DOMESTIC CREDIT IN TIMES OF SUPERVISION: AN EMPIRICAL INVESTIGATION OF EUROPEAN COUNTRIES

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Domestic Credit in Times of Supervision:
An Empirical Investigation of European Countries

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Abstract

We study the impact of prudential supervision on domestic credit in 27 countries throughout 1999-2012. We use the Empirical Iterative Bayes’ estimator to account for country heterogeneity. We find: (i) the interest rate not to be a fundamental variable in explaining domestic credit, (ii) negative relations between credit sensitivity to past investment and to financial dependence, (iii) the effects of supervision on credit differ by country, but (iv) without systematic negative impact of increased supervisory stringency. Our results are coherent with two interpretations: one encouraging regulatory set-ups where increased supervision positively affects credit, and another cautioning about the associated risks.

Keywords: Prudential supervision; Supervision in the EU; Banking system supervision; Financial institution regulation; Bayesian shrinkage estimator;

JEL Codes: C51; E65; G28

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1. Introduction

The 2008 financial crisis constituted a wake-up call for scientists and practitioners alike, as the soundness of theoretical models and empirical results was put into question. The crisis was largely unforeseen and, furthermore, had a magnitude that defied expectations. Initially a small housing sector conundrum, it quickly turned into a full-scale banking sector crisis as the linkages between financial institutions through opaque and inefficient risk-diversification instruments started to gain contour. In an effort to reduce risk and maximize profitability in order to obtain better safety ratings, many Western European and American banks had opted to use highly complex instruments that served to pool assets of different quality into a single instrument, deemed more secure and easily tradable. The faults of this logic were proven when mortgage-backed securities started to lose value as a result of the defaulting households, which, given the conjectural macroeconomic situation were unable to return their loans.

The crisis shed light on the dangers of a banking system functioning in near absolute deregulation. In the US and the other European countries that were affected, a lot of focus was placed on improving and increasing the regulatory stance of the prudential agencies. New research, models and tools started to be considered by authorities increasingly worried of the recession and, later on, lack of growth that had left the developed world at a standstill. Whereas many began to focus on traditional prudential regulation research branches, such as the ones on the effects of capital ratios on risk and growth, others took bolder moves in proposing now tools and transmission mechanisms⁴, such as the liquidity ratio proposed by the Basel committee, prudential reserve requirements or LTV-ratios⁵.

The European Union, in particular, is an interesting case in this affair. The EU has taken up the challenge of creating a unified supervision mechanism aiming to ensure the safety and stability of the European banking

⁴ See Agenor and da Silva (2011), Gertler and Kiyotaki (2010), Benigno et al. (2012) for examples

⁵ Loan-to-Value ratios (LTV ratios, in short) have been used in some countries as a prudential instrument specifically geared towards controlling housing-market credit.
system and provide mechanisms for an efficient response to disturbances encountered in the banking sector\(^6\).

The particularity of the set-up envisaged by the EU is that the supervisory mechanism will consist of a supranational body (the European Central Bank), as well as the habilitated national authorities tasked with the prudential regulation of the banking system. Countries belonging to the Eurozone will also have to comply with the European Single Supervisory Mechanism (SSM) – a set of additional supervisory prerogatives assumed by the ECB.

However, not all of the EU-member countries were directly affected by the 2008 financial crisis. Many of the countries of the Eastern Block were initially unaffected, with subsequent economic side-effects being felt later on as a result not of financial instability or deregulation, but rather through mechanisms unrelated to the banking sector, such as decreasing remittances or missed export opportunities due to contracting demand in the more developed western nations. As such, given the complexity, as well as the overarching role of supervision in the new regulatory drive in the EU, it becomes important to assess the role of prudential supervision for the EU as a whole, as well as that for its individual member countries in order to ascertain whether indeed a unified supervisory mechanism would benefit all the parties involved\(^7\). Furthermore, in our selection of prudential instrument to analyze we are encouraged by recent papers such as Delis and Staikouras (2011) that start to question the effectiveness of traditional tools such as capital requirements in reducing risk. They instead focus

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\(^7\) For certain European nations, there may be positive effects from a single supervisory mechanism associated with a common rescue fund since, as described in Engle et al. (2014), for some countries the burden of saving systemically important financial institutions may prove too difficult, resulting in the appearance of “banks too big to be saved”, the failure of which would severely compromise social wellbeing. Countries such as the UK, however, have already raised concerns over the rapidly developing unified supervisory mechanisms developed by the ECB and the EBA whose role is to promote and ensure supervisory convergence. See: EBA, 2014, Supervisory Convergence (http://www.eba.europa.eu/supervisory-convergence) and The Telegraph, 2012 (http://www.telegraph.co.uk/finance/financialcrisis/9743498/George-Osborne-wins-City-safeguards-as-EU-secur...
on supervisory efficiency in terms of bank audits and sanctions to find that such alternative tools produce significant results where capital requirements falter. Acharya and Merrouche (2012) study the precautionary liquidity behavior of financial institutions during crises leading us to believe that, unless properly timed, the insertion of liquidity ratios may also have limited efficiency.

In terms of efficiency, we would ideally want a supervisory structure that would allow for reduced risk, without having a negative impact on growth or credit supply. This, however, may be difficult to attain according to some of the recent theoretical literature. DeWalque et al. (2010) in his paper on financial (in)stability, supervision and liquidity injections provides a dynamic stochastic general equilibrium model that explains that prudential tools such as capital ratios serve to improve the resilience of the economy, but may also lead to output contraction via the credit-investment channel. Martinez and Suarez (2011) conclude that capital requirements reduce the systemic risk taking of the bank, and, hence the losses caused by systemic shocks, but such prudential tools concurrently reduce credit and, subsequently, output in normal times. Chadha and Corrado (2012), uses different tools, but similarly find that increasing reserve requirements for banks serves to limit the expansion of credit in times of sustained economic growth. Conversely, during recessions, increased reserves can prevent an excessively rapid fall in credit. Angelini et al. (2010) confirms that regulation serves to smooth fluctuations in the cycle.

As we can see, despite the recent overhaul of some research methods in the form of newer, enhanced versions of theoretical models, the consensus remains that the credit channel is the primary means through which prudential instruments impact the economy.

Furthermore, despite a more significant focus of the theoretical literature on traditional prudential tools such as capital requirements and, more recently, liquidity ratios, new studies confirm the role of supervision, and specifically supervisory stringency on credit. Maddaloni and Peydro (2013) find that softening supervisory stringency serves to reduce the risk of a credit crunch when lending conditions are tightened as a result of higher bank capital requirements and/or liquidity ratio constraints. They conclude that because of this effect, supervisory measures and traditional macro-prudential tools should coexist. Bassett et al. (2012) find that increased supervisory stringency increases the quality of loans by incentivizing banks to lend to relatively risk-free clients. However, if stringency levels become elevated, then the lending activity of financial institutions may become perturbed. The Federal Reserve System (2014) of the United States dictates that there must be a correlation between supervisory stringency and the degree of risk that the financial institution assumes, its size and scope. Implicitly this is indicative of the existence of linkages between supervisory stringency and the
amount of credit emitted by a financial organization. Finally, Hardy and Nieto (2008) confirm that increased supervisory stringency has positive effects on risk reduction and therefore contributes to the stability of the financial system as a whole, the reduction of the risk of default for individual institutions and that of a credit crunch. Therefore, increased supervisory stringency seems to have a positive impact on credit supply. Given both the recent theoretical foundations of the interactions between prudential supervision and credit, as well as the practical interest in studying the interactions between these two variables as a result of the recent changes to the supervisory structure of the EU our paper investigates the impact of prudential supervision on credit. We find that as a result of the heterogeneity of European economies, the impact of supervision on credit is not the same for all the countries that we study. Indeed, increased supervision has a positive effect on credit for most countries, while some remain unaffected and two experience a decline in credit. We delve deeper into why this may be the case and what implications this may have for policy in the following sections. The rest of this paper is structured as follows: Section 1 has presented an introduction into our work, its scope and objectives, concurrently explaining the need for research into prudential regulation. Section 2 takes a closer look at the data that’s been used and presents our expectations with respect to the exogenous variables chosen for the model. Section 3 explains the advantages of extending the credit empirical analysis to the Bayesian framework given the non-uniformity of countries in the EU. In this section, we propose to apply the Empirical Iterative Bayes’ estimator suggested by Maddala et al. (1997) since it provides a heterogeneous (country by country) estimation of the credit-supervision relationship and allows us to establish a classification of countries according to their credit sensitivity. Section 4 provides an in-depth discussion of our findings, as well as alternative interpretations for our results. Finally, we formulate conclusions regarding the effects of supervision on credit.

2. Data and Model Specification

Our choice of an endogenous variable is subjected to both data availability constraints, as well as pertinence with regard to our objective. Most theoretical studies focus on the effects of regulation on credit supply. As such, we will also choose an indicator for credit: domestic credit provided by the financial sector, as a percentage of GDP. This is the variable with the largest scope that covers most of the sources of domestic credit in the economy. The data is taken from the World Development Indicators database.
2.1 THE IMPACT OF TRADITIONAL MACRO-ECONOMIC VARIABLES ON CREDIT

The impact of macro-economic indicators on credit has been studied in a number of prominent papers. Some of the most commonly examined relationships are that between interest rates and credit, as well as that between credit and investment. Furthermore, recent studies also focus on the relationship between the financial dependence of a country and its private credit to determine the efficiency of the banking sector in ensuring productivity and output growth. We refer in particular to Inklaar and Koetter (2008).

When looking at the impact of interest rates on credit, early literature focusing on the credit supply suggests that there should be a positive impact of interest rates on credit. The McKinnon-Shaw Hypothesis (1973) presents an empirical study based on the proposed theoretical hypothesis of credit rationing as a result of financial repression. The study concludes that artificial ceilings on interest rates prevent banks from attaining a sufficient interest margin and thereby can lead to lower credit (via credit rationing) concurrently potentiating lower investment levels. Fry (1988) finds that credit supply receives a positive boost from an increase in interest rates. More recent literature on asymmetric information indicates the presence of a negative relationship between interest rates and credit. The basis for this is explained in studies such as Walsh (1998) which focus on the credit rationing effects that may occur as a result of an increase in interest rates. Higher interest rates are accompanied by an increase in moral hazard and adverse selection. This means higher expected default rates for banks, and consequently higher monitoring costs to avoid bankruptcy situations. Banks can therefore resort to credit rationing because of higher perceived risk levels. Bernanke et al. (1999) in their study of the financial accelerator mechanism confirm the negative relationship between interest rates and credit.

It would seem that this second strand of literature is more in line with the Keynesian school of thought that viewed the increase of interest rates as having a negative effect on credit, passing through the demand channel. The literature regarding the interactions between credit and investment does not attempt to decipher the potential effect of investment on credit, focusing largely on the inverse relation. We do, however, believe that there exists a causality effect of past investments on credit. Prabodhachandran (2004) argues that past investment serves to build momentum for present investment. A result confirmed by Hsieh and Hong (2004), who similarly, in an analysis of Asian economies, find that present investment is an increasing function of past investment. Finally, Hernandez et al. (2001), in their study on private capital flows during the 1990s find that increasing investment influences debt flows positively. They find a similar effect for past investment. We therefore have reason to believe that past investment is an indicator of anticipations of the private sector regarding present and future investments to be made and consequently influences credit. We do expect however, that the effect may vary
amongst countries of different development levels. To exemplify, countries with experienced firms focused on high-tech production or on export will most likely take previous investment levels into consideration, as these will be crucial for their current credit decisions. Developing and transition countries may have a weaker link between past investment and credit, as their fledgling private sector struggles with issues such as excessive demand for collateral by the banking sector, under-developed financial markets and a preponderance of very small to small firms with little power to negotiate credit requests. As such, credit to enterprises in these countries is likely to be restricted by factors non-related to previous investment levels. Our empirical analysis confirms that there are strong linkages between past investment and current credit levels. We, therefore, opt to keep past investment as an exogenous variable for our model.

Finally, the interactions between credit and the financial dependence ratio are explained in more recent articles such as Inklaar and Koetter (2008) or Rajan and Zingales (1998). Rajan and Zingales (1998) find that the financial dependence ratio is linked to credit. The channel through which this effect passes involves financial development which reduces the costs of external finance to firms, thereby facilitating access to credit. Inklaar and Koetter (2008) find similar results, however, using a different indicator formulation.

2.2 THE DATA
The "traditional" macro-economic variables that we will take as exogenous variables will consist of: the interest rate, investment and the financial dependence ratio. The data for these variables comes from several databases: the World Bank’s World Development Indicators, the World Bank DataBank and Eurostat. Our indicator of the interest rate is the bank’s net interest margin (annual, in %). Although not an interest rate indicator per se, the bank’s interest margin represents the difference between the lending and the borrowing rate. As such, given the stability of the interest rate for deposits in most European countries, the variations of this indicator are expected to be proportional with those of the interest rate for credit. The indicator is taken with a minus one-year lag to account for the systemic rigidities that may exist. We assume, that there is a relationship between past investment and credit. It is expected that higher previous investment levels should contribute positively to

\[ \text{financial dependence ratio} \]

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8 see Agenor (2011)

9 see Levine R.(2004)

10 see the ECB 2014 survey on the access to finance of small and medium-sized enterprises in the Euro Area
present credit demand, although that may not be the case for all countries, as explained above. Finally, the financial dependence ratio is an advanced indicator that can be constructed in multiple ways. Rajan and Zingales (1998) use Compustat data on U.S. firms to construct a measure of dependence on external finance, which they constitutes the benchmark for other countries. Their financial dependence indicator is constructed as follows:

\[
\text{Financial Dependence Ratio} = \frac{\text{Capital expenditures} - \text{Cash flow}}{\text{Capital expenditures}}
\]

(1)

Inklaar and Koetter (2008), in their study of the financial dependence of European firms, refer to Furstenberg and Kalckreuth (2006) who argue that external dependence is not a ‘structural’ parameter, as implicitly assumed by Rajan and Zingales (1998). They find that another way of expressing the financial dependence ratio, as suggested by Guevara and Maudos (2006):

\[
\text{Financial Dependence Ratio} = \frac{\text{Debt}}{\text{Total assets}}
\]

(2)

Given the macro-level orientation of our research, we maintain Inklaar and Koetter’s (2008) formulation of the financial dependence ratio. In the debt category, we take into consideration both internal and external private sector debt. The total assets position is filled by total fixed assets, which is the only indicator that is concurrently available for all of the countries we select.

In our selection of the variable to include in our study of the impact of supervision on credit, we find the World Bank’s survey on bank regulation by Barth, Caprio and Levine (2013) to be highly adequate. It provides macro-level data on prudential regulation and supervision for 180 countries from 1999 to 2011. In the given timeframe four surveys have been conducted. Answers have been collected from regulatory authorities and consist of both quantitative and qualitative data, with qualitative data having been converted into indices by the authors. All in all, the database comprises 52 indicators categorized into one of 10 sections: I. Bank Activity Regulatory Variables ; II. Financial Conglomerate Variables ; III. Competition Regulatory Variables ; IV. Capital Regulatory Variables ; V. Official Supervisory Action Variables ; VI. Official Supervisory Structural Variables ; VII. Private Monitoring Variables ; VIII. Deposit Insurance Scheme Variables ; IX. Market Structure Indicators ; X. External Governance Variables.

Given our interest in the impact of supervisory measures on credit, we will focus on section V, Official Supervisory Action Variables. The index is constructed by combining the answers to 14 questions regarding the
ability of supervisors to change the internal organization of banks by means of restructuring or reorganization, their ability to order the bank to constitute provisions to cover for existent or potential losses, off-balance sheet item disclosure, as well as the supervisor’s powers to examine bank auditors. Higher index values indicate a greater power for the supervisory agency, and therefore a more stringent regulatory system.

The database provided by Barth, Caprio and Levine is used in a number of empirical papers focused on banking sector efficiency. Gaganis et al. (2013) use the data to study bank efficiency in different financial supervision regimes. They find that banks in advanced countries are the most efficient. Furthermore, they also find evidence that suggests that banks in transition economies are less efficient than banks in developing countries. Finally, they indicate that banks located in countries with a greater degree of supervisory unification are less profit efficient. Barth et al. (2013) also study the impact of prudential regulation on bank efficiency. They find that tougher restrictions on bank activities decrease bank efficiency, that increasing the official supervisory power is positively associated with bank efficiency in countries with independent prudential authorities, and that market-based monitoring of banks increases bank efficiency. Finally, Chortareas et al. (2012) use an earlier version of the database and find results similar to the ones detailed in the aforementioned papers. Fonseca and Gonzales (2010) study the influence of regulation on bank capital buffers and find that restrictions on bank activities and supervision leads to lower capital buffers being held by banks as a result of the lack of market discipline, but, at the same time, the restrictions lead to higher capital buffers because of increased market power. Finally, Serres et al. (2006) use the database to study competitiveness and economic growth in an OECD research paper. They find that regulation aiming to reduce banking sector barriers to competition does have a statistically significant influence on output, productivity growth and firm entry levels, with most of the effect stemming from industrial sectors dependent on external financing. The authors also find evidence that, given the negative impact of barriers to competition in the banking sector on firm entry rates, greater market power does not lead to increased entry levels via a mechanism of easier access to credit for new firms.
For our study, we select 26 of the now 28 countries of the European Union, plus Switzerland. That gives us a total of 27 countries. Two EU countries have had to be excluded for lack of data – Croatia and Slovakia. Croatia has entered the European Union in 2013 and access to its data is still unavailable. Both, however, represent some of the smallest countries in terms of both GDP and population in the EU. As such, their exclusion is not expected to affect the reliability of the results presented in this paper. The selected period for our study will span from 1999 to 2012. The year 1999, coinciding with the introduction of the euro in the EU, is the first year in which the survey on prudential regulation was conducted, and 2012 is the last year for which we have data for all of our indicators.

2.3 MODEL FORMULATION AND METHODOLOGICAL CONSIDERATIONS

We specify our two models. For each model, we use three independent variables. The introduction of another explanatory variable would require more coefficients (specifically 27 coefficients in the case of the Empirical Iterative Bayes’ estimator) to estimate, thus reducing the efficiency of the estimation procedure (in terms of degrees of freedom).

For our first (baseline) model we select three traditional macro-economic variables that are known to produce an effect on credit: the interest rate, investment, and the financial dependence ratio.

\[ \text{Credit}_t = \alpha + \beta_i \text{Fin}_\text{Dep}_{i,t} + \delta_i \text{Inv}_{i,t-1} + \gamma_i \text{Bank}_\text{Margin}_{i,t-1} + \varepsilon_{it} \]  

(3)

where \( \text{Credit} \) is the domestic credit provided by financial sector, as a % of GDP, \( \text{Fin}_\text{Dep} \) - the Financial Dependence Ratio, \( \text{Inv} \) - the lagged total investment to GDP ratio, \( \text{Bank}_\text{Margin} \) - the lagged bank’s net interest margin, \( t \) - the time index indicating periods spanning from 1999-2012, and \( i \) - the index indicating the country.

The second model introduces the prudential supervision indicator (Supervis) and excludes the interest rate (Bk_marg). As such, our three explanatory variables are: the interest rate (Bk_Marg), investment (Inv) and prudential supervision (Supervis).

\[ \text{Credit}_t = \alpha + \beta_i \text{Fin}_\text{Dep}_{i,t} + \delta_i \text{Inv}_{i,t-1} + \gamma_i \text{Supervis}_{i,t} + \varepsilon_{it} \]  

(4)

11 Austria (AUT), Belgium (BEL), Bulgaria (BLG), Cyprus (CYP), Czech Republic (CZE), Denmark (DNK), Estonia (EST), Finland (FIN), France (FRA), Germany (DEU), Greece (GRC), Hungary (HUN), Ireland (IRL), Italy (ITL), Latvia (LTV), Lithuania (LTU), Luxembourg (LUX), Malta (MLT), Netherlands (NLD), Poland (PLD), Portugal (PRT), Romania (ROM), Slovenia (SVN), Spain (SPA), Sweden (SWE), Switzerland (SWZ), United Kingdom (UK).
Please make note, however, that the parameter estimates should not be interpreted as elasticities, because we do not provide our results in logarithmic form.

In order to include the country heterogeneity that characterizes European economies (both in terms of size, but also development levels) into our analysis we must find a method of estimation adequate for the task.

Recent empirical panel studies point to the problem of inconsistent estimators due to the insufficient consideration of cross-country heterogeneity (Baltagi and Kao, 2000; Baltagi et al., 2008; Hsiao, 2003). Indeed, the hypothesis of homogeneity in the slope parameters across the countries (implicit in the use of a pooled estimator) is often rejected in favor of heterogeneous regressions (Hsiao et al., 1999; Baltagi et al., 2003). An alternative estimation method for heterogeneous panel data comes from a Bayesian approach which considers the parameters as random, drawn from a joint distribution with a finite number of parameters (Maddala et al., 1997; Hsiao et al., 1999). The random coefficients formulation reduces the number of parameters to be estimated, while still allowing the coefficients to differ across countries. As such, given the Bayesian framework that we will utilize, we will have 108 coefficients to estimate (4 for each of the 27 European countries that we analyze) per model.

At this stage, we also provide interpretations for the exogenous variables that we have chosen and explain what our expectations are with respect to the sign taken by the parameters.

Inv is an "instrumental variable" that measures anticipated investment. As such, the coefficient associated with this variable indicates the sensitivity of credit to firms’ investment needs. We expect to have a positive sign, since a firm with higher past investment levels would, all things equal, expect to have higher credit needs in the present or future periods.

Dep_fin is presented as a debt-to-assets ratio and its coefficient may be interpreted as the sensitivity of credit to the dependence of firms on external financing. We also expect it to have a positive sign.

Bk_Marg can be regarded as an indicator of the cost of credit. The parameter associated with it may have either a positive or a negative sign. A negative sign reflects a traditional Keynesian credit demand effect, whereas a positive sign underscores the dominance of the credit supply channel.

With respect to our supervisory variable, the “prudential supervision index”, the theoretical literature provides mitigated conclusions as some works find that tightening supervision, similarly to other more traditional prudential instruments, produces a restrictive effect on credit, whereas others suggest that increased supervisory stringency has positive effects on credit.
3. The Empirical Iterative Bayes Estimator

In order to better take into consideration the cross-country heterogeneity, we will use the empirical iterative Bayes estimator, which is a shrinkage-type estimator. Indeed, in the panel data analysis, it is customary to pool the observations with or without individual-specific dummies. These dummy variables are assumed to be fixed (fixed-effects models) or random (random-effects or variance-components models). This procedure, however, assumes a complete homogeneity of the slope coefficients. On the other hand, when the time series estimation is used to obtain the separate estimates of cross-section coefficients, the parameters are assumed to be all different. This implies that the equations should be estimated separately for each country rather than obtaining an overall pooled estimate. For Maddala et al. (1997), the reality is situated between complete homogeneity and complete heterogeneity. “The truth probably lies somewhere in between. The parameters are not exactly the same, but there is some similarity between them. One way of allowing for the similarity is to assume that the parameters all come from a joint distribution with a common mean and a nonzero covariance matrix” (Maddala et al., 1997, p. 91). The authors show that the resulting parameter estimates are a weighted average of the overall pooled estimate and the separate time-series estimates based on each cross-section. In this framework, the empirical Bayes method allows us to calculate the shrinkage-type estimators: each individual estimator is shrunk toward the overall pooled estimate. Maddala et al. (1997), Hsiao et al. (1999) show that, in the case of panel data models with coefficient heterogeneity, this method provides more stable estimates and better predictions, since the two other estimation methods, of either pooling the data or obtaining separate estimates for each cross-section, are based on extreme assumptions (namely, cross-sectional homogeneity and heterogeneity of slope coefficients). Similarly, Maddala and Hu (1996) have presented some Monte Carlo evidence to suggest that the iterative procedure gives better estimates for panel data models. For instance, Hsiao (2003), Trapani and Urga (2009) also confirmed that in the case of panel data models with coefficient heterogeneity, the shrinkage estimators should be preferred, even when the time dimension is small.

3.1 THE BAYES’ ITERATIVE PROCEDURE

In the framework of the random-coefficients model, the Bayesian approach for the Domestic Credit Model can be rewritten with the following specification:

\[ y_i = X_i \gamma_i + u_i \]  

(5)
where $y_i$ contains the domestic credit time series, $X_i$ is the matrix with explanatory variables and $\gamma_i$ slope coefficients. In the Bayesian framework, the prior distribution of $\gamma_i$ is given by: $\gamma_i \sim N(\mu, \Sigma)$ where the parameters $\mu$ (mean of $\gamma_i$), $\Sigma$ (variance of $\gamma_i$) and $\sigma^2_i$ (residual variance) are unknown. That is why some assumptions have to be made on prior specification of these parameters. Then we can derive the posterior distribution for the parameters $\gamma_i$. On the other hand, if $\mu$, $\Sigma$ and $\sigma^2_i$ are all known, the posterior distribution of $\gamma_i$ is normal and calculated by:

$$\gamma_i^* = \left[ \frac{1}{\sigma^2_i} X_i' X_i + \Sigma^{-1} \right]^{-1} \left[ \frac{1}{\sigma^2_i} X_i' X_i \hat{\gamma}_i + \Sigma^{-1} \mu^* \right]$$  \hspace{1cm} (6)

where $\hat{\gamma}_i$ is the OLS estimator of $\gamma_i$. The posterior distribution mean of $\gamma_i$ and its variance are shown in Equations (3) and (4) respectively.

$$\mu^* = \frac{1}{N} \sum_{i=1}^{N} \gamma_i^*$$ \hspace{1cm} (7)

$$V[\gamma_i^*] = \left[ \frac{1}{\sigma^2_i} X_i' X_i + \Sigma^{-1} \right]^{-1}$$ \hspace{1cm} (8)

Since in general, $\Sigma$ and $\sigma^2_i$ are unknown parameters, one needs to specify priors for them. For this purpose, Smith (1973) suggested using the mode of the joint posterior distribution given by the following equations:

$$\sigma^2_i = \frac{1}{T+\zeta_i} + 2 \left[ \zeta_i \lambda_i + (y_i - X_i \gamma_i^*)' (y_i - X_i \gamma_i^*) \right]$$ \hspace{1cm} (9)

and

$$\Sigma^* = \frac{1}{T-k-2+\delta} \left[ R + \sum_{i=1}^{N} (\gamma_i^* - \mu^*) (\gamma_i^* - \mu^*)' \right]$$ \hspace{1cm} (10)

where the parameters $\zeta_i$, $\lambda_i$, $\delta$ and $R$ arise from the specification of the prior distributions. Moreover, Smith (1973) proposed the approximation of these parameters by setting $\zeta_i = 0$, $\delta = 1$ and $R$ as a diagonal matrix with small positive entries (e.g., 0.001). By doing so, the estimators take the following forms:

$$\sigma^2_i = \frac{1}{T+2} \left[ (y_i - X_i \gamma_i^*)' (y_i - X_i \gamma_i^*) \right]$$ \hspace{1cm} (11)

$$\Sigma^* = \frac{1}{T-k-1} \left[ R + \sum_{i=1}^{N} (\gamma_i^* - \mu^*) (\gamma_i^* - \mu^*)' \right]$$ \hspace{1cm} (12)
\[ \gamma_i^* = \left[ \frac{1}{\sigma_{\gamma_i}^2} X_i' X_i + \Sigma^{-1} \right]^{-1} \left[ \frac{1}{\sigma_{\gamma_i}^2} X_i' X_i \hat{\gamma}_i + \Sigma^{-1} \mu^* \right] \]  

(13)

and

\[ \mu^* = \frac{1}{N} \sum_{i=1}^{N} \gamma_i^* \]  

(14)

\[ V[\gamma_i^*] = \left[ \frac{1}{\sigma_{\gamma_i}^2} X_i' X_i + \Sigma^{-1} \right]^{-1} \]  

(15)

Then Equations (7-11) should be solved iteratively, with the initial iteration using the OLS estimator \( \hat{\gamma}_i \) to compute \( \mu^*, \Sigma^* \) and \( \sigma_{\gamma_i}^2 \). The second iteration is based on the empirical iterative Bayes’ estimator \( \gamma_i^* \). The third and the following iterations are identical to the second one. The empirical Bayes’ estimator was proposed by Maddala et al. (1997). The only difference with the Smith’s estimator lies in the computation of the parameters \( \sigma_{\gamma_i}^2 \) and \( \Sigma^* \), that is, we have:

\[ \sigma_{\gamma_i}^2 = \frac{1}{T-K} \left( y_i - X_i \hat{\gamma}_i \right)' \left( y_i - X_i \hat{\gamma}_i \right) \]  

(16)

\[ \Sigma^* = \frac{1}{N-1} \left[ R + \sum_{i=1}^{N} (\gamma_i^* - \mu^*) (\gamma_i^* - \mu^*)' \right] \]  

(17)

In what follows, we present our results from applying this procedure to the Domestic Credit model.

### 3.2 EMPIRICAL RESULTS

In order to better grasp the analysis method to be used for the survey data, we look at the way in which other papers using the bank regulation survey integrate the prudential indicators into the regression. Serres et al. (2006) resort to multiplication in order to alleviate the lack of variability resulting from the presence of limited observations. We remind the reader that the survey comprises 4 observations for each country within the 1999 – 2012 timespan. As such, they multiply the chosen prudential indicators by an external finance dependence indicator à la Rajan and Zingales (1998). Fonseca and Gonzales (2010) also multiply the prudential indicators with one of two variables: the Lerner Index or the cost of deposits. The cost of deposits is chosen as a multiplication variable since, according to the authors, it represents a measure of the discipline that the market imposes on the bank. In other words it represents an amplifier for prudential regulation. Finally, Gaganis et al. (2013) work on an unbalanced dataset. They perform a cross-sectional analysis and provide no temporal
dimension. It is also noteworthy that they study bank-level data and assign the value taken by the prudential indicator in the respective year and country to each of the banks included in the study.

In our analysis, we will refrain from using the multiplication method, as this renders data interpretation cumbersome and diminishes its meaningfulness. Consequently, for the years in which no survey was performed, we will assume that the value of the prudential indicator has not changed from its last known value. This will allow us to study the effect solely of the prudential indicator, without introducing any unnecessary distortions. The complete regression results for both models can be found in Appendix: Empirical Bayes’ Estimator, by country, 1999–2012 timeframe in the Annex.

We notice, as depicted in Table I, that the financial dependence ratio is significant for all the countries that we study in both models. Past investment significantly explains domestic credit for 85% of the European countries we analyze in the first model. When we select prudential supervision instead of the interest rate as an explanatory variable, past investment becomes significant for all of the countries. Bk_Marg, which we include in the first model, is explicative for only 37% of the countries, whereas Supervis, which replaces Bk_Marg in the second model, is significant for 63% of the countries we study.

Table I. Countries for which regression coefficients are individually non-significant at a 5% confidence level

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<thead>
<tr>
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<th>Model 1</th>
<th>Model 2</th>
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</tr>
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<td>BLG, CYP, FIN, ITL, LTU, LUX, ROM, SVN, SPA, SWZ</td>
</tr>
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</table>

Note: “None” means that the coefficient associated with the given variable is significant for all countries included in our research.

The Empirical Iterative Bayes estimator allowing for heterogeneity in the results shows that Fin_Dep and Inv always have a positive coefficient sign, which is in line with our expectations.
Within Model 1 which, we remind, has no prudential supervision indicator, Bk_marg has a significant positive coefficient sign for Germany, Ireland and Spain. We can, therefore, conclude that credit supply effects are dominant in these countries. The sign is negative and significant for Bulgaria, Czech Republic, Estonia, Latvia, Lithuania, Slovenia (all Eastern European countries), and Luxembourg. We can interpret the negative sign as an indicator of credit rationing à la Walsh (1998) in the countries manifesting this effect. We anticipate slightly the results of our next section by mentioning that we find such negative correlation between interest rates and credit only in the countries in which supervision has no effect on credit, and specifically, the ones in the low-right region of Figure 1.

In our second model which incorporates prudential supervision we notice that the financial dependence ratio is always positive and is significant for all countries. Past investment is similarly positive and significant. As for the supervision variable, it is:

- negative – only for two countries: the Czech Republic and Poland;
- non-significant – for 11 countries: Bulgaria, Cyprus, Estonia, Finland, Italy, Lithuania, Luxembourg, Romania, Slovenia, Spain, Switzerland;
- positive – for 14 countries: Austria, Belgium, Germany, Denmark, France, Greece, Hungary, Ireland, Latvia, Malta, Netherlands, Portugal, Sweden, and the United Kingdom.

As such, we can conclude that taking country heterogeneity into consideration brings to light the effect of prudential supervision – an effect which is otherwise hidden (when using standard OLS regression techniques). We therefore keep the second model which includes prudential supervision, both on account of the number of countries for which individual variables are significant, and as a result of that, on the basis of the lower residual sum of squares (RSS). In what follows, we focus our attention exclusively on the second model.

### 3.3 ALL DIFFERENT?

The Empirical Iterative Bayes estimator has made it possible to introduce country heterogeneity into our analysis. Now, our objective turns to finding out if there are countries with similar profiles that could be grouped together.

When plotting our regression results with lagged investment and the financial dependence ratio on the vertical and horizontal axis, respectively (Figure 1), we notice a grouping of countries. We see that in the lower-right-hand corner we mostly have transition economies characterized by a low level of past investment dependence and a higher level of financial dependence ratio. Conversely, in the upper-left area of the graph, we notice
highly developed countries with lower financial dependence ratios, but higher dependence on past investment.

When we factor in the significance level of the variable Supervis on domestic credit, we notice that for countries with a higher level of the financial dependence ratio, supervision has no significant effect on domestic credit. Also, many of the countries in this region also have low levels of credit sensitivity to past investment.

Figure 1. Overview of the estimation results for Model 2
Note: On the horizontal and vertical axes we have the coefficients associated with Fin_dep and Inv, respectively.

Upon first inspection, the most likely groups that we can divide the analyzed countries into are the following:

Group 1: Malta constitutes a first exception. Situated in the lower-left region of the graph, it concurrently manifests weak sensitivity both to financial dependence and past investment. Malta is positively affected by supervision.

Group 2: Italy and Spain are both situated in the upper-right part of the graphic and manifest high credit sensitivity to financial dependence and past investment, but remain unaffected by prudential supervision. We must note that Italy and Spain are the fourth and fifth largest economies of the EU (after Germany, the UK and France).
Group 3: the Czech Republic and Poland are highly sensitive to financial dependence, but manifest weak sensitivity to past investment. Supervision has a negative effect on the quantity of allocated credit in these two countries.

Group 4: Bulgaria, Cyprus, Estonia, Finland, Lithuania, Luxembourg, Romania, Slovenia and Switzerland are sensitive to financial dependence, but manifest low sensitivity to past investment. Supervision has an insignificant effect on these countries.

Group 5: Austria, Belgium, Germany, Denmark, France, Greece, Hungary, Ireland, Latvia, Netherlands, Portugal, Sweden and the United Kingdom are highly sensitive to past investment and have lower sensitivity to financial dependence. Increased supervision has a positive effect on credit in these countries. It is noteworthy that these are the largest European economies in terms of GDP.

This division imposes a study of the countries that we have observed in order to determine what characteristics have brought them together, and how we should explain the results that we have obtained.

4. Discussion of the Findings and Concluding Remarks

After careful consideration of the literature on the matter, we find that our results correspond with the theoretical framework of supervisory systems adopted by various countries proposed by Schoemaker (2011) and depicted in Table II. There are, however two possible interpretations associated with our results: one considering that countries experiencing a positive effect of supervision on credit are “winners” and an alternative interpretation stressing that the positive effect of supervision on credit may, in fact, be a sign of an inefficient regulatory set-up.

Table II. Types of supervisory systems

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<td>(3b) Cross-sector: Integrated with central bank role in banking supervision</td>
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<td>United States (2010)</td>
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<td>Japan (2000)</td>
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4.1 REGULATORY SYSTEM EFFECT

After investigating, in Goodhart et al. (2002), the micro and macro-approaches of regulators in environments with varying central bank involvement in prudential regulation, Schoenmaker (2011) studies European and some non-European nations from the perspective of their adherence to one of several supervisory systems: sectoral, cross-sector functional, cross-sector integrated without central bank role in supervision (CSI-NOCB) and cross sector integrated with central bank role in supervision (CSI-WITHCB).

The sectoral model implies that countries have separate supervisory agencies for various financial activities (banking, securities, insurance). The Central Bank is not actively involved in prudential regulation, but focuses on its own independent objective (implicitly, utilizing monetary policy to ensure price stability).

The cross-sector functional archetype involves two prudential regulators. One of them ensures prudential supervision while the other focuses on business conduct. In the Eurozone, where countries have assigned their monetary policy prerogatives to the European Central Bank, central banks also play a role in prudential supervision.

The CSI-NOCB model implies that there is only one prudential regulator responsible for all supervisory matters, ensuring both prudential supervision and business conduct functions. The regulator does so without active involvement from the Central Bank. Both institutions pursue largely separate objectives.

Finally, the CSI-WITHCB model, similarly to the previous one, has a single prudential institution. However, here, the central bank plays an important role in regulation and supervision as it actively directs and dominates the prudential authority. As with the cross-sector functional archetype, this model involves less independence between the central bank’s and the prudential regulator’s objectives.

We find that countries belonging to the cross-sector functional, cross-sector integrated without central bank role in banking supervision and cross-sector integrated with central bank role in banking supervision models all manifest a positive and significant relationship between supervision and domestic credit.

As for the other countries, we notice that with the exception of Greece, all the countries from the sectoral group are located in the lower-right quadrant where supervision has no effect on credit. These countries all retained their initial sectoral regulatory structure. Greece is an exception, in the sense that in its case, supervision does tend to affect domestic credit significantly. It is however well-known that in Greece, neither the Central Bank, nor presumably the prudential institutions were immune to government interventionism. As such, it is
impossible to maintain that the objectives of the central bank and of the other supervisory institutions were separate, thus, giving Greece a structure more similar to the one adopted by cross-sector functional countries.

In the unaffected group, we also notice Switzerland which has recently undergone changes to its regulatory stances, but whose regulatory system remains similar to the initial sectoral model, despite aiming to transition towards a cross-sector, integrated, with central bank role in banking supervision archetype\(^\text{12}\). Furthermore, we have Italy which would seem to be an exception, given its adherence to the cross-sector functional category. Still, supervision does not manifest any effects on credit. This could be explained by recent theoretical models developed by the Bank of Italy\(^\text{13}\) which stress that, in normal times (outside of financial crises), the use of capital requirements by prudential institutions has little effect on macroeconomic stability. As such, we can conclude that in the Italian case, factors unrelated to its regulatory structure cause it to manifest weak sensitivity of its domestic credit to changes in the stringency of supervision. Finland is an example of a country that very recently changed its supervisory structure, passing in 2009 from the sectoral model to the cross-sector, integrated, with central bank role in banking supervision archetype. The effects of this transition have yet to be felt, as Finland continues to stay anchored to its sectoral model counterparts. Similarly, we have two countries, Poland and the Czech Republic who recently underwent similar transitions from the sectoral model to the cross-sector, integrated, without central bank role in banking supervision model (for Poland, in 2008) and to the cross-sector, integrated, with central bank role in banking supervision model (for the Czech Republic, in 2006).

These post-socialist transition economies may well have taken the changes in regulatory structure more difficultly, as evidenced by the significant negative correlation between the stringency of their supervisory stance and the domestic credit variable. Indeed, these are the only two countries that have a negative correlation between supervision and credit. This conjecture could be due to a signaling effect ignited by the regulatory structure reform. In effect, for these post-socialist countries, the transition to a new system could have been associated with a lack of trust (stemming from both local private agents and public authorities) in the financial sector. As such, increases in supervisory stringency may have been misinterpreted as attempts to bring increasing banking insecurity under control, rather than efforts to improve an already sound system, thus influencing credit in a negative manner.

\(^{12}\) see the FDF 2012 report on macro-prudential oversight in Switzerland addressing the issue of financial institutions too big to fall

\(^{13}\) see Angelini, Neri, Panetta (2010)
There also exists an alternative explanation where countries with no effect of supervision on credit are, in fact, winners, in the sense that it is their economies that would seem to be better adapted to face financial shocks. This alternative explanation based on the findings of Ueda and Valencia (2012) indicates that when central banks are assigned the additional objective of regulating the financial system by ensuring the supervision of the banking sector as well as the prerogative of intervention in the event of disturbances, the Central Bank is, in fact, incapable of satisfying both objectives at the same time. Given its statutory role of ensuring price stability, it will first and foremost focus on this primary objective. As for prudential regulation, it will tend to get sidelined and, therefore become less efficient. This is the main reason for which we observe a positive and significant effect of regulation on credit. In other words, due to the overlapping objectives, regulation does not fulfill its role of tightening credit to reduce risk. On the contrary, it seems that the higher the regulation the more credit is issued. This way of viewing things would indicate that transitioning towards prudential systems based on a single regulator reduces the efficiency of prudential regulation and, specifically, supervision. It would also indicate that the recent crisis experienced first and foremost by western nations may have come as a result of a transition towards such systems. If that were indeed the case, then it would be recommendable for countries to reconsider their stance on the unification of regulatory systems. Consider that since entrusting supervisory roles to the central bank of one’s own country leads to efficiency losses, delegating these responsibilities to a supranational body would only serve to exacerbate the situation.

All in all it seems to be that increased supervision has a signaling effect. As such, higher supervisory stringency would indicate increased safety of the banking sector and thus would serve to stimulate credit demand resulting in an increase in overall credit. This theory is in line with Schoenmaker (2011) while not negating the provisions of our alternative explanation. Such an interpretation, however, would only be valid if the supply side increased to match the higher credit demand. This, in turn, is possible under the condition that the regulatory stance remains unchanged for other prudential indicators excepting supervision, such as: capital requirements, liquidity ratios, reserve requirements, etc.

This means that we would ideally isolate the singular impact of supervision on credit, when other prudential regulation indicators remain unchanged. However, since in the vast majority of recent cases prudential regulation measures and changes have come as “package deals”, including alterations to multiple areas of regulatory control, we must also consider the effects of other prudential tools on the economy and in particular on the supply of credit, when making any conclusions or previsions regarding the effects of supervision on domestic credit.
4.2 CONCLUSION

To conclude, we find, as suggested in the recent theoretical literature, that prudential supervision can have a positive effect in terms of credit growth. Such is the case when there is a conflict of interest amongst the objectives of the Central Bank and the prudential regulator or when the regulation presents a moving target reacting to fluctuations in the economic cycle. We find no evidence to suggest that increased supervision systematically produces a negative effect on credit. To the contrary, our results are also coherent with a strand of the theoretical literature assigning prudential regulation a positive effect as a result of better credit allocation. In this context, enhanced prudential regulation in the form of increased supervisory stringency signals to creditors and depositors alike a safer business environment suitable for increased credit and growth. As stressed in the literature however, this effect is only applicable to advanced economies with competitive markets and developed financial institutions.

Indeed, it would seem that old-school regulatory set-ups involving multiple independent prudential institutions each focusing on separate objectives are better aligned with the traditional literature that emphasizes the restrictive effects of regulation on credit. However, the transition to newer forms of prudential regulation with either central bank involvement in prudential affairs or the consolidation of objectives into a single supervisory institution, leads increased supervisory stringency to produce a positive effect on credit.

With the coming into fruition of the Single Supervisory Mechanism towards the end of 2014, we will be better able to study the effects of prudential regulation under a sole supervisory institution. This will hopefully lead us to find a resolution to the debate over the efficiency of supervisory independence. However, we expect more questions to arise regarding the coordination of monetary and prudential policies, and the economic effects of applying uniform prudential regulation over countries manifesting strong heterogeneity.
Appendix: Empirical Bayes’ Estimator, by country, 1999–2012 timeframe

*Table A. Model 1. Traditional macro-economic variables*

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