unification of financial regulators is inversely related to the central bank's role in banking regulation and supervision. More recently, the 2008 financial crisis questioned this apparent consensus towards the separation of functions, and several countries, including the United Kingdom, Ireland and Iceland, but also the euro area, implemented reforms towards the reinforcement of the role of the central bank in banking supervision (Pellegrina et al., 2010).

Notwithstanding the financial supervisory architecture trends around the world, there are strong arguments for and against separation of banking supervision from the central bank in the academic literature. On one hand, a combined institutional mandate, in which the central bank is also in charge of banking supervision, provides gains in terms of information, in the sense that the central bank has access to confidential information regarding banks' financial situation[3]. This type of information is useful in situations in which the lender-of-last-resort support is deployed, since the decision to use this mechanism to support banks in financial distress should be based on accurate information regarding the solvency of these institutions.[4]

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[1] For example, countries with an Anglo-Saxon influence include the United States, United Kingdom, Australia and Hong Kong, whereas countries with German influence include Austria, Germany, Denmark, and Switzerland.

[2] Most notably, in 1999 the European Central Bank was assigned the responsibility for the conduct of monetary policy in the euro area and the national authorities became in charge of the banking regulation and supervision. Likewise, the United Kingdom and Australia have opted for the separation of these functions.

[3] There are other arguments in favour of combined institutional mandates, such as the access to expertise and qualified staff argument (Garicano and Lastra (2010)) and the independence argument (Tuya and Zamalloa (1994)).

[4] Supervisory data is also relevant as a source of information regarding economic conditions and, therefore, it

On the other hand, it is argued that a combined institutional mandate may lead to conflicts in the objectives of monetary policy and banking supervision, in certain economic circumstances.[5] This argument in favour of the separation of policy regimes states that a central bank responsible for banking regulation will be more flexible in its inflation mandate if it fears that tight monetary conditions may cause bank distress due to adverse effects of high interest rates on the profitability and soundness of the banking sector (Goodhart and Schoenmaker, 1993, 1995).

The aim of this paper is, thereby, to examine, both theoretically and empirically, the implications of different designs of monetary and financial supervisory architecture on the inflation rate dynamics. The first part of the paper develops a theoretical model to examine the interaction between different policy transmission channels, namely the credit channel that directly affects macroeconomic variables and the banks' balance sheet channel which indirectly affects macroeconomic variables through its effect on the price of various components of aggregate demand. Focusing on the case of combined mandates, cases where the price and financial stabilisation objectives are complementary or conflicting are identified, highlighting the role of policy instruments and types of macroeconomic shocks on welfare.

The second part empirically investigates whether monetary policy and banking regulation have conflicting goals by assessing whether institutional mandates in which the central bank plays a banking supervisory role have, on average, led to higher inflation rates in relation to a separate regime. In addition, we consider the impact on inflation from other components of the monetary and financial supervisory architecture, namely the degree of independence of central banks, whether they were assigned an explicit inflation targeting mandate, or whether the establishment of deposit insurance systems with the view to enhancing financial stability by protecting deposits may influence the monetary policy stance.

Building upon the work by DiNoia and DiGiorgio (1999) and Copelovitch and Singer (2008), we address several limitations in their models and extend the analysis in several ways. As Copelovitch and Singer (2008) point out, some of their results should be interpreted carefully due to the small size of the sample they are using, which is a panel data that comprises 23 industrialised countries ranging from 1975 to 1999. Since they opt for transforming the annual data into five-year averages, the sample size is even more reduced. To overcome problems related to sample size, we introduce two innovations. First, we suggest the use of annual panel data, instead of the five-year average inflation rate approach. We also undertake the estimation of a dynamic panel data model for inflation analysis, taking into consideration empirical evidence on the persistence of inflation rates. Even more relevant are the improvements regarding the estimation approach. Despite the construction of a panel data sample to measure the effect of the separation of banking supervisory powers from the central bank on inflation outcomes, previous studies adopt simple estimation methods, such as ordinary least squares, which do not take into account unobserved effects that are typical of panel data analysis. We use appropriate methods to estimate panels, both static and dynamic, namely the Fixed Effects and the Arellano-Bover approaches.

Second, we extend the time span from 1999 to 2012, which results in a dataset covering a sufficiently wide time span of 38 years to allow for some of these countries to change their

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can also be used to improve the accuracy of economic forecasting, which is commonly one of the core functions of central banks.

[5]Another argument against the combination of monetary policy and banking regulation refers to the reputation risk that is associated to this type of institutional arrangement. It is argued that public perception of central bank credibility may likely be affected by its performance as a banking supervisor, mainly if a bank failure occurs.

institutional mandates of banking supervision more than once.[6] For the remaining countries, there is a predominance of jurisdictions that never changed their supervisory arrangements (16 out of 25) and 7 countries introduced reforms during this period. The period of the sample is wide enough to capture normal macroeconomic and financial times, characterised by the 'Great Moderation' period, and a worldwide financial and economic crisis period .

Finally, we allow for the inclusion of additional explanatory variables that were not considered in past analyses and that are likely to explain inflation behaviour. Indeed, variables that aim at capturing other aspects of the financial and monetary architecture, such as the monetary policy regime (in particular whether or not an inflation targeting regime is in place) and the presence of deposit insurance schemes, together with variables that account for the degree to which open economies are exposed to 'imported' inflationary shocks, are of crucial importance in studies on this topic.

Estimation results show that the institutional separation of banking supervision from central banks does not have a significant impact on inflation, suggesting that inflation rates are not systematically above in countries in which a combined mandate of monetary policy and banking regulation is in place. This result is robust to time spans not including the financial crisis period and to the dynamic version of the panel data model. More interestingly, our findings suggest that there are other characteristics of the monetary and financial supervisory architectures that are driving forces of low inflation rates, such as inflation targeting and deposit insurance systems. Developed economies implemented major reforms in their monetary and financial institutional setup in the last decades of the twentieth century. These reforms included changes in the central banks' institutional mandates, turning these institutions more independent from the political system and transparent in what their goals are concerned, and the introduction of explicit deposit guarantee schemes, which have a crucial role in restoring depositors confidence in the banking system thereby promoting financial stability. Our findings show that these aspects of the institutional architecture of the monetary and financial systems are important to promote price stability in these economies. Deposit insurance schemes, in particular, are seen as incentives to the banking industry to undertake riskier activities, putting the stability of the banking system at stake. This study suggests that, on the contrary, deposit insurance schemes are important institutional cornerstones for the stability of prices, by steering confidence in the well functioning of the banking system. As such, they contribute in a non-negligible manner to the stability of the overall economy.

The negative impact of these elements on inflation is a robust result for both normal and crisis times. Finally, economic factors, such as the output gap, trade and capital account openness, are also important determinants of inflation.

The paper proceeds as follows. Section 2 describes the transmission mechanisms of monetary policy and how banking regulation and supervision may affect these channels. Section 3 develops a theoretical framework that illustrates the conflicting goals between monetary policy and bank regulation. Section 4 presents the data, describes the methodology used in the empirical analysis and the estimation results. Section 5 concludes.

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[6]This is the case for Ireland which reviewed its banking supervisory institutional arrangement in 2003 and again in 2010, after the subprime crisis, and Luxembourg, which reviewed its supervisory mandate in 1983 and 1999.

2 Interactions of monetary policy and banking supervision - a review

Monetary policymakers have distinct policy goals from banking supervisors. While the former are focused on price stability, the latter look after the solvency of the individual banks and the resilience of the banking system as a whole (microprudential and macroprudential approaches of banking supervision, respectively). Although they are distinct policy objectives *per se*, they are likely to positively contribute to the ultimate goal of macroeconomic stability. In this sense, policy objectives of monetary authorities and banking supervisors are complementary at least in the long-run, since both promote the economic and financial conditions needed to achieve stability at the macroeconomic level.

Nonetheless, under specific economic circumstances, the outcomes on financial and price stability of banking supervision and monetary policy, respectively, can be conflicting, due to the fact that banking supervision may alter the monetary policy transmission mechanism. The monetary policy propagation channels more likely to interact with bank stability and ultimately with the stability of the financial system are mainly three: i) the borrowers' balance-sheet channel, ii) the bank lending channel, and iii) the risk-taking channel.[7]

Through the borrowers' balance-sheet and bank lending channels, monetary policy shocks have an impact not only on the level of interest rates, but also on the size of the external financial premium (i.e. the difference between the cost of funds raised externally and the opportunity cost of internal funds) (Bernanke and Gertler (1995)). The borrowers' balance-sheet and the bank lending channels illustrate the link between monetary policy decisions and the external finance premium. The borrowers' balance-sheet channel is based on the assumption that the external finance premium is directly related to the borrowers' financial condition, which, in turn, is positively determined by their net worth (which may be thought as the sum of the liquid assets and the market value of collaterals). Given that the borrowers' financial situation affects the external finance premium, thus determining the general credit conditions available to them, variations in the quality of borrowers' balance-sheets should likewise impact on credit terms they face and, consequently, on their investment and spending decisions. Changes in interest rates affect the borrowers' net worth, at least in two ways. A rise in policy interest rates increases the cost of liabilities, reducing cash flows and deteriorating borrowers' financial position. In addition, it decreases the price of assets that can be used as collateral, deteriorating borrower's financial position and limiting the amount of lending provided to borrowers.[8]

The bank lending channel of monetary policy operates through the banks' balance-sheet. Specifically, monetary policy may affect the external finance premium by changing the financial intermediaries' supply of funds. A rise in interest rates induces a reduction in the supply of funds, by raising the relative funding costs faced by banks, leading to a fall in credit supply. In the case of a decline in credit supply, the most bank-dependent borrowers, although they may not be completely excluded from credit, may have to face higher funding costs themselves. The higher costs are likely to increase their external finance premium and reduce real activity (Bernanke and Gertler (1995)).

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[7] In this section we only address the transmission channels of conventional monetary policy.

[8] These are the direct effects from a rise in interest rates. Indirectly, a rise in interest rates may also reduce demand for a certain product, also affecting firms' net cash flows and collateral values. In both situations, a tightening in monetary policy interest rates increases the external finance premium, negatively affecting the borrowers' ability to make loans (i.e. it reduces credit demand in general) (Bernanke and Gertler (1995)).

The risk-taking channel, as first argued by Borio and Zhu (2012), claims that low interest rates boost assets and collateral prices and if the market believes that this is a sustainable rise, it prompts banks and borrowers to accept higher risks. Then, a softening of credit standards can follow, which may lead to an excessive increase in loan supply. By the means of the risk-taking monetary policy channel, low interest rates reduce risk perceptions and/or improve risk tolerance, thereby encouraging risk taking behaviour. By promoting risk taking and search for yield behaviours, monetary policy may sow the seeds for financial instability.

Due to the sharing of transmission channels, interactions of banking supervision and monetary policy may have conflicting goals. For example, in an economic downturn, monetary policymakers' response is to avert deflationary pressures by decreasing interest rates, whereas the banking supervisor, under the same economic circumstances, may favour raising capital requirements to guarantee the resilience of the banking system to economic shocks (Goodhart et al. (1993; 1995)). The raise in capital requirements in a deflationary economic environment may lead to a reduction on credit supply, exacerbating the adverse economic conditions and counteracting the monetary stimulus promoted by the decrease in interest rates. This example illustrates a potential conflict between the objective of monetary authorities, which aim at keeping inflation around the target by decreasing interest rates, and banking supervisors, whose actions may constrain the transmission mechanism of monetary policy.

Another example comes from a situation in which strong inflationary pressures are detected and the central bank increases interest rates to counteract the upward developments in prices. Nevertheless, high increases in interest rates may negatively affect banks' profitability and solvency, depending on their magnitude (high interest rates may pose more serious risks to banks' profitability than lower rates), and on banks' balance sheet structures. A high increase in short-term interest rates is likely to be an important determinant of systemic banking crisis, since it may deteriorate banks' balance sheets. Consider an increase in short-term interest rates. Banks adjust by raising the deposits rate. Assuming that the assets side of the balance sheet is mainly composed by loans with longer maturities at fixed interest rates, the banks cannot pass through to borrowers the increase in interest rates, and, as a result, the interest margins compress, reducing banks' profits. Even if the banks' loans are provided at a variable rate, allowing them to pass on the rise in interest rates to borrowers, losses may result from a larger fraction of non-performing loans, since the debt service augments, making some borrowers unable to meet their obligations. Therefore, banking supervisors may prefer a gradual monetary policy tightening in the presence of inflationary pressures than a sudden large increase in interest rates.

Conflicts of this sort challenge the institutional arrangements of monetary policy and banking supervision. In the case central banks are in charge of banking supervision, they have to deal with these potentially conflicting goals: controlling inflation at the target levels, while maintaining financial stability. These decisions may depend on the emphasis that is given to financial stability, but the conflict of interest argument states that central banks may opt for being more flexible in their inflation mandates, when financial stability is at stake. Goodhart and Schoenmaker (1993) and Goodhart and Schoenmaker (1995), among others, argue that central banks responsible for banking supervision have incentives to be particularly attentive to the effects of their interest rate decisions on the profitability and stability of the banking sector. Against this background, it is therefore argued that an inflation bias may arise in institutional mandates characterised by central banks with supervisory functions, in opposition to an institutional set-up in which banking regulation is assigned to a separate authority.

The potentail inflation bias stems from a less strict monetary policy stance towards inflation

than in the case in which the monetary policymaker is not concerned about financial stability. In this sense, the argument can be stated as follows: countries in which central banks have banking supervisory powers will experience larger inflation rates, on average, than countries in which banking supervision is assigned to an agency other than the central bank.

The evidence in the literature supports the existence of conflicting goals between monetary policy makers and bank regulators. Using data from the United States over the period 1990-1998, Ioannidou (2005) examines whether monetary policy responsibilities have implications in the conduct of the bank supervision when the Federal Reserve System (Fed) is responsible for both functions.[9] The results suggest that monetary policy influences Fed's supervisory actions as it turns out to be more flexible in its banks' supervisory role when it tightens the monetary policy stance. Moreover, focusing on 25 industrialised countries over the period 1960-1996, DiNoia and DiGiorgio (1999) find evidence that average inflation rate is explained by countries' institutional mandate when controlling for central bank independence from the government. The authors conclude that central banks are less effective in controlling inflation when they are responsible for the regulation of the banking sector.

In a similar study, Copelovitch and Singer (2008) consider 23 industrial countries from 1975 to 1999 and found empirical evidence that inflation rates have been significantly lower, on average, in countries where the central bank and the banking supervisor are separate agencies.[10] This effect is conditional on the choice of the exchange rate regime and the size of the domestic banking sector. In particular, the separation mandate has a significant negative effect on inflation under floating rates, but this effect is only observed at middle to high levels of banking sector size.

The interlinkages between monetary policy and banking regulation are poorly addressed in the theoretical literature. The few examples of studies investigating upon these issues are from Cecchetti and Li (2008) and Cecchetti and Kohler (2014). Cecchetti and Li (2008) develop a model through which the conflict of interest that arise from diverse policy objectives of monetary policymakers and banking regulators is analysed. The model extends the Blum and Hellwig (1995) banking sector framework to include a central bank and derive an optimal monetary policy rule, in which the potential procyclicality of capital requirements is incorporated. The central bank and the banking regulator are separate authorities and, due to the fact that monetary policy is usually conducted on a daily basis, whereas banking regulation change slowly, interactions between the two are modelled by assuming that the central bank moves first and it is followed by the banking regulator. Results show that the central bank should respond to the banking system's balance sheet in order to neutralize the procyclical effect of prudential capital regulation. Thus, in a situation of financial distress and economic downturn, the optimal mon-

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[9]Note that the regulatory architecture of the banking system in the United States is such that the Fed, along with the Office of the Comptroller of the Currency (OCC) and the Federal Deposit Insurance Corporation (FDIC), all share the supervisory powers, but the Fed is the only regulator responsible for monetary policy.

[10]This paper uses as control variables: central bank independence (Cukierman's methodology 1992, from Comparative Political Dataset), exchange rate regime (dummy, IMF classification), trade openness (measured as imports plus exports as a percentage of GDP, World Development Indicators database), capital account openness (Chin-Ito index), log of GDP, GDP per capita (World Development Indicators database), dummy variables (sum of individual year observations for each period of five years, divided by 5) for currency crisis and banking crisis (Glick and Hutchinson, 1999), dummy for explicit deposit insurance (World Bank's Deposit Insurance Around the World database), size of the domestic credit provided by the banking sector as a % of GDP (proxy for the size of the domestic banking sector, World Development Indicators), time trend variable (ranges from 1 to 5).

The authors also test for additional explanatory variables, such as lagged dependent variable, union density, centralization and coordination of wage bargaining, veto players, the partisan composition of government, unemployment rates, GDP growth, and a dummy for an election year and conclude that these variables do not affect the basic results.

etary policy stance should decrease interest rates more aggressively when the banking system is capital constrained, counteracting the procyclicality of capital regulation and, simultaneously, stabilising the aggregate economic activity.[11] The authors show that capital regulation requires adjustments by monetary authorities, but they are not an obstacle to the effective conduct of monetary policy. Hence, the potential conflicts between policies' objectives can be overcome in a type of game where the central bank response takes into account whether the banking system is capital constrained.

Cecchetti and Kohler (2014) extend the Cecchetti and Li (2008) methodology to investigate whether interest rates and capital requirements are interchangeable instruments in stabilising the economy. They find that the instruments are full substitutes for achieving a standard monetary policy goal of output and price stability, due to their similarities regarding the transmission mechanism. They also show that introducing a financial stability goal impacts on the substitutability between interest rates and capital requirements. Coordination is, in this case, suggested to achieve full substitutability, but the type of coordination also matters. In the case in which partial coordination is assumed (where the authority in charge of financial stability moves first), the worse outcomes may be attained, given that the policymakers do not take each other's reactions into their optimisation problem.

3 The Model

The theoretical model that is presented in this section aims to provide a underlying framework to highlight some of the important issues that have been raised in the literature. We consider a static closed-economy version of the standard workhorse model that is widely used to describe macroeconomic policy design problems (see e.g., Svensson (1997) and Gertler et al. 1999) with a banking sector as in Cecchetti and Kohler (2014). The main objectives of using this model are to examine whether there are any welfare gains from the inclusion of financial variables on simple policy rules, analyse the interaction of the transmission channels of monetary policy and financial stability and evaluate the welfare effects.

More specifically, the model that is considered is written in log-linearised form around the steady state and is summarised below:

$$y^d = -y_\pi \pi - y_i(i - \pi^e) - y_\rho(\rho - \pi^e) + h \tag{1}$$

$$y^s = \beta(\pi - \pi^e) + \epsilon \tag{2}$$

$$\ell^d = -\ell_\rho(\rho - \pi^e) + \ell_y y \tag{3}$$

$$\ell^s = \ell_l y - k. \tag{4}$$

The goods market is described by the aggregate demand y^d and aggregate supply y^s that depend on inflation π and are subject to uncorrelated shocks h and ϵ which are assumed to have zero means and constant variances σ_h^2 and σ_ϵ^2, respectively. The demand side of the economy depends negatively on the short-term policy rate i and the lending rate ρ, where π^e denotes expected inflation. The two rates are considered to influence different components of aggregate demand.

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[11]Cecchetti and Li (2008) show that, from 1989 to 2000, the Fed has optimally decreased the federal funds rate in response to a higher leverage ratio, that was embedded in its reaction function to capture greater banking system distress under capital regulation.

The policy rate (or 'repo' rate) has a direct effect on y^d and represents the standard instrument set by the monetary policymaker through open market operations to stabilise inflation and output gap. The aggregate demand is also affected by the lending rate ρ which is determined in the lending market. In particular, the loan demand ℓ^d depends negatively on the price of loans and positively on the output gap y. The supply of loans ℓ^s is equal to the resources available for lending $\ell_l y$ which depends on the state of the economy as more resources will become available when the economy is growing since more loans repayments are made, minus the required capital requirement k that the banks have to keep on their balance sheet. As such, k can also be thought as an alternative instrument that the policymaker can adjust to stabilise the economy in response to a macroeconomic shock. In this case, by controlling the availability of credit, a policymaker can affect the aggregate demand indirectly by influencing the price of credit in the lending in a capital constrained banking sector.[12] The coefficients y_π, y_i, ℓ_ρ, ℓ_y, ℓ_l and β are assumed to be positive, while y_ρ is non-negative.

To simplify the analysis, output is normalised to zero and agents are assumed to have rational expectations, so that expected inflation is zero, but they are unaware of the macroeconomic shocks. In addition, it is assumed that ℓ^d is more sensitive to changes in output than ℓ^s so that output has a positive effect on the equilibrium ρ. This is a sufficient assumption for the model's parameters which guarantees the standardised fact that an aggregate supply shock has a negative effect on inflation.

In this environment, the monetary policy maker is assumed to minimise the standard quadratic loss function as described in the following optimisation problem:

$$\min_{i \text{ or } k} \pi^2 + \lambda y^2 \tag{5}$$

subject to: $(1), (2), (3), (4)$

the market clearing conditions $y = y^d = y^s$ and $\ell^d = \ell^s$.

The policymaker's inflation aversion is captured by $\lambda \in [0, 1)$ and the targeted inflation rate is set to zero for simplicity. Solving the optimisation problem yields the policy rule

$$i = -\left(\frac{y_\rho}{\ell_\rho y_i}\right) k + \left(\frac{y_\pi \lambda \beta - (1 + \theta y_\rho)}{1 + \lambda \beta^2}\right) \frac{\epsilon}{y_i} + \frac{h}{y_i}, \tag{6}$$

where k is treated as a constant and $\theta = (\ell_y - \ell_i)/\ell_\rho > 0$ denotes the sensitivity of the equilibrium ρ to changes in y. Although the effect of h on i is positive as expected, the model's parameters are assumed to satisfy $y_\pi \lambda \beta < 1$ which is a sufficient condition so that an aggregate supply shock leads to a rise in π which in turn requires a negative response of i, in accordance with the standard theory.

There are some interesting implications that are observed from the above policy rule. Firstly, there is perfect substitutability between the two instruments. Indeed, the policymaker can directly affect the economy through the credit channel by setting the policy rate to the desired level, for a given level of k. Alternatively, the policymaker can control the availability of credit in the economy through capital requirements, and consequently the price of credit and affect

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[12] A version of the model with a banking sector that is not capital constrained can be found in Cecchetti and Li (2008).

macroeconomic outcomes though the banks' balance sheet channel for a given i. This is due to the linearity of the above rule in the two instruments which results from the quadratic form of the loss function and the linearity of the model. [13] Therefore, instrument independence does not have any effect on this model as the same welfare outcome can be achieved by either instrument. Notice also that it is only the supply shock that affects macroeconomic outcomes as either instrument can be adjusted to reverse the effects of demand shocks.

From the above optimal policy rule it follows that the inclusion of financial variables in the interest rate rule does not always improve welfare as this depends on the macroeconomic shock. The role of the financial system in this economy is captured by the lending rate which in turn is influenced by the characteristics of the banking sector. For a policymaker that ignores the effect of lending market on macroeconomic outcomes, the interest rate rule is described by equation (6) where $y_\rho = 0$. In this case, a supply shock will also influence y^d through its effect on ρ and will result to an increase in the welfare loss as the instrument does not adjust sufficiently to bring down inflation and output to the optimal levels. In contrast, however, the effect of a demand shock on output is fully neutralised by the adjustment in the policy rate and consequently it has no effect on the banks' balance sheet. As such, the welfare loss resulting from an aggregate demand shock remains the same independently of whether the policymaker considers the influence of the lending rate when setting the instrument under control.

Moreover, the model can be extended to examine the interaction between the two policy transmission channels in attaining the objectives of monetary and financial stability. Although monetary stability is well defined in the literature and commonly described by the loss function in equation (5), the financial stability goal is subject to debate. As credit creation is frequently associated with financial imbalances, popular measures of financial stability that have been introduced in the literature include banks' credit to GDP (see Angelini et al. 2011) and the leverage ratio (see Valencia 2014), where the latter is constant in this simple set up of the financial sector that is consider. Instead, similarly to Curdia and Woodford (2010) and Teranishi (2012) who argue that policymakers should respond to credit spreads as suggested by the empirical findings, financial stability is captured by the deviation of the lending rate from the policy rate.

In this general case, the optimisation problem of a policymaker with two objectives is given by

$$\min_{i \text{ or } k} \zeta(\rho - i)^2 + (1 - \zeta)(\pi^2 + \lambda y^2) \tag{7}$$

$$\text{subject to:} (1), (2), (3), (4)$$

$$\text{the market clearing conditions } y = y^d = y^s \text{ and } \ell^d = \ell^s,$$

where ζ is the weight that is assigned to the objective of financial stability.

The optimal policy rule for a policymaker with two mandates but one available instrument can be derived by solving the above optimisation problem. As capital requirements do not adjust as frequently as the policy rate to steer the economy back to equilibrium due to the uncertainty that it creates on banks' balance sheet, the policymaker is restrained to one instrument. In the extreme scenario where the policymaker values only monetary stability, the optimal policy rule is described by equation (6) whereas if the policymaker values only financial stability, the policy rule indicates that either instrument adjusts such that the lending rate does not deviate from the policy rate. Instrument substitutability is maintained for these extreme scenarios where

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[13] In this case, the capital requirements rule can be obtain by solving for k in equation (6).

the first-best welfare outcome can be achieved. However, when mandates are combined so that $0 < \zeta < 1$, only second-best welfare outcomes are attainable. The resulting welfare loss depends on the policymaker's instrument under control and the macroeconomic shock that disturbs the economy.

Depending on the instrument used, there are two transmission channels of policymaking that interact with each other. One is through the credit channel where a change in policy rate has a direct effect on y and an indirect effect on ρ, and the other channel is through the capital requirements that has a direct effect on ρ and an indirect effect on y. The transmission channels interact in a way that they lessen each others effect on macroeconomic variables. A policymaker that raises the policy rate in response to a shock, reduces inflation and output due to its effect on aggregate demand. However, since loan demand is more sensitive to changes in output than loan supply (i.e. $\theta > 0$), the fall in output results in a fall of the equilibrium lending rate which in turn stimulates the aggregate demand, crowding out some of the initial drop in output. Alternatively, if the policymaker raises capital requirements, the loan supply and consequently the equilibrium lending rate will fall, leading to a reduction in aggregate demand and a fall in output and inflation. As before, the drop in output leads to a reduction in the lending rate which stimulates the aggregate demand and crowds out some of the initial drop in output.

The welfare effect from pursuing both price and financial stability with one instrument depends upon whether the two objectives are conflicting or complement each other for a given policy response. The relationship between the objectives relies on the instrument used and the type of shock the economy experiences. In particular, for an economy that experiences an aggregate demand shock, price and financial stabilisation policies are complementary when the policymaker controls the policy rate, and conflicting when controlling capital requirements. This is because, in response to a positive shock for example, an increase in the policy rate does not only reduce the impact on inflation and output but also reduces the spread between the two rates. However, the extent of the policy rate adjustment depends on the weight that is assigned on each objective. Hence, although the first best outcome is not attainable with a single instrument, control over the policy rate leads to a welfare improvement to both objectives following a demand shock.

In contrast, the direction of adjustment of capital requirements depends on the objective pursued by the policymaker. If a greater weight is placed on price stability, capital requirements should rise in response to the shock in order to bring down inflation and output. However, this results in a further increase in the lending rate and consequently to a greater dispersion between the two rates which deteriorates the financial stability goal. In a similar manner, when the focus is on financial stability, the decrease in capital requirements enhances financial stability by reducing the spread between the two rates. The resulting lower lending rate leads to a further increase in inflation and output and therefore to a greater welfare loss due to monetary instability.

Contrary to the demand shock, when the shock comes from the supply side of the economy, price and financial stabilisation policies are complementary when the policymaker controls banks' capital requirements, and conflicting when controlling the policy rate. The intuition behind this result is the same as above when considering that the supply shock causes inflation and output to move in opposing directions. More specifically, a drop in capital requirements in response to a positive shock for example, leads to a fall in the lending rate which reduces the spread between the two rates and moves inflation back towards its initial value. The extent of the adjustment depends again on the weight that is assigned on each objective. Thus, control over capital requirements leads to a welfare improvement to both objectives following a supply shock.

However, the direction of adjustment of the policy rate depends on the objective that is valued

the most by the policymaker. If a greater weight is placed on price stability, the policy rate should fall in response to the shock to bring back inflation close to the targeted value. However, the fall in the policy rate and the associated increase in the lending rate yields a greater dispersion between the two rates, and therefore a greater welfare loss due to financial instability. In contrast, when the focus is on financial stability, an increase in the policy rate improves financial stability but leads to further deterioration of price stability as it leads to a further fall in inflation.

It is important to note that certain parameters of the model have an important role to play on the complementarity between the two objectives that determine the welfare outcomes. In the case of the aggregate demand shock, although the lending and policy rates move in opposite directions, the loss from financial instability is reduced for any parameter values provided that the aggregate demand is more sensitive to changes in the policy rate than to changes in the lending rate via capital requirements, or $y_\rho < y_i$. It is reasonable to expect that the direct effect of the policy rate is more effective in influencing macroeconomic outcomes as less frictions are involved in the policy transmission. In terms of the aggregate supply shock, the complementarity result is generalised provided that the policymaker is sufficiently inflation averse such that the benefits from pricing stabilisation outweigh the cost of a greater output gap.

4   Empirical Analysis

The empirical analysis has the purpose to investigate the interactions of monetary and financial supervisory institutional arrangements. In particular, we aim at assessing the validity of the conflicting goals argument, by analysing the impact of a combined mandate of monetary policy and banking supervision on inflation rates. We also consider the impact on inflation from other components of the monetary and financial supervisory architecture, namely the degree of independence of central banks, whether they were assigned an explicit inflation targeting mandate, or whether the country has a deposit insurance scheme to protect depositors from bank failures.

Our dataset covers 25 developed countries along the time period from 1975 to 2012. We consider distinct model specifications and use appropriate estimation methods for each type of model specification.

Subsection 4.1 describes the data, subsection 4.2 presents the regression model specifications and estimation results are reported in subsection 4.3.

4.1   Data

We consider annual time series data for 25 OECD countries over the period 1975-2012. The dependent variable is the logarithm of the annual inflation rate while, in addition to the explanatory variables considered in related empirical literature,[14] a number of other regressors is included in the analysis, since we expect they can be also related to inflation.[15] The group of regressors are divided in four categories: institutional, external, economic and banking structure. Descriptive statistics for each one of the variables are presented in the Appendix, together with a summary of the expected impact of each explanatory variable on inflation rates, which can be found in Tables 6.4 and 6.1, respectively.

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[14]See DiNoia and DiGiorgio (1999), Copelovitch and Singer (2008) and Aisen and Veiga (2006).

[15]Table 6.2 in the Appendix provides the definition and data sources for each explanatory variable considered in the econometric analysis.

4.1.1 Institutional Factors

The characteristics of the monetary and financial supervisory architecture in each country are captured by several variables. The main institutional variable incorporated in this study controls for monetary policy and banking regulation institutional arrangements in each country. This variable is referred to as *separate banking supervision* and represents the mandate of each central bank in terms of banking supervision responsibilities and captures its impact on inflation rates behaviour. This is captured by a dummy that takes value of 1 if the function of banking regulation is assigned to an authority independent from the central bank, and value of 0 if banking supervision is a central bank's responsibility (the latter case refers to a *combined* institutional arrangement).[16] The classification of countries into these two groups (i.e. *separate banking supervision* or *combined mandate*) is based on information disclosed in the Bank Regulation and Supervision Surveys (updated June 2008 and 2012) provided by the World Bank, which collects information regarding the main aspects of regulation and supervision from supervisory authorities located in 143 jurisdictions for the years 2008 and 2012.[17]

Data is complemented with other information sources. We consulted Copelovitch and Singer (2008)'s classification and in the cases for which there was uncertainty about the type of mandate, the central banks and supervisory agencies websites were also employed for cross-check. The survey by Courtis (2011) on international supervision arrangements was also useful to confirm our previous classifications. Still, there are some countries for which a clear-cut separation of banking supervision responsibilities is difficult to undertake.

Table 1 shows the evolution of inflation rates and the institutional arrangements in the 25 countries included in our sample along the period 1975-2012. Over the sample period, inflation rates decreased substantially: in 1975, the global sample inflation was 13.5% on average, continuously falling during the 1980's and the 1990's, and stabilising around 2% in the 2000's (i.e. in 2012 the country average inflation was 2.2%).

According to our classification, banking supervision responsibilities were assigned to the central bank in 17 OECD countries in 1975, whereas only 8 countries preferred to allocate this responsibility to an independent authority. This distribution remained stable until the late 1990's, a period from which it is observed an increase in the number of countries that have opted to separate banking supervisory responsibilities from the central bank. In the early 2000's, there was a balance in this sample between countries with separate institutional arrangements of banking supervision and monetary policy (12) and countries with combined mandates (13). In the

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[16]Note that the variable *separate banking supervision* does not account for whether a separate banking supervision also oversees securities markets and / or insurance companies. The classification only captures the allocation (or exclusion) of banking supervision to central banking responsibilities. The classification of countries in terms of *separate* and *combined* institutional mandates is presented in Table 1 in Appendix B. For the euro area Member States, we consider a combined banking supervision regime after their entrance in the European Monetary Union, in 1999 (except for Greece which joined the European Monetary Union in 2001), due to the fact that national central banks are part of the Euro system, which also comprises the European Central Bank, responsible for the conduct of monetary policy. It can also be argued, though, that the European Monetary Union should be treated as a separate mandate, given that monetary policy is centralised in the European Central Bank. We perform a sensitivity analysis to assess for the latter case, in which we assume a separate institutional mandate between monetary policy and banking supervision, whenever the national central bank is in charge of supervisory responsibilities. The estimation results do not change substantially and are shown in Appendix B, Tables 6.9 and 6.10.

[17]This classification is based on the answers given by the countries in this sample to questions 12.1 of the World Bank survey for 2008 utilized by the authors to compile the dataset. The questions are stated as follows: in the 2008 survey, "What body or agency supervises banks?", or, in the 2012 update, "What body/agency supervises commercial banks for prudential purposes?".

Table 1: Mandates of banking supervision and average inflation for 25 countries

Year	Separate Bank. Superv.	Combined Mandates	Inflation Rate (average)
1975	8	17	13.5%
1980	8	17	13.4%
1985	7	18	8.0%
1990	7	18	6.1%
1995	7	18	3.3%
2000	12	13	2.5%
2005	14	11	2.1%
2010	13	12	2.0%
2012	11	14	2.2%

2000 decade, the number of countries with separate banking supervision mandates outpaced the number of countries with combined regimes, reaching a peak of 14 countries out of 25 from 2003 to 2009. After the onset of the financial crisis of 2007/2008, and as a response to it, some countries reformed their institutional settings of banking supervision towards its allocation to the central bank. This tendency is already to some extent reflected in 2012 figures, which illustrate a decrease in the number of countries with separate banking supervision mandates, from 14 in 2009 to 11 in 2012.

This can be considered a rich dataset in the sense that it covers a sufficiently wide time span to allow for some of these countries to change their institutional mandates of banking supervision more than once. This is the case for Ireland which reviewed its banking supervisory institutional arrangement in 2003 and again in 2010, after the subprime crisis, and Luxembourg, which changed its supervisory mandate in 1983 and 1999. Iceland and the United Kingdom also have recently reformed their supervisory arrangements for the second time since 1975, but since their entering into effect was in 2013 and 2014 respectively, these changes are not covered by our database. For the remaining countries, there is a predominance of jurisdictions that never changed their supervisory arrangements (16 out of 25) from 1975 to 2012 and only 5 introduced reforms during this period.

There is a large literature following Cukierman et al. (1992) claiming that the degree of independence of the central bank (thereafter CBI) has a significant negative impact on inflation outcomes. Accordingly, it is expected that a country with a higher degree of central bank independence will also experience lower average inflation rates. The CBI variable used in this study is based on the work of Arnone et al. (2007) who update the Cukierman et al. (1992) and Grilli et al. (1991) measures for central bank political and economic autonomy. Political autonomy is interpreted as the power of central banks to define and implement monetary policy, whereas economic autonomy evaluates the central banks operational independence. Following the literature, we assume that CBI measures computed in the late 80's do not vary until 2003, the year for which Arnone et al. (2007) update the index.[18]

The insurance of bank deposits is another common pillar of the financial supervisory architecture. Deposit insurance systems are considered necessary for the stability of the financial system and

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[18] As CBI measures are usually computed for specific periods of time, researchers circumvent the problem of using a CBI index in panels by considering that CBI measures do not change significantly across time. We built the dataset based on the same assumption.

the protection of depositors. In 1933, the United States was the first country to establish a national deposit insurance system, but it was only over the last quarter of the twentieth century that explicit deposit insurance has spread across countries, rising from 12 in 1974 to 71 in 1999 (Demirguc-Kunt and Kane (2002)). Currently, most OECD countries and an increasing number of developing countries feature some sort of explicit depositor protection.

A country with an explicit deposit insurance scheme that provides depositors with protection from losses in the event of a bank failure will experience lower average inflation rates. This is because the central bank can be aggressive on its inflation mandate as it is less concerned about the effect of interest rates on banking stability (Copelovitch and Singer (2008)). In our dataset, the deposit insurance variable takes value of 1 for countries with explicit deposit insurance and of 0 otherwise. The classification uses information from the World Bank Deposit Insurance Around the World Dataset, from 1975 to 2003, and from the International Association of Deposit Insurers (IADI), for the remaining years.

To account for the effects of inflation targeting on inflation behaviour, a dummy variable is introduced taking the value of 1 at the year that a country adopted inflation targeting and onwards,[19] and the value of 0 in the remaining cases based on Roger (2010)'s classification. Since this approach pursues an explicit public commitment to control inflation as the principal policy goal, we expect that a country that has adopted inflation targeting will experience lower inflation rates.

In addition, we include a "Great Moderation Period" dummy variable to control for the persistent decline of inflation rates (and their volatilities) in the developed world since the early 1980's. The breakpoint is 1984, according to McConnell and Perez-Quiros (2000), the year from which we consider the beginning of the great moderation period. We build a dummy that takes value of 1 from 1984 until 2007, when the crisis started. The remaining years covered in the dataset are assigned a value of 0. We also condition our inflation estimations on an exchange rate regime variable that takes value of 1 for all varieties of "hard" fixed exchange rates and 0 for floating or managed floating regimes. Data are based on the International Monetary Fund classification by Ilzetzki et al. (2008). Finally, in what institutional factors are concerned, euro membership is included to control for the euro area countries' specific monetary policy mandate and it takes the value of 1 from 1999 onwards for the euro area member countries, except for Greece that entered the European Monetary Union two years later (2001).

4.1.2 External and Economic Factors

In order to capture the impact of external factors on inflation outcomes, we consider the following explanatory variables: trade openness, capital account openness and oil imports as percentage of GDP. Trade openness is measured as the sum of imports and exports as a percentage of GDP and data are taken from the Comparative Political Dataset (1960-2011). An inverse relation between trade openness and inflation is expected as more open economies benefit from lower inflation, on average. According to Romer (1993), the degree of openness of the economies affects inflation through two different channels. First, a more closed economy has a higher incentive to engage in surprise inflation since its impact on the real depreciation is less costly,

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[19] In our sample, the countries that use inflation targeting are New Zealand (since 1990), Canada (since 1991), United Kingdom (since 1992), Sweden (since 1993), Australia (since 1993), Iceland (since 2001) and Norway (since 2001). Finland and Spain adopted inflation targeting, in 1993 and 1995 respectively, but abandoned it when they entered the in 1999.

given that the fraction of imported goods is lower in this economy.[20] Second, openness affects the output-inflation trade-off: for a given increase in output, the rise in domestic prices will be higher as more open the economy is, given the exchange rates disciplining effect. Thus, monetary policymakers incentives to engage in expansionary policies are lower in more open economies, and therefore inflation is expected to be smaller. There is a broad empirical support for this view, in which a strong and robust negative impact of openness on inflation outcomes is shown to be present.

Capital account openness is measured using the Chinn-Ito index, developed in Chinn and Ito (2008) for the period ranging from 1970 to 2012.[21] This index accounts for restrictions on capital account transactions, current account transactions, requirements of the surrender of exports proceeds and the presence of multiple exchange rates. Similarly to trade openness, empirical evidence shows a negative relationship between financial openness and inflation (Gruben and McLeod, 2002; Gupta, 2008). For oil import countries, we expect that oil prices will have a positive effect on inflation. The data for the value of oil imports is from the World Economic Outlook Database, published by the International Monetary Fund. We consider the oil imports as percentage of national GDP, to account for the different dimensions across countries.

To account for the effect of economic conditions on inflation, we include as regressors the output gap, currency and banking crisis. Output gap measures the difference between the actual level of national output and the estimated potential level. A positive output gap implies upward pressures on inflation. Currency and banking crisis are dummy variables that take value of 1 whenever the country is experiencing a currency or a banking crisis.[22] The impact of banking crisis on inflation depends to a certain extent on the monetary stance that can be maintained during a crisis and whether inflation is kept as the primary policy objective (Garcia-Herrero (1997)). Currency crisis, on the other hand, may have inflationary consequences.

4.1.3 Banking Sector Factors

In order to capture the possible influence on inflation outcomes of the characteristics of the banking system in each country, we control for the size of the banking system, which is measured by domestic credit over GDP. In our sample of industrialised countries, there is significant variation in the size of the banking systems. While the weight of the banking system in the total economy has an average around 85%, the variation across countries ranges from 15% to 311% (see Table 6.4, in appendix).

As argued by Copelovitch and Singer (2008), central banks with regulatory powers may be more concerned with banking stability when facing a large banking system relative to the overall size of the economy, due to the reputation costs stemming from bank distress. In institutional frameworks in which central banks are also in charge of banking supervision, a large banking system may aggravate the inflation bias - therefore, we may expect the size of the banking system to have a positive impact on inflation outcomes, since when the banking system contributes to a

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[20]In these models it is assumed that domestic and foreign goods are not perfect substitutes.

[21]The Chinn-Ito index is taken from the Comparative Political Dataset (1960-2009).

[22]Banking crisis data is based on Glick and Hutchison (1999), except for Australia and USA, for which data comes from Caprio and Klingebiel (2003). For the remaining years (2000-2010), data comes from Laeven and Valencia (2008). Currency crisis data is based on Glick and Hutchison (1999), except for Australia and USA, for which the data comes from Laeven and Valencia (2008). For the time span 2000-2010, data comes from Laeven and Valencia (2008).

larger share of the domestic economy, central banks may fear to a greater extent the monetary policy effects on bank stability.

4.2 Model Specifications

The following panel data regression model is adopted to estimate the relationship between inflation rates and institutional arrangements of banking regulation and supervision:

$$\pi_{i,t} = \beta_0 + \beta_1 separate\_sup_{i,t} + \lambda X_{i,t} + \nu_i + u_{i,t}, \tag{8}$$

where $\pi_{i,t}$ is the (log) inflation rate for country i in year t, $separate\_sup_{i,t}$ is a binary variable that takes value of 1 if the country is classified as having a separate banking supervision at time t and value of 0 otherwise, $X_{i,t}$ is a vector of control variables, as described in the previous subsection, ν_i accounts for unobserved country specific effects and $u_{i,t}$ is the error term.

We consider three alternative specifications of this model. Model 1 is a simplified form version of model in equation (8), in which the vector of controls is not included, keeping only the variable of interest, $separate\_sup_{i,t}$. Model 2 is the regression model in equation (8), Models 1 and 2 are called hereafter static panel data models. Model 3 is an extension of Model 2, allowing for the study of inflation dynamics, by adding to the vector of regressors the one period lagged inflation:

$$\pi_{i,t} = \beta_0 + \beta_1 separate\_sup_{i,t} + \beta_2 \pi_{i,t-1} + \lambda X_{i,t} + \nu_i + u_{i,t}, \tag{9}$$

The inclusion of lagged inflation as an independent variable is motivated by a strand of the literature regarding a hybrid version of the Phillips curve, in which inflation depends on a combination of expected future inflation and lagged inflation.[23] The lagged inflation term in the hybrid Phillips curve has the purpose of capturing inflation persistence. As pointed out by Gali and Gertler (1999), empirically, the hybrid Phillips curve provides a good characterization of inflation dynamics at the annual frequency.

We suggest the use of annual panel data, with a time-series dimension (T = the number of years) of 38 years, from 1975 to 2012, and a cross-section pool (N = the number of countries) of 25 advanced countries, which allows to capture the richness of the dynamics of many variables, while simultaneously integrating cross-country heterogeneity in the means of the dependent variable. Nonetheless, given that in panel data is highly likely that country-specific characteristics (such as cultural factors, geographic location, language, etc.) are correlated with the explanatory variables[24], we resort to panel data estimation with fixed effects,[25] using heteroskedasticity-robust standard errors.[26] Fixed Effects is an estimation method that deals directly with this source of correlation, by applying a means-deviation transformation to each variable, in which the mean is computed at the country level. This transformation rulls out the unobserved individual effect

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[23]See Gali and Gertler (1999) for an overview of the Phillips curve literature, from the traditional version to the hybrid approach.

[24]Namely with the variable of interest in this analysis, which refers to the *separate banking supervision*, since, as already mentioned, the institutional arrangements of banking supervision are influenced by the Anglo-saxon and the German traditions.

[25]Random effects, on the other hand, assume that the unobserved individual effects are uncorrelated with the observed exogenous variables.

[26]In terms of estimation methods, previous studies, such as DiNoia and DiGiorgio (1999) and Copelovitch and Singer (2008), adopt pooled Ordinary Least Squares with corrected standard errors.

from the original model and, in consequence, it enables to obtain coefficients on the regressors that do not suffer from bias due to the omission of relevant individual attributes.

With respect to Model 3, the dynamic panel data version of model 8, the inclusion of the lagged dependent variable $\pi_{i,t-1}$ in a model with unobserved individual-specific time-invariant effects turns the OLS estimator inconsistent, since the error term is positively correlated with the explanatory variable $\pi_{i,t-1}$ (Arellano and Bond (1991)). This correlation does not disappear as the number of individuals in the sample gets larger. Moreover, the Fixed Effects estimator is also generally inconsistent, namely in the case when N tends to infinity and T is fixed, because of the problem of incidental parameters (Nickell (1981)). However, contrary to the OLS estimator, the Fixed Effects estimator becomes consistent when both T and N tend to infinity.

On the other hand, the Arellano-Bond estimator is a dynamic panel data estimator with the advantage that is designed to fit linear functional relationships with a dependent variable that depends on its own past values, additional independent variables, fixed individual effects and heteroskedasticity and autocorrelation within individuals but not across them (Roodman (2009)). In addition, it is a more appropriate estimator for short, wide dynamic panels (i.e. small T, large N type of panel datasets). Arellano-Bond estimator (also known as Arellano-Bond difference GMM estimator) thereby corrects those problems by first-differencing all regressors to eliminate ν_i (i.e. unobserved country specific effects) and produce an equation estimable by instrumental variables:

$$D.\pi_{i,t} = \beta_0 + \beta_1 D.separate\_sup_{i,t} + \beta_2 D.\pi_{i,t-1} + \lambda D.X_{i,t} + D.u_{i,t}, \tag{10}$$

where D stands for the first-difference operator and the variables and parameters are defined as in equation (9).

Dynamic panel data estimators do not assume that good instruments are available outside the immediate dataset. Instead, they assume that the only available instruments are internal – based on lags of the instrumented variables.[27] The Arellano-Bond estimator uses as instruments the levels of the dependent variable lagged two or more periods, the levels of endogenous variables, the lagged two or more periods and the first differences of the strictly exogenous regressors, which are used as their own instruments.

In the case we assume that the explanatory variables are not correlated with the individual effects, there are more moment conditions that can be used as instruments for the levels equation, such as the lagged differences of the covariates and of the dependent variable (see Arellano and Bover (1995)). The Arellano-Bond difference GMM estimation is thereby augmented by estimating simultaneously two equations, one in differences and another in levels, which are distinctly instrumented, originating the system GMM estimator. As shown by Blundell and Bond (1998), this system GMM estimator is more suitable than that of Arellano-Bond estimator when the dependent variable and / or the independent variables are persistent.

Both difference and system GMM estimators are more adequate for small T, large N samples, while the Fixed Effects estimator is suitable for a dynamic panel data when we have a sample with large T and small N type of panel data, because the panel data bias tends to disappear as the T component expands. Taking into account that our panel dataset features a T=38 and N=25, it can be considered one with large T and small N type of panel data, Fixed Effects estimator seems to be more adequate to estimate the dynamic version of the model.

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[27] Nonetheless, they allow for the inclusion of instruments from outside the dataset.

Against this background, considering the features of a dynamic panel data model and recognizing the unsuitability of the OLS estimator for these type of models, we opt to estimate the dynamic panel data model specification (Model 3) using both Fixed Effects and Arellano-Bover estimators.

4.3   Estimation Results

4.3.1   Static Panel Data Models

The regression results based on the estimation of Model 1 and Model 2 for the period 1975-2012 are presented in Table 2, which are, respectively, the reduced and the full versions in equation (8). The estimation procedure for both models follows the Fixed Effects estimator. F test and Wald Chi^2 statistics for the global statistical significance are also reported.

Table 2: Estimation Results (1975-2012)

Dependent Variable: (log) inflation	Model 1 Fixed Effects	Model 2 Fixed Effects
Constant	0.606***	0.966***
	(0.031)	(0.130)
Separate Banking Supervision	-0.229**	−0.036
(1 = Yes)	(0.083)	(0.052)
Inflation Targeting	-	-0.165**
(1 = Yes)		(0.065)
CBI	-	-0.130
(index)		(0.097)
Deposit Insurance	-	-0.117**
(1 = Yes)		(0.056)
Exchange Rate Reg.	-	-0.052
(1 = fixed)		(0.048)
euro area Member	-	-0.008
(1 = Yes)		(0.047)
Time	-	-0.019***
(1 = 1975; ... 38 = 2012)		(0.004)
Great Moderation Period	-	-0.133***
(1 = 1984-2007)		(0.041)
Domestic Credit	-	0.001**
(% of GDP)		(0.000)
Output Gap	-	2.428***
		(0.654)
Banking Crisis	-	-0.011
(1 = Yes)		(0.046)
Currency Crisis	-	0.049
(1 = Yes)		(0.064)
Trade Openness	-	0.003**
		(0.002)
Capital Account Openness	-	-0.073***
		(0.021)
Oil imports	-	2.245**
(% GDP)		(0.931)
Observations	961	639
No of Countries	25	24
F Test / Wald Chi2 Test	7.65***	171.15***
(global significance)	(1, 24)	(15, 23)
R squared (within)	0.02	0.56

$^*p \leq .10; ^{**}p \leq .05; ^{***}p \leq .01$

Robust standard errors are in brackets.

Focusing first on the institutional factors of inflation dynamics and starting with the estimation results obtained for the variable *separate banking supervision,* we observe that it is statistically

significant in the reduced form of the model (Model 1) in accordance with DiNoia and DiGiorgio (1999) and Copelovitch and Singer (2008) findings. However, this result does not subsist when we control for more explanatory variables (Model 2), including the remaining institutional factors. Estimation results of Model 1 suggest thereby that, at a first glance, it seems to exist an inflation bias, as advocated by the conflicting goals thesis, but it tends to disappear when other factors are controlled for, as in Model 2.

These findings are robust to alternative specifications of the variable *separate banking supervision*, namely for i) countries for which doubts concerning the classification of the institutional mandates were raised (this was the case of Australia, Austria, Denmark and Finland), and ii) countries which joined the euro area. As an alternative option, for this latter group it was assumed that the institutional arrangement is separate from the moment it joined the euro area, regardless of the central bank having or not supervisory powers. This assumption is based on the argument that the conduct of monetary policy in the euro area was centralised within the European Central Bank, leaving the national central banks powerless in this regard.[28] Estimation results obtained under this sensitivity analysis are reported in Appendix 6.4.

Regarding the other components of the monetary and financial supervisory architecture, our findings from the estimation of Model 2 show that inflation targeting countries benefit from lower inflation rates than countries that do not pursue this specific type of monetary policy mandate. The explanatory variable inflation targeting is statistically significant and it has an estimated impact on inflation rates of approximately -15%.[29] By the same token, according to our results, a country with an explicit deposit insurance scheme will have inflation rates that are on average -11% lower than a country without deposit protection, all else equal. The other institutional variables, such as central bank independence and exchange rate regimes, appear to have had a less significant effect on inflation outcomes.

In particular, it is worth discussing in more detail the results for central bank independence. There is a vast literature investigating the impact of central bank independence on inflation rates which highlights its role on determining inflation outcomes. Although early studies indicate a significant negative effect of CBI on inflation rates (Grilli et al., 1991; Cukierman et al., 1992), recent empirical work fails to find a strong impact (Mangano, 1998; Crowe and Meade, 2007). Our findings are in line with studies that do not find a strong relationship between central banks inepedence and inflation. Estimation results show that, although central bank independence enters the regressions with the expected negative sign, it is not statistically significant in explaining inflation outcomes.

The CBI variable used in our analysis is based on the work of Arnone et al. (2007), which update a *de jure* measure of independence (following Cukierman et al. (1992)) and it assesses regulations only. As suggested by Cukierman et al. (1992), *de facto* measures of central bank independence are also important to assess how regulations work in practice. Our results seem to suggest that the degree of legal independence *per se* is not sufficient to guarantee a significant negative impact on inflation outcomes. The lack of significance of central bank independence may be due to measurement issues (given that it does not address how regulations are implemented),

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[28]With the creation of the Single Supervisory Mechanism (SSM) in 2013, which conferred banking supervisory powers upon the European Central Bank, additional issues regarding the classification of the euro area countries in terms of their banking supervisory mandates will be raised. The SSM Regulation empowers the ECB to supervise the significant banks in each Member State, but the responsibility to supervise the less significant banks is still under in the national supervisory authorities domain.

[29]Since the dependent variable in our model is the log of inflation, the coefficients of dummy variables should be read as $e^{\hat{\beta}} - 1$.

which perhaps could lead to a theoretical reconsideration of the association between central bank independence, the banking structure and inflation.

Explanatory variables such as output gap, size of the banking system as percentage of GDP and great moderation period are also statistically significant and the estimated coefficients enter the regression with the expected sign. Furthermore, our results suggest that a more open economy in terms of trade and capital flows has a statistically significant impact on inflation rates, all else equal. The results for the degree of capital account openness are consistent with previous empirical evidence by Gupta (2008) and consistent with Copelovitch and Singer (2008), since they also observe a negative significant effect of capital account openness on inflation rates. As for the degree of trade openness, results suggest a positive significant impact on inflation outcomes, which contradicts previous empirical findings (see, for instance, Romer (1993)), in which a negative significant impact is reported. The effect on inflation rates of the weight of oil imports in GDP is also statistically significant, implying that, in sum, external factors have an important role in determining inflation behaviour.

The positive (although modest in magnitude) statistically significant impact on inflation rates of the size of the banking system relative to the economy suggests that countries characterised by large banking sectors experience, on average, higher inflation rates than countries in which the banking sector is small. According to these findings, banking system features may be relevant determinants of the regulatory central bank's bias.

As such, it would be interesting to empirically explore further this result in future analysis, not only by considering the size of the banking sector, but also its degree of concentration and how these features may impact on the transmission channels of monetary policy and influence inflation outcomes. There are two distinct views in the literature concerning the impact of banking concentration on the monetary policy transmission mechanism. The more common perspective states that higher concentration implies less competition, hence higher profitability due to greater interest margins between deposits and loans, and therefore a less efficient transmission mechanism of monetary policy to the real economy. In this case, we would expect higher bank concentration measures to lead to higher levels of inflation. Alternatively, the efficient-structure theory (Demsetz, 1973) argues that cost-efficient banks could drive cost-inefficient banks out of the market and increase their market share, which would lead to higher concentration and greater profitability. In this case, profitability is generated due to cost efficiency and the transmission of monetary policy is not affected as interest margins remain unchanged. Therefore, according to this approach, a higher degree of concentration in the banking industry would lead to lower inflation rates.

Finally, results suggest that the remaining explanatory variables, such as the ones that control for the occurrence of currency and banking crisis, appeared to have had a less significant impact on inflation in industrialised countries. This finding may be related to the fact that the occurrence of banking and currency crisis is not very frequent along the period from 1975 to 2012 in our sample. Industrialised countries, such as the ones included in our database, have more mature banking systems and economies, and, as such, they are not so prone to be affected by banking and currency crisis as emergent or less developed economies.

In summary, estimation results of the static panel data models suggest that the design of monetary and financial supervisory architectures has a non-negligible influence on inflation rates in industrialised countries. Inflation rates are affected by institutional features, such as inflation targeting and deposit insurance, but not by the institutional mandates of monetary policy and banking supervision. Other factors, such as the degree of openness of the economy or economic

developments are also important determinants of inflation behaviour.

4.3.2 Dynamic Panel Data Model

Table 3 reports the estimation results for the dynamic panel data model in equation 9, obtained from using both Fixed Effects and Arellano-Bover estimators. The main conclusion is that the estimation results obtained for the static version of the model (Model 2) are fully supported by the estimation results for the dynamic panel data version (Model 3), particularly in what regards the lack of evidence of a significant impact of the institutional arrangements of banking supervision and monetary policy on inflation outcomes.[30] Estimation results confirm, though, that one year lagged inflation is statistically significant in explaining current inflation behaviour and it has, as expected, a positive impact on inflation, providing empirical support to the hybrid version of the Phillips curve, to a certain extent.

Institutional factors such as deposit insurance schemes, belonging to the euro area, the exchange rates regime or even inflation targeting practices do not reveal empirical evidence of their influence on inflation rates. Exception is made to the independence of central banks, which has a significant impact on inflation when a dynamic panel data model is considered.

External factors such as oil imports as percentage of GDP and the degree of capital openness have a statistically significant impact on inflation. This result is robust in the sense that it holds across different model specifications. The same is observed for the output gap: its impact on inflation is positive, as expected according to the Phillips Curve theory, and very strong. The negative influence of the great moderation period on inflation outcomes is also statistically significant according to the dynamic panel data estimation results.

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[30]This finding holds even in the case we consider raw inflation as the dependent variable (instead of the logarithm of inflation). We have performed the estimation of Models 1-3 assuming an alternative measure of inflation rates, and we employed the same estimation procedure. Results obtained in this robustness test stress the lack of statistical significant of the variable *separate banking supervision* also in this model specification. Estimation results are available upon request.

Table 3: Estimation Results (1975-2012)

Dependent Variable:	Model 3	
(log) inflation	Fixed Effects	Arellano-Bover
Constant	0.554***	0.783***
	(0.089)	(0.134)
Lagged Inflation (t-1)	0.356***	0.384***
	(0.048)	(0.095)
Separate Banking Supervision	−0.012	−0.039
(Yes = 1)	(0.050)	(0.028)
Inflation Targeting	−0.102**	0.023
(1 = Yes)	(0.040)	(0.046)
CBI	−0.132*	−0.117**
(index)	(0.062)	(0.054)
Deposit Insurance	−0.085*	−0.019
(1 = Yes)	(0.041)	(0.035)
Exchange Rate Reg.	−0.029	−0.025
(1 = fixed)	(0.024)	(0.023)
Euro area member	-0.033	0.058
(1 = Yes)	(0.028)	(0.039)
Time	-0.012***	−0.008***
(1 = 1975; ... ; 38 = 2012)	(0.002)	(0.003)
Great Moderation Period	-0.101***	−0.091***
(1 = 1984-2007)	(0.030)	(0.036)
Domestic Credit	0.001*	−0.000
(% of GDP)	(0.000)	(0.000)
Output Gap	2.653***	1.986***
	(0.501)	(0.638)
Banking Crisis	-0.010	0.011
(1 = Yes)	(0.033)	(0.027)
Currency Crisis	0.040	−0.007
(1 = Yes)	(0.061)	(0.049)
Trade Openness	0.004***	−0.001
	(0.001)	(0.001)
Capital Account	−0.039***	−0.087***
Openness	(0.002)	(0.022)
Oil imports	1.613*	1.556**
(% GDP)	(0.808)	(0.707)
F Test / Wald Chi2 Test	624.14***	3228.20***
(global significance)	(16, 23)	(16)
Sargan Test (p-value)	-	0.325
AR(2) (p-value)	-	0.887

$^{*}p \leq .10$; $^{**}p \leq .05$; $^{***}p \leq .01$

Notes: Observations: 623; No. countries: 24 and 22, respectively. For Fixed Effects estimations, robust standard errors are in brackets. Arellano-Bover estimations based on twostep system-GMM, using robust standard errors corrected for finite samples (using Windmeijer's correction). Since Output Gap can be affected by inflation, it was treated as endogenous. As done for lagged inflation, its lagged values two and three periods were used as instruments in the first-difference equations and its once lagged first differences were used as instruments in the levels equations. In total, 21 instruments were used.

4.3.3 Robustness checks

So far, we have reported some results from of the robustness analysis, such as the consideration of alternative specifications of the variable *separate banking supervision*, to control for situations such as countries in which the institutional mandates of monetary policy and banking regulation are characterised by the sharing of powers in what banking regulation is concerned, or for countries that joined the euro area, making the classification into separate or a combined regimes less obvious. Our estimation results were robust to these alternative classifications of countries' institutional arrangements.

As an additional robustness check, the estimation of the three models was undertaken for the period from 1975-2007, a time span that does not include the financial crisis period which begun in 2008, and captured in full the so-called 'Great Moderation' period, which corresponded to an economic environment characterised by lower levels and volatility of inflations rates, coupled with stable growth and low unemployment. Appendix 6.4 - Robustness Checks, Tables 6.12 and 6.13 presents the estimation results.

Results are consistent to the ones obtained for the larger sample period, which covers normal times and the onset of the financial crisis, both for static and dynamic specifications of the annual panel data model. In what regards the institutional factors, results show that the variables inflation targeting and explicit deposit insurance schemes have negative and statistically significant impact on average inflation rates. According to these results, the separation of banking supervisory powers from the central bank is not an institutional determinant of low inflation rates in industrialised countries.

5   Conclusions

The paper aims at investigating the implications of different designs of the monetary and financial supervisory architecture on the inflation rate outcomes. In particular, the paper empirically examines if monetary policy and banking regulation have conflicting goals by assessing whether institutional mandates in which the central bank with a banking supervisory mandate has, on average, led to higher inflation rates than a separate regime. In addition, we consider the impact on inflation from other components of the monetary and financial supervisory architecture, namely the degree of independence of central banks, whether they were assigned an explicit inflation targeting mandate, or whether the establishment of deposit insurance systems with the view to enhancing financial stability by protecting deposits may influence the monetary policy stance.

This conflicting goals argument in favour of the separation of policy mandates states that a central bank responsible for banking regulation will be more flexible in its inflation mandate if it is concerned with the impact of tight monetary conditions on bank's profitability and soundness (Goodhart and Schoenmaker, 1993, 1995). Under these circumstances, it is likely that the flexibility in guiding monetary policy will lead to higher inflation rates. We build a panel data set comprising 25 OECD countries from 1975 to 2012 and we specify a regression model to explain the effect of a separate mandate of banking supervision on the inflation rate. We consider additional regressors to control for other possible determinants of inflation rates.

Our analysis differs from other studies in three ways. First, we have expanded the time span of the sample (while maintaining the same group of countries under scrutiny); second, we adopt

more appropriate estimation methods to deal with country specific effects and their correlation with the explanatory variables; and third, we consider additional explanatory variables to control for the effect on inflation rates, such as of inflation targeting practices, oil imports over GDP, and output gap, among others. We have also performed a battery of robustness tests, which supported the main conclusion of this study.

Estimation results for both static and dynamic panel data specifications show that the separation of banking supervision from the central bank does not have a statistically significant impact on inflation. In this sense, the conflicting goals argument against a monetary and financial supervisory architecture in which the central bank has a supervisory role is not supported by our empirical findings. Indeed, these results contradict previous empirical evidence (see, as examples, DiNoia and DiGiorgio (1999) and Copelovitch and Singer (2008)). A possible explanation may lay in the argument that, even in institutional mandates in which central banks do not have supervisory powers, they may still be concerned with the stability of the banking system, since distress in the banking sector may disrupt the bank transmission channels of monetary policy, impairing its effectiveness. Being this the case, central banks with a price stability mandate may guide their monetary policy decisions also by attending to their impact on the banking system.

Although the allocation of banking regulation and supervision inside or outside the central bank does not seem to be relevant in determining inflation rates, our findings indicate that there are other features of the monetary and financial supervisory architecture that may play a role in maintaining inflation rates in low levels, thereby contributing for the stability of the economy. On one hand, results underline the importance of the establishment of deposit insurance schemes in determining lower levels of inflation rates. In fact, the central bank can be more aggressive in their inflation mandate when deposits are protected, in a large extent, by these insurance systems. Therefore, our results suggest that deposit insurance schemes can be seen not only as an important institutional pillar in fostering financial stability, but also in contributing to attaining the goal of price stability.

Another institutional feature related to low levels of inflation is the adoption of inflation targeting mandates. Curiously, central bank independence does not arise as an indicator of low inflation rates, even though there is an extensive literature suggesting its important effect on this macroeconomic variable. This result might be explained by the use of imperfect measures of the degree of independence of central banks (Posso and Tawadros (2013)). Finally, economic factors, such as trade openness and capital account openness have also strong effects on inflation behaviour, but the output gap stands out in terms of the magnitude of its impact on inflation.

Policy implications are that, given our empirical findings, the 'conflict of interests' argument should not be considered a major obstacle when designing the institutional architecture of banking supervision and monetary policy in developed countries. Other concerns, such as 'reputation risks' and 'organisational costs', may pose higher challenges for central banking than the 'conflict of interests effect'. Recent reforms to assign an explicit financial stability mandate to monetary authorities may imply new sources of conflicts with monetary policy - see Smets (2014) for a review of potential conflicts and a discussion on the optimal institutional arrangements of macroprudential and monetary policies.

In this new institutional and supervisory environment in which central banks have price and financial stability mandates, the most important challenge for central banks is to avoid that severe disruptions in the banking system or regulatory capture by the banking industry damage

its reputation as a monetary policymaker. In order to accomplish such an outcome, Smets (2014) suggests that price stability remains as the ultimate goal for central banks, while the objective of financial stability should lay under the primacy of stability of prices.

Future research should be focused on understanding the economic circumstances in which these conflicts are more likely to arise, taking into account the interactions of monetary, macroprudential and microprudential policies. In addition, deeper knowledge is needed on the influence of each institutional component of the financial and monetary architecture in promoting the stability of macroeconomic aggregates.

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6 Appendix

6.1 Variables: definitions, expected impact on inflation and sources

Table 6.1: Variables' description and expected impact on inflation

Variables	Description	Exp. Impact on Inflation
Institutional Factors		
Separate CB	Yes = 1	−
CBI	Central Bank Independence Index	−
Inflation Targeting	Yes = 1	−
Great Moderation	1975-83 & 2008-12 = 0; 1984-2007 = 1	−
Deposit Insurance	Yes = 1	−
Exchange Rate Regime	Fixed = 1	+
Euro Membership	Yes = 1	?
External Factors		
Trade Openness	Index	−
Capital Accounts Openness	Chinn-Ito Index	−
Oil Imports (% GDP)	Controls for oil importing countries	+
Economic Factors		
Output Gap	Controls for economic growth	+
Banking Crisis	Yes = 1	+
Currency Crisis	Yes = 1	+
Banking Structure Factors		
Domestic Credit (% GDP)	Controls for the banking sector size	−

Table 6.2: Variables - Sources and Definitions

Variables	Sources and Definitions
Inflation Rate (log)	World Economic and Financial Surveys, World Economic Outlook database April 2003 (site IMF). Inflation (consumer prices; index and annual percent change). Data for inflation are averages for the year, not end-of-period data. The index is based on 1995=100.
Separate Banking Supervisor	DiNoia and DiGiorgio (1999); Copelovitch and Singer (2008); World Bank - Banking Regulation Survey 2000 and 2008; Central Banks and Banking Supervisors webpages for the years missing. Dummy=1 if a country has separated mandates for monetary policy and banking regulation/supervision.
Output Gap	Output gap is calculated by applying the HP filter to GDP at constant prices. GDP is obtained from World Bank (2011): World Development Indicators (Edition: September 2011). ESDS International, University of Manchester. GDP (constant LCU): GDP at purchaser's prices is the sum of gross value added by all resident producers in the economy plus any product taxes and minus any subsidies not included in the value of the products. It is calculated without making deductions for depreciation of fabricated assets or for depletion and degradation of natural resources. Data are in constant local currency.
Central Bank Independence Index	Data on CBI are based on Cukierman et al. (1992)'s methodology for calculating legal independence and are compiled from the Comparative Political Dataset for the period 1975-1996 (Armingeon et al., 2011) and Polillo and Guillén (2005) for the remaining yearsCopelovitch and Singer (2008). China and Singapore are missing. Central Bank Index 1971-1996 from Lijphart (1999).
Banking Crisis	Glick and Hutchison (1999); for Australia and USA, data comes from Caprio and Klingebiel (2003); for the years 2000-2010, data comes from Laeven and Valencia (2010).. Dummy=1 when the country has a banking crisis.
Currency Crisis	Glick and Hutchison (1999); for Australia and USA, the data comes from Laeven and Valencia (2008). Dummy=1 when the country has a currency crisis, 0 otherwise. For the years 2000-2010, data comes from Laeven and Valencia (2010).
Openness of the economy	Armingeon et al. (2011). Openness of the economy in current prices, measured as total trade (sum of import and export) as a percentage of GDP. 1960-2009.
Capital Account Openness Index	Armingeon et al. (2011) and Chinn and Ito (2008). Index for the extent of openness in capital account transactions. 1960-2009.

Variables	Sources and Definitions
Deposit Insurance Scheme	World Bank Deposit Insurance Around The World dataset. Deposit Insurance Fund Dummy=1 if a country has deposit insurance, 0 if not.
Exchange Rate Regime	Ilzetzki et al. (2008). It takes the value of 0 for floating or managed floating regime and 1 for all varieties of hard fixed exchange rates.
Euro Membership	Dummy that takes a value of 1 if a country belongs to the euro area and 0 otherwise.
Oil imports over GDP	Own calculations. Value of oil imports in US dollars over GDP. Value of oil imports in US dollars and GDP current prices ($): International Monetary Fund, World Economic Outlook Database, April 2013.
Domestic Credit over GDP	Domestic credit provided by banking sector (% of GDP). Source: World Bank World Development Indicators (Financial Sector).
Time	From year 1975 to 2012 takes value 1 to 38.
Inflation targeting	Roger (2010); for Finland and Spain, data comes from Little and Romano (2009). Dummy=1 if the country has Inflation Targeting, 0 otherwise. We assume that the Member States of Euro zone have inflation targeting.

6.2 Descriptive Statistics

Table 6.4: Descriptive Statistics

Variable	# Obs.	Mean	Std. Dev.	Min.	Max.
Inflation (%)	950	5.34	6.78	-1.89	84.28
Separate Bank. Supervision	950	0.38	0.49	0	1
Output Gap	950	0	0.02	-0.09	0.10
Degree of Commercial Openness	900	82.25	71.23	9.18	440.43
Degree of Capital Openness	876	1.44	1.32	-1.88	2.42
Deposit Insurance Scheme	950	0.67	0.47	0	1
Inflation Targeting	950	0.15	0.35	0	1
Bank Crisis	925	0.11	0.32	0	1
Currency Crisis	925	0.01	0.11	0	1
Domestic credit / GDP (%)	912	84.36	44.28	14.84	311.06
Exchange Rate Regime	887	0.55	0.50	0	1
Euro area member	950	0.17	0.38	0	1
Great Moderation Period	950	0.63	0.48	0	1
Oil imports / GDP (%)	803	0.04	0.06	0	0.66
Central Bank Independence Index	950	0.52	0.23	0.19	0.94
Time	950	19.50	10.97	1	38

6.3 Countries classification - separate and combined mandates of monetary policy and banking supervision

Table 6.5: Countries classification - separate and combined mandates

Countries	Combined Mandate (Separate Bank. Sup. = 0)	Separate Mandate (Separate Bank. Sup. = 1)
Australia	1975-1997	1998-2012
Austria	1975-2012	-
Belgium	2011-2012	1975-2011
Canada	-	1975-2012
China	1975-2002	2003-2012
Denmark	2011-2012	1975-2011
Finland	-	1975-2012
France	1975-2012	-
Germany	1975-2012	-
Greece	1975-2012	-
Iceland	1975-1998	1999-2012
Ireland	1975-2002 / 2010-2012	2003-2009
Italy	1975-2012	-
Japan	1975-1997	1998-2012
Luxembourg	1983-1997	1975-1982 / 1998-2012
Netherlands	1975-2012	-
New Zealand	1975-2012	-
Norway	-	1975-2012
Portugal	1975-2012	-
Singapore	1975-2012	-
Spain	1975-2012	-
Sweden	-	1975-2012
Switzerland	-	1975-2012
United Kingdom	1975-1997	1998-2012
United States	1975-2012	-

6.4 Robustness Checks

Tables 6.6 and 6.7 show the estimation results for Model 1-3, to test for the robustness of results to alternative classifications of the institutional mandates in countries for which doubts were raised. This is the case for Australia, Austria, Denmark and Finland, where central banks, in specific periods of time, have also played a role in banking supervision.

Table 6.6: Fixed Effects Estimation Results (1975-2012)

Dependent Variable: (log) inflation	Model 1	Model 2
Constant	0.590***	0.954***
	(0.024)	(0.131)
Separate Bank. Superv. Alternative (1 = Yes)	-0.240**	−0.046
	(0.081)	(0.049)
Inflation Targeting (1 = Yes)	-	-0.167**
		(0.064)
CBI (index)	-	-0.122
		(0.100)
Deposit Insurance (1 = Yes)	-	-0.121**
		(0.056)
Exchange Rate Reg. (1 = fixed)	-	-0.050
		(0.048)
Euro area member (1 = Yes)	-	-0.008
		(0.047)
Time (1975: 1, ..., 2012: 38)	-	-0.020***
		(0.004)
Great Moderation Period (1 = 1984-2007)	-	-0.132***
		(0.041)
Domestic Credit (% of GDP)	-	0.001**
		(0.000)
Output Gap	-	2.421***
		(0.653)
Banking Crisis (1 = Yes)	-	-0.007
		(0.046)
Currency Crisis (1 = Yes)	-	0.050
		(0.064)
Trade Openness	-	0.004**
		(0.002)
Capital Account Openness	-	-0.072***
		(0.022)
Oil imports (% GDP)	-	2.225**
		(0.934)
Observations	961	639
No of Countries	25	24
F Test / Wald Chi2 Test (global significance)	8.66***	165.74***
	(1, 24)	(15, 23)
R squared (within)	0.02	0.58

$^*p \leq .10$; $^{**}p \leq .05$; $^{***}p \leq .01$

Robust standard errors are in brackets.

Table 6.7: Dynamic Panel Data Model - Estimation Results (1975-2012)

Dependent Variable: (log) inflation	Fixed Effects Estimation	Arellano-Bover Estimation
Constant	0.547***	0.778***
	(0.087)	(0.135)
Lagged Inflation (t-1)	0.356***	0.383***
	(0.047)	(0.094)
Separate Bank. Superv. Alternative (1 = Yes)	−0.039	−0.020
	(0.040)	(0.039)
Inflation Targeting (1 = Yes)	−0.101**	−0.016
	(0.040)	(0.047)
CBI (index)	−0.126*	−0.114**
	(0.069)	(0.057)
Deposit Insurance (1 = Yes)	−0.088**	−0.023
	(0.042)	(0.036)
Exchange Rate Reg. (1 = fixed)	−0.027	−0.028
	(0.025)	(0.022)
Euro area member (1 = Yes)	-0.034	0.066*
	(0.027)	(0.038)
Time (1975: 1, ..., 2012: 38)	-0.018***	−0.008***
	(0.002)	(0.003)
Great Moderation Period (1 = 1984-2007)	-0.101***	−0.088**
	(0.030)	(0.035)
Domestic Credit (% of GDP)	0.001*	−0.000
	(0.000)	(0.001)
Output Gap	2.659***	1.933***
	(0.503)	(0.630)
Banking Crisis (1 = Yes)	-0.007	0.011
	(0.034)	(0.027)
Currency Crisis (1 = Yes)	0.040	−0.005
	(0.061)	(0.050)
Trade Openness	0.004***	−0.001
	(0.001)	(0.001)
Capital Account Openness	−0.039***	−0.089***
	(0.012)	(0.022)
Oil imports (% GDP)	1.626*	1.610**
	(0.800)	(0.752)

$^*p \leq .10$; $^{**}p \leq .05$; $^{***}p \leq .01$

Table 6.8: Dynamic Panel Data Model - Estimation Results (1975-2012) (cont. Table 6.7)

Statistical Tests	Fixed Effects Estimation	Arellano-Bover Estimation
F Test / Wald Chi2 Test (global significance)	656.17*** (16, 23)	3467.75*** (16)
Sargan Test (p-value)	-	0.319
AR(2) (p-value)	-	0.874

$^{*}p \leq .10$; $^{**}p \leq .05$; $^{***}p \leq .01$

Notes: Observations - 623. # Countries - 24. For fixed Effects estimations, robust standard errors are in brackets. Arellano-Bover estimations based on twostep system-GMM, using robust standard errors corrected for finite samples (using Windmeijer's correction). Since Output Gap can be affected by inflation, it was treated as endogenous. As done for lagged inflation, its lagged values two and three periods were used as instruments in the first-difference equations and its once lagged first differences were used as instruments in the levels equations. In total, 21 instruments were used.

Tables 6.9 and 6.10 show the estimation results for Model 1-3, to test for the robustness of results to alternative classifications of the institutional mandates in countries that joined the euro area. It is assumed that countries that joined the euro area have separate institutional mandates of banking supervision, even in the cases in which the central bank is the supervisory authority.

Table 6.9: Fixed Effects Estimation Results (1975-2012)

Dependent Variable: (log) inflation	Model 1	Model 2
Constant	0.717***	0.969***
	(0.025)	(0.126)
Separate Bank. Supervisor - euro area (1 = Yes)	-0.380***	−0.038
	(0.049)	(0.049)
Inflation Targeting (1 = Yes)	-	-0.163**
		(0.065)
CBI (index)	-	-0.138
		(0.095)
Deposit Insurance (1 = Yes)	-	-0.114*
		(0.056)
Exchange Rate Reg. (1 = fixed)	-	-0.052
		(0.048)
Euro area member (1 = Yes)	-	-0.023
		(0.061)
Time (1975: 1, ..., 2012: 38)	-	-0.020***
		(0.004)
Great Moderation Period (1 = 1984-2007)	-	-0.134***
		(0.040)
Domestic Credit (% of GDP)	-	0.001**
		(0.000)
Output Gap	-	2.432***
		(0.644)
Banking Crisis (1 = Yes)	-	-0.009
		(0.046)
Currency Crisis (1 = Yes)	-	0.050
		(0.064)
Trade Openness	-	0.003**
		(0.002)
Capital Account Openness	-	-0.072***
		(0.022)
Oil imports (% GDP)	-	2.264**
		(0.929)
Observations	961	639
No of Countries	25	24
F Test / Wald Chi2 Test (global significance)	60.20***	197.26***
	(1, 24)	(15, 23)
R squared (within)	0.12	0.56

$^*p \leq .10$; $^{**}p \leq .05$; $^{***}p \leq .01$

Robust standard errors are in brackets.

Table 6.10: Dynamic Panel Data Model - Estimation Results (1975-2012)

Dependent Variable: (log) inflation	Fixed Effects Estimation	Arellano-Bover Estimation
Constant	0.556***	0.787***
	(0.087)	(0.133)
Lagged Inflation (t-1)	0.356***	0.382***
	(0.048)	(0.095)
Separate Bank. Superv. - Alternative (Yes=1)	−0.017	−0.038
	(0.045)	(0.030)
Inflation Targeting (1 = Yes)	−0.101**	−0.022
	(0.040)	(0.046)
CBI (index)	−0.136*	−0.120**
	(0.067)	(0.055)
Deposit Insurance (1 = Yes)	−0.083*	−0.019
	(0.041)	(0.035)
Exchange Rate Reg. (1 = fixed)	−0.029	−0.025
	(0.024)	(0.023)
Euro area member (1 = Yes)	-0.019	0.088**
	(0.043)	(0.040)
Time (1975: 1, ..., 2012: 38)	-0.012***	−0.008***
	(0.002)	(0.003)
Great Moderation Period (1 = 1984-2007)	-0.101***	−0.089**
	(0.030)	(0.035)
Domestic Credit (% of GDP)	0.001*	−0.000
	(0.000)	(0.001)
Output Gap	2.657***	1.980***
	(0.497)	(0.629)
Banking Crisis (1 = Yes)	-0.009	0.012
	(0.034)	(0.027)
Currency Crisis (1 = Yes)	0.040	−0.006
	(0.061)	(0.049)
Trade Openness	0.004***	−0.001
	(0.001)	(0.001)
Capital Account Openness	−0.039***	−0.088***
	(0.012)	(0.022)
Oil imports (% GDP)	1.631*	1.624**
	(0.806)	(0.691)

$^*p \leq .10$; $^{**}p \leq .05$; $^{***}p \leq .01$

Table 6.11: Dynamic Panel Data Model - Estimation Results (1975-2012) (cont. Table 6.10)

Statistical Tests	Fixed Effects Estimation	Arellano-Bover Estimation
F Test / Wald Chi2 Test (global significance)	843.13*** (16, 23)	2856.91*** (16)
Sargan Test (p-value)	-	0.326
AR(2) (p-value)	-	0.895

$^*p \leq .10$; $^{**}p \leq .05$; $^{***}p \leq .01$

Notes: Observations - 623. # Countries - 24. For fixed Effects estimations, robust standard errors are in brackets. Arellano-Bover estimations based on twostep system-GMM, using robust standard errors corrected for finite samples (using Windmeijer's correction). Since Output Gap can be affected by inflation, it was treated as endogenous. As done for lagged inflation, its lagged values two and three periods were used as instruments in the first-difference equations and its once lagged first differences were used as instruments in the levels equations. In total, 21 instruments were used.

Tables 6.12 and 6.13 report estimation results for the period prior to the financial crisis of 2008.

Table 6.12: Fixed Effects Estimation Results (1975-2007)

Dependent Variable: (log) inflation	Model 1	Model 2
Constant	0.689***	1.069***
	(0.136)	(0.122)
Separate Bank. Superv. (Yes =1)	-0.334**	−0.083
	(0.049)	(0.066)
Inflation Targeting (1 = Yes)	-	-0.179**
		(0.069)
CBI (index)	-	-0.119
		(0.134)
Deposit Insurance (1 = Yes)	-	-0.130**
		(0.058)
Exchange Rate Reg. (1 = fixed)	-	-0.064
		(0.047)
Euro area member (1 = Yes)	-	0.051
		(0.052)
Time	-	-0.020***
		(0.005)
Great Moderation Period (1 = 1984-2007)	-	-0.154***
		(0.046)
Domestic Credit (% of GDP)	-	0.001**
		(0.001)
Output Gap	-	2.152***
		(0.660)
Banking Crisis (1 = Yes)	-	0.064
		(0.048)
Currency Crisis (1 = Yes)	-	0.030
		(0.060)
Trade Openness	-	0.002
		(0.002)
Capital Account Openness	-	-0.071***
		(0.022)
Oil imports (% GDP)	-	1.842**
		(1.137)
Observations	804	584
No of Countries	25	24
F Test / Wald Chi2 Test (global significance)	5.99**	281.82***
	(1, 24)	(15, 23)
R squared (within)	0.04	0.58

$^*p \leq .10$; $^{**}p \leq .05$; $^{***}p \leq .01$

Robust standard errors are in brackets.

Table 6.13: Panel Data Model - Estimation Results (1975-2007)

Dependent Variable: (log) inflation	Fixed Effects Estimation	Arellano-Bover Estimation
Constant	0.554***	0.748***
	(0.085)	(0.178)
Lagged Inflation (t-1)	0.428***	0.425***
	(0.043)	(0.126)
Separate Banking Supervision (1 = Yes)	−0.037	−0.033
	(0.073)	(0.043)
Inflation Targeting (1 = Yes)	−0.085**	−0.005
	(0.039)	(0.056)
CBI (index)	−0.120	−0.108
	(0.078)	(0.070)
Deposit Insurance (1 = Yes)	−0.076*	−0.028
	(0.041)	(0.041)
Exchange Rate Reg. (1 = fixed)	−0.026	−0.029
	(0.020)	(0.025)
Euro area member (1 = Yes)	-0.026	0.082*
	(0.027)	(0.044)
Time	-0.012***	−0.008***
	(0.003)	(0.002)
Great Moderation Period (1 = 1984-2007)	-0.098***	−0.079*
	(0.028)	(0.042)
Domestic Credit (% of GDP)	0.001*	−0.000
	(0.000)	(0.001)
Output Gap	2.280***	2.368***
	(0.432)	(0.704)
Banking Crisis (1 = Yes)	0.036	0.004
	(0.041)	(0.027)
(1 = Yes)	(0.041)	(0.027)
Currency Crisis (1 = Yes)	0.021	−0.002
	(0.059)	(0.063)
Trade Openness	0.003***	−0.001
	(0.001)	(0.001)
Capital Account Openness	−0.036***	−0.069***
	(0.010)	(0.026)
Oil imports (% GDP)	0.945	1.169
	(0.785)	(0.908)

*$p \leq .10$; **$p \leq .05$; ***$p \leq .01$

Table 6.14: Dynamic Panel Data Model - Estimation Results (1975-2007) (cont. Table 6.13)

Statistical Tests	Fixed Effects Estimation	Arellano-Bover Estimation
F Test / Wald Chi2 Test (global significance)	576.57*** (16, 23)	2668.33*** (16)
Sargan Test (p-value)	-	0.036
AR(2) (p-value)	-	0.997

$^{*}p \leq .10$; $^{**}p \leq .05$; $^{***}p \leq .01$

Notes: Observations - 575. # Countries - 24. For fixed Effects estimations, robust standard errors are in brackets. Arellano-Bover estimations based on twostep system-GMM, using robust standard errors corrected for finite samples (using Windmeijer's correction). Since Output Gap can be affected by inflation, it was treated as endogenous. As done for lagged inflation, its lagged values two and three periods were used as instruments in the first-difference equations and its once lagged first differences were used as instruments in the levels equations. In total, 21 instruments were used.