# European Banking Integration under a Quadratic Loss Function

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Abstract

European banking markets have become increasingly integrated in recent years, but barriers to full integration, especially in retail banking, still remain. This paper covers a gap in the literature by providing a first insight into the process of financial integration in the European Union (EU) in terms of convergence in the speed of adjustment of cost inefficiency to equilibrium level. We employ a quadratic loss function specification based on forward-looking rational expectations to model the underlying dynamics of efficiency scores in the banking industry of the EU-15 region over the period 1998-2005. Results show that there is considerable variation in the speed of adjustment across banking systems, while over time it also appears that continuing efforts to advance financial integration have not as yet led to an improvement in the speed of adjustment to the long run equilibrium.

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# 1. Introduction

In recent years the European Union (EU) has been transforming rapidly into a more competitive and integrated economic region. Initiatives, such as the harmonization of banking and other financial services legislation as part of the EU's Single Market, the establishment of the European Economic and Monetary Union (EMU), and the ongoing implementation of the Financial Services Action Plan (FSAP) have helped reducing the barriers to cross-border trade in banking services, thus, enhancing the degree of financial integration. EU deregulation has also facilitated the environment in which technology and other bank strategic drivers have become operationally more important (European Commission 2001).

Indeed, substantial progress has been achieved over the years, though this progress has not been uniform across different segments of the market. Despite a sustained legislative drive at EU level that led to substantial integration and harmonization of money, bond and equity markets (Emiris 2002; Hartmann et al. 2003; Baele et al. 2004; Manna 2004; Guiso et al. 2004; Cappiello et al. 2006), banking integration still faces significant barriers. These barriers arise from national economic conditions, culture, language and differences in fiscal and legal systems (ECB 2000; Berger et al. 2001; Buch and Heinrich 2002; Berger et al. 2003). In particular, the integration process has clearly been slower in the retail banking area due to the traditionally strong local nature of these activities (Cabral et al. 2002; Heinemann and Jopp 2002; Eppendorfer et al. 2002; Schuler and Heinemann 2002). The establishment of the Monetary Union has led to some convergence in the levels of retail loan and deposit interest rates in the euro area, though significant differences still exist, suggesting that market segmentation remains strong thus impending banking integration (Cabral et al. 2002; Sørensen and Gutiérrez 2006).

European banking integration is of particular importance as it could positively contribute to economic growth by removing frictions and barriers to exchange, and by allocating capital more efficiently (Baele et al. 2004), while, on the other hand, it could mitigate negative effects derived from systemic risk (Goddard et al. 2007). After all given that banks are major players in the euro area financial system achieving homogeneity with an integrated banking sector would improve the effectiveness of the monetary policy transmission mechanism in the euro area (Cabral et al. 2002).

European integration has also implications for: the competition in banking markets, the nature of long-term borrower-lender relationships, and the links between ownership structure, technological change and bank efficiency (Goddard et al. 2007). In addition, Molyneux et al. (1997) argue that the formation of a single financial market place would improve bank's efficiency.

The topic of European financial integration is not new as it remains at the forefront of economic research for some years. A plethora of studies in European financial integration have employed different approaches, using various types of convergence and dispersion measures (see Cabral et al. 2002; Sørensen and Gutiérrez 2006; Casu and Girardone 2004; 2006). Several studies have examined the degree of homogeneity across EU banking systems in terms of cost and profit efficiency, with a particular focus on cross-country comparisons (see for example Allen and Rai 1996; Altunbas et al. 2001; Lozano-Vivas et al. 2001; 2002; Biker 2002; De Guevara and Maudos 2002; Maudos et al. 2002; Vander Vennet 2002; Casu and Molyneux 2003).

In this study, we depart from the traditional efficiency literature, and apply a multi-period forward looking rational expectations specification to measure the speed of adjustment to the optimal cost level in fifteen EU countries, namely Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Netherlands, Portugal, Spain, Sweden and the UK, over the period 1998-2005. Moreover, we focus on the degree of homogeneity, and hence implicitly on the degree of integration, as measured by the speed of adjustment to equilibrium and its evolution over time in the period 1998-2005. In detail, we opt for the stochastic frontier analysis within a translog cost function framework, so as to derive bank-specific inefficiency scores, while as a second step we apply a multi-period forward looking rational expectations specification to measure the speed of adjustment to the optimal cost level. In particular, using a dynamic panel model we opt for a quadratic loss function to account for adjustment costs between the current level of inefficiency and the optimal one. To this end, the adjustment of banks' costs is seen as a dynamic process based on rational expectations, and not as a static procedure. This idea first came up in the literature of aggregate demand (Cuthbertson and Taylor 1990; Mizen 1994), while Huang and Chen (2006) follow a similar methodology in banking.

The banking sector is usually found to be the least integrated segment of the European financial system and therefore we should a priori not expect to find a common speed of adjustment across countries (Sørensen and Gutiérrez 2006). According to Freixas (2003) and ECB (2004), European Union banking systems are inherently heterogeneous due to historical differences in market structures, bank supervision and regulation, and legal traditions, while anecdotal evidence suggests there are considerable difficulties in reducing heterogeneity or integrating markets via financial deregulation. This is confirmed by our findings that show different paces of banking adjustment across countries, providing insights of a lagging integration within EU banking. Moreover, over time results show that the launch of the euro in

2002, along with the intensifying efforts to achieve a higher degree of financial integrations, have not had a crucial impact on the speed of adjustment of banks.

The rest of the paper is organized as follows. Section 2 analyses the theoretical specification, while Section 3 describes the data used in the analysis. Our main findings are presented in Section 4, while some conclusions are offered in the final section.

## 2. A theoretical specification - the efficiency scores under a quadratic loss function

Firstly, we employ the stochastic frontier approach (SFA), as developed by Aigner et al. (1977) and Meeusen and Van den Broeck (1977), to estimate cost inefficiency. According to the SFA, total cost follows the following specification:

$$TC_{it} = f\,(P_{it}, Y_{it}, N_{it}, Z_{it}) + v_{it} + u_{it} \tag{1}$$

where $TC_{it}$ denotes observed total cost for bank $i$ at year $t$, $P$ is a vector of input prices, $Y$ is a vector of outputs of the firm, N is a vector of fixed netputs and $Z$ stands for a set of control variables. This approach disentangles the error term in two components. The first one, $v_i$, corresponds to the random fluctuations and is assumed to follow a symmetric normal distribution around the frontier, while the second one, $u_i$, accounts for the firm's inefficiency and is assumed to follow a half-normal distribution.

For our cost efficiency function, we opt for a translog specification. This representation gives:[1]

[1] For simplification, we omit the subscripts for time ($_t$).

$$\ln TC_i = \alpha_0 + \sum_i a_i \ln P_i + \sum_i \beta_{\mathrm{i}} \ln Y_i + ½ \sum_i \sum_j a_{ij} \ln P_i \ln Pj + ½$$
$$\sum_i \sum_j \beta_{ij} \ln \mathrm{Y}_i \ln \mathrm{Y}_j + \sum_i \sum_j \delta_{ij} \ln P_i \ln \mathrm{Y}_j + \sum_i \varphi_{\mathrm{i}} \ln \mathrm{N}_{\mathrm{i}} + ½ \sum_{\mathrm{i}} \sum_j \phi_{\mathrm{ij}} \ln N_i \ln N_j +$$
$$\sum_i \sum_j \xi_{\mathrm{ij}} \ln P_i \ln N_j + \sum_i \sum_j \zeta_{\mathrm{ij}} \ln Y_i \ln N_j + \sum_i \eta_{\mathrm{i}} \ln Z_i + kD_i + \theta_1 t + ½ \theta_2 \mathrm{t}^2 +$$
$$\sum_i \mu_{\mathrm{i}} t \ln P_i + \sum_i \kappa_{\mathrm{i}} t \ln Y_i + + \sum_i \nu_{\mathrm{i}} t \ln N_i + v_i + u_i \qquad (2)$$

Standard linear homogeneity and symmetry restrictions in all quadratic terms are imposed in accordance with economic theory, thus $\alpha_{ij}=\alpha_{ji}$; $\delta_{ij}=\delta_{ji}$; $\xi_{ij}=\xi_{ji}$, $\mu_{ij}=\mu_{ji}$, $\forall i, j$ , while we also include both country and time effects. The cost frontier can be approximated by maximum likelihood, and efficiency levels are estimated using the regression errors. Jondrow et al. (1982) show that the variability, $\sigma$, can be used to measure a firm's mean efficiency, where $\sigma_\varepsilon^2 = \sigma_u^2 + \sigma_v^2$.

Firm level inefficiency for the exponential model is then derived from the following function[2]:

$$E[u_i / \varepsilon_i] = z + \frac{\sigma_v \phi(z/\sigma_v)}{\Phi(z/\sigma_v)} \qquad (3)$$

where z = ε-θσ, Φ is the standard normal cumulative distribution function and φ(.) is the density of the standard normal distribution.

As a next step, the dynamics of inefficiency scores derived from the first stage are modelled using a forward-looking rational expectations specification similar to the one found in the optimal money demand literature (see Cuthbertson and Taylor 1990; Mizen 1994; Huang and Shen 2002). According to this approach the typical bank is assumed to minimize the conditional expectation of a discounted quadratic loss function (*L*). This objective function takes the form:

[2] The normal-exponential model comes from: $f(u) = \theta e^{-\theta u}$, where $E[u] = \frac{1}{\theta}$ and $E^2[u] = \frac{1}{\theta^2}$.

$$L = E_t \left\{ \sum_{i=1}^{n} D^i \left[ \gamma_1 (InC_{t+i} - InC^*_{t+i})^2 + \gamma_2 (InC_{t+i} - InC_{t+i-1})^2 \right] \right\} , \qquad (4)$$

where $E_t$ is the conditional expectations operator on the information set at time *t*, *D* denotes a discount factor less than unity, and $\gamma_i$ ( i=1, 2) are the non-negative adjustment cost coefficients. More specifically, $\gamma_1$ represents the disequilibrium parameter, measuring the deviation of actual costs $InC_{t+i}$ at time *t+i* from its optimal (long-run equilibrium) value $InC^*_{t+i}$, while $\gamma_2$ counts for the short-run adjustment (transaction) between any two consecutive periods.

Taking a partial derivative of equation (4) with respect to $InC_{t+i}$ and rearranging gives the following equation for operational costs:

$$InC_t = \lambda InC_{t-1} + (1-\lambda)(1-D\lambda)\sum_{i}^{n}(D\lambda)^j E_t (InC^*_{t+i}) , \qquad (5)$$

where $\lambda$ is the stable root of the Euler equation and its value lies between zero and one.

We assume that $InC^*_t$ approximates the functional form of the desired minimum inefficiency. Here, we assume that this functional form follows a simple stochastic process:

$$InC^*_t = \zeta InC^*_{t-1} + \varepsilon_t , \qquad (6)$$

where $\varepsilon_t$ is white noise.

The reduced form cost equation on the basis of (5) and (6) can then be expressed as:

$$InC_t = InC^*_t + \lambda InC_{t-1} + \varepsilon_t , \qquad (7)$$

where $InC^*_t$ is function of *D*, $\gamma$, and the parameter $\zeta$ of equation (6).

The above equation shows the identification of the underlying dynamic effect as measured by $\lambda$. In detail, $\lambda$ captures the persistence of inefficiency scores over time, whilst *1-λ* reflects the adjustment speed to equilibrium. The values of λ range between zero and unity. The higher the value of λ the longer the suboptimal inefficiency level persists, resulting in slower adjustment to the optimal cost level. A firm having a zero value of λ means that it could correct its past-period inefficiency instantly, while a unit value of λ corresponds to a bank that never adjusts its past-period inefficiency.

## 3. Data description

Our data includes commercial banks operating in EU-15 countries that are listed in the IBCA-Bankscope database over the period 1998 to 2005. After confining our analysis to credit institutions that report positive equity capital and reviewing the data for reporting errors and other inconsistencies, we obtain an unbalanced panel of 5,568 observations, which includes a total of 883 different banks. As a result, our sample is quite extensive and covers the largest credit institutions in each country, as defined by their balance sheet aggregates.[3]

While there continues to be a debate about the definition of bank inputs and outputs, we follow along the lines of the traditional intermediation approach as suggested by Sealey and Lindley (1977), which views banks as institutions that collect deposits, using labour and physical capital, to transform them into loans and other earning assets.[4] In particular, regarding input prices, the price of labour is proxied by the ratio of personnel expenses to total assets, while the price of deposits is

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[3] The year and number of included banks are: 1998:586, 1999:633, 2000:673, 2001:714, 2002:769, 2003:807, 2004:710, and 2005:676. The additions to the sample are not necessarily new market entrants, but rather successful banks that are added to the database over time. Exits from the sample are due primarily to lack of updated data, mergers with other banks or bank failures.

[4] A variety of approaches have been proposed in the literature for the definition of bank inputs and outputs; yet, there is little agreement among economists as what unequivocally constitutes an acceptable definition, mainly as a result of the nature and functions of financial intermediaries. See

defined as the ratio of interest expenses to total funds. The output vector includes loans (defined as total loans net of provisions) and other earning assets, while total cost is defined as the sum of overheads (personnel and administrative expenses), interest, fee, and commission expenses.

We also specify physical capital and equity as fixed netputs. The treatment of physical capital as a fixed input is relatively standard in efficiency estimation (Berger and Mester 1997), while the level of equity is included so as to account for different risk preferences of banks and to control for bank's insolvency risk (Mester 1996; Berger and Mester 1997). If financial capital is ignored, the efficiency of banks that may be more risk averse than others and may hold a higher level of financial capital would be mismeasured, even though they are behaving optimally given their risk preferences.[5] Apart from this, a bank's capital directly affects costs by providing an alternative to deposits as a funding source for loans (see Berger and Mester 1997).

Moreover, to allow for the effect of country features on bank's underlying technology, we also include country-level variables in the estimation of the stochastic frontier, which may be associated with the variations of inefficiency measures across banks and may affect incentives and managerial decisions. In other words, by introducing country-specific variables in the estimated cost frontier, we are able to attribute differences in banking sectors across countries to the characteristics of the operating environment that are beyond the control of bank managers, thus effectively conditioning the frontier of the banking sector in each country in a way that is amenable for cross-country comparisons of bank performance.

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Berger and Humphrey (1997) for a review of studies on financial institution efficiency and the various methods used to define inputs and outputs in financial services.

[5] Hughes and Moon (1995) and Hughes, Lang, Mester and Moon (1996) tested and rejected the assumption of risk neutrality for banks.

These variables include: the Herfindahl index, capturing asset market concentration, the average capitalization ratio to proxy for regulatory conditions, the logarithm of bank assets to control for bank size, the intermediation ratio that is defined as the ratio of total loans to total deposits to capture differences across banking markets in terms of their ability to transform deposits into loans, the number of branches per square kilometre, which is a measure of branch density and takes into account the spatial dimension and the potential overcapacity of each banking industry and finally the GDP per capita variable which affects numerous factors related to the demand and supply of financial services.[6]

Table 1 provides summary statistics of the variables used in this study for the overall sample and by country over the period 1998-2005. Comparing mean values across countries, we can observe significant variations regarding total cost, outputs and input prices, as well as country-level variables. In particular, the average cost to assets ratio for all EU-15 countries stands at about 6 percent, ranging from 4.28 percent in Ireland to 6.75 percent in Greece. This indicates that there is still room for improvement in terms of operating cost. Nevertheless, the average cost ratio for the whole EU-15 region and for most EU member states follows a negative path over time, in particular since 2001, flagging out banks' efforts to restrain their cost exposure. Moreover, the introduction of organizational changes (e.g. outsourcing), the centralization of information technology and back-office activities and the establishment of unified platforms appear to be widely applied strategies aiming at

[6] Asset market concentration can have either a positive or a negative impact on efficiency: if market concentration reflects market power for some banks, it may increase the costs for the sector through slack and inefficiency; if concentration reflects consolidation through survival of more efficient banks and markets remain contestable, it would be associated with higher efficiency (see Demsetz 1973). The relationship between bank size and inefficiency is also ambiguous. On the other hand, the capitalization and the intermediation ratios, as well as the GDP per capita variable are expected to have a positive impact on bank efficiency, while we anticipate the opposite relationship is expected between branch density and inefficiency (see also Dietsch and Lozano-Vivas 2000)

reducing cost, standardizing operating and information procedures and exploiting specialization according to the customer segment (ECB 2003).

*(Please insert Table 1 about here)*

Substantial differences across the banking industry are also revealed by looking at banks' output structure in the respective European countries. Regarding bank outputs, loans still comprise the largest proportion of banks' balance sheets. In detail, the average loans to assets ratio stands at about 48 percent, which is higher than the average ratio of other earning assets, standing at about 45 percent. Nevertheless, the increasing ratio of non-loan assets in banks' balance sheets confirms the trend of reorienting banking activities from traditional bank lending towards investment activities, such as creating and selling new capital market products. We should note, however, that in the majority of EU-15 countries, the loan ratio remains higher than the other earning assets ratio, with the exception of Belgium, Ireland, Luxembourg and the UK. Regarding input prices, note that the average price of deposits stands at about 4 percent for the whole EU-15 region, ranging from 2.63 in Denmark to 6.75 in Netherlands, while the average price of labour is 1.54, and ranges from 0.37 in Ireland to about 2 percent in Denmark.

Country-level variables that capture the structure and regulatory environment of banking markets also exhibit significant variation across EU member states. Overall, it appears that the EU-15 banking industry is relatively unconcentrated, although the Herfindahl index exhibits a fair amount of dispersion across EU-15 countries. Concentration is closely related to market size, as some of the smaller countries tend to have a higher degree of concentration due to the presence of a few large banks. This may point towards the presence of scale economies, since in a smaller market fewer banks may be able to reach a viable size, whereas in a large market, a smaller percentage share may provide sufficient scale to operate efficiently (ECB 2004). Branch density also exhibits wide variation across countries, ranging from 0.04 branches per square kilometre in Finland to 0.145 in Germany. This is also the case for the capitalization ratio and for the average intermediation ratio, the latter ranging from about 60 percent in Luxembourg to over 238 in Denmark.

# 4. Empirical Results

## 4.1. Inefficiency scores

The average cost inefficiency scores per country and over time are presented in Diagram 1.[7] Our results are in line with the vast majority of the literature that estimates the average cost inefficiency of EU countries in the range of 0.15 to 0.20 (see for example Allen and Rai 1996; Cavallo and Rossi 2001; Bos and Schmiedel 2003; Casu and Girardone 2004; Maudos and Guevara 2007). In particular, the average cost inefficiency level for all EU-15 countries is estimated at 0.166, ranging from 0.123 in Denmark to 0.237 in Ireland. The Scandinavian banking markets (Denmark, Finland and Sweden) show remarkably low inefficiencies scores. Swedish banks tend to be measured as best performers, despite the fact that these banks suffered a crisis in the early 1990s requiring substantial government intervention (Berger et al., 2000). On the other hand, countries that show a less rosy picture over time are: Netherlands, Italy, France and the UK. The low performance in terms of efficiency of the Italian and French banks could be partly explained by the slow pace of deregulation that raises obstacles to improve operation based on new technologies (Bikker 2002). In the case of the UK, though a country with an advanced financial

[7] Parameter estimates of the translog cost frontier can be provided upon request. Most of the coefficients are statistically significant and have the expected sign according to economic theory.

system, it ranks low in terms of cost efficiency in many efficiency studies (i.e., Altunbas et al. 2001; Cavallo and Rossi 2001; Casu and Girardone 2004), which could be attributed to a low degree of competition.

*(Please insert Diagram 1 about here)*

Regarding the evolution of inefficiency scores over time, we observe different patterns across countries. The highest improvement in terms of efficiency is observed in Finland and Portugal, and to a lesser extent in Belgium. Late in the sample period a sharp reduction of inefficiency is also observed in the case of Greece. Remarkably, the underlying efficiency trends do not appear to show a common pattern across EU-15, as Ireland, Luxembourg, Germany and Spain present a clear upward trend in inefficiency over the examined period. In addition, we observe that the efficiency gap, roughly measured as the difference between the most and the least cost efficient banking sector, seems to have widened over time. In detail, the efficiency gap increases significantly from 1998 to 2001, while it follows a diminishing pattern up to 2003. However, this trend is short-lived, as it is reversed after 2003.

The above results clearly demonstrate the existence of some diversity across EU-15 countries given that no apparent homogenous pattern of inefficiency scores is reported. This lack of homogeneity may reflect inherent differences in the underlying markets due to historical differences in market structures, bank supervision, regulation, legal traditions and due to different approaches that have been followed in terms of the timing and the implementation of banking reforms. At a general level, previous studies (Beck et al. 2003a,b; Beck and Levine 2004; La Porta et al. 1997, 1998; Levine 2003, 2004; Levine et al. 2000; Stulz and Williamson 2003) argue that differences in financial development, and thus economic growth, could be explained by differences in the legal tradition, the accounting conventions, the regulatory structures, the property rights, the culture and even in the religion explain.

Despite the observed heterogeneity in the reported inefficiency levels, an efficiency analysis fails to identify differences in the speed of reaction to a shock in the short term. As a way of tackling this issue, we employ the quadratic loss function that could provide evidence on convergence, if any, in the speed of adjustment towards long-run equilibrium. If Europe's banking markets have become more alike over the eight-year period under consideration, we would expect to observe convergence in the speed of adjustment across countries

## 4.2. Speed of adjustment across countries

Next, we employ the GMM estimator for dynamic panel data models proposed by Arellano and Bond (1991) so as to estimate Equation (7), which includes the lagged dependent variable ($C_{it-1}$) as an endogenous explanatory variable.[8] Based on Arellano and Bond (1991), we take first difference of Equation (7) on both sides and remove in this way the firm-specific effects. The lagged dependent variables with two or more periods are likely to be valid instruments for the equation in the first differences, depending on whether disturbance $\varepsilon_{it}$ is serially correlated.[9]

Table 2 presents the estimated results for our sample and reports some relevant diagnostic tests.[10] In our first unrestricted model (Model A), we estimate a different

[8] The least squares estimator of the fixed effects or random effects models in the presence of a lagged dependent variable among the regressors is both biased and inconsistent (see for example, Baltagi 2001).

[9] The chosen instrumental variables include the dependent variable lagged two to six to last periods.

[10] The models seems to fit the panel data reasonably well, as the Wald tests indicate fine goodness of fit, while the Sargan tests imply no evidence of over-identifying restrictions. Arellano and Bond (1991) tests for autocorrelation, AR(1) and AR(2), show some evidence of first-order autocorrelation. Note, however, that for the cases that the AR(1) test indicate some evidence of autocorrelation in models A and B, the AR(2) rejects the existence second-order autocorrelation, implying that the estimates are consistent (see Tables 2 and 3).

persistent parameter λ for each country, in order to compare the speed of adjustment across banking markets. In effect, λ identifies the persistence to a given level of inefficiency, whereas 1-λ captures the adjustment speed to the long-run equilibrium. λ takes values form 0 to 1, whereas the longer the current suboptimal inefficiency level persists, the higher the value of λ. In this framework, if integration is occurring, we would expect institutions from every country to *'catch up'* with best practice and therefore move towards a common EU-15 banking stochastic frontier at a higher speed. Thus, a higher value of 1-λ would imply a higher degree of integration across EU-15, as banks adjust their cost levels in a timelier manner so as to operate efficiently in an increasingly competitive environment.

*(Please insert Table 2 about here)*

Table 2 shows that most of the persistent parameters are statistically significant, but for Belgium, Denmark, and Sweden.[11] Overall, we observe a substantial variation in the estimated coefficients of λ across countries. In particular, the estimates range from 0.053 in Italy to 0.25 in Ireland. This indicates that the adjustment speed lies between 0.75 in Ireland and 0.95 in Italy. Thus, an Italian bank is able to adjust its previous period's inefficiency level at a much higher rate than an Irish bank. In detail, the Italian banking industry has the highest adjustment speed across EU countries, closely followed by Germany and Luxembourg. Although Italian banks rank low in terms of cost efficiency, their ability to adjust their cost levels to the long-run equilibrium in a timely manner indicates a *'catching up'* process that fosters integration. The high speed of adjustment observed in the Italian banking industry, which ranks at the top of our country-list, could be the result of large-scale consolidation and competitive pressure from other European countries. Similarly, the

[11] In the following discussions we ignore the outcomes for these three countries.

good performance of German financial institutions could be the result of their successful efforts to reduce their costs on a permanent basis and could also be attributed to the three-pillar structure of the German banking system, which has shown a high degree of flexibility and stability over the years. In a similar vein, the high speed of adjustment in Luxembourg could be explained by the large presence of foreign investors in the country.

Note that besides the slow speed of adjustment of Ireland, the speed of adjustment is also relatively low in Austria, Finland, Spain and the UK, as indicated by their high persistence parameters. Overall, we should also note that the average level of inefficiency in each country appears to exhibit some relation to the speed of adjustment towards equilibrium. In particular, the low speed of adjustment for Ireland, Austria and the UK, all ranking low in terms of efficiency, suggests that their *"efficiency gap"* with the best performers within EU not only has not narrowed over time, but in contrast it has exhibited a positive trend. Undoubtedly, the widening of *"efficiency gap"* does little to assist the European financial integration. On the other hand, the low adjustment speed observed in the case for Finland, and to some extent in the case of Spain, is less worrying for financial integration, as these banking systems rank high in terms of efficiency.

The speed of adjustment in France, Greece, the Netherlands and Portugal takes values that lie around the EU-15 average. In particular, the consolidation phase in the French banking industry in the mid 90s, the privatization of state-owned credit institutions that led to a drastic decrease in the number of bank branches and employees in Greece and paved the way for greater profitability and efficiency, and the liberalisation and increased competition in the Portuguese banking market along with strong investment in information technology may have positively contributed to an adequate speed of adjustment.

For comparison purposes, we also estimate a restricted model by imposing the single adjustment speed restriction, i.e., letting $\lambda_c=\lambda$ for all countries. The single persistence parameter by Model B is found to be quite low at 0.056. However, this result must be treated with caution given that most of the country specific parameters in Model A are significant. Thus, the imposition of $\lambda_c=\lambda$ for all countries on Model B might appear too restrictive.

Overall, we observe significant differences in the estimated persistence parameters across countries. The different speed of adjustment across banking systems could reflect differences in the terms of institutions, supervisory rules, government inferences, customer preferences and level of development across countries. Moreover, differences in competitive conditions that affect the need to reduce cost and to increase efficiency may explain the reported variation across EU-15. Nevertheless, the relationship between the speed of adjustment towards equilibrium and the average level of inefficiency in each banking industry is less clear. For instance, Ireland, which is lagging in terms of cost efficiency, is also the worst performer in terms of adjustment speed. On the other hand, Finland, which is considered to be among the most efficient banking systems in the EU, appears to adjust its costs to long-run equilibrium at a lower speed than the average.

### 4.3. Speed of adjustment over time

Next in our analysis, we investigate whether the adjustment speed changes over the examined period. In order to do so and given data availability issues, we split our sample into two sub-periods 1998-2001 and 2002-2005. If, indeed, the process of integrating European banking markets increases competition, we would expect a higher speed of adjustment over time. The estimated results are presented in Table 3.[12] We observe that the persistent parameter λ is estimated at 2.8% for the sub-period 1998-2001, while it marginally increases at 2.9% for the period 2002-2005. Our findings suggest that the adjustment speed has remained almost stable over the examined period, though we can observe a slight decreasing trend between the two periods from 97.2 to 97.1. A possible explanation could be that the first sub-period coincides with a phase of an intense consolidation process in most banking systems, swift rationalization of banks' operations and increasing competition resulting from the entry of new investors in most financial sectors. These developments could have clearly improved banks' performance and homogeneity across EU for the period 1998-2001, thereby leading to a somewhat lower adjustment speed for 2002-2005.

*(Please insert Table 3 about here)*

As a result, it appears at a first sight that the launch of the euro in 2002, along with the intensifying efforts to achieve a higher degree of financial integrations have not had a crucial impact, at least so far, on the speed of adjustment of banks.

## 5. Conclusion

This paper provides insights on the issue of European integration by examining the homogeneity across banking systems in terms of their underlying adjustment speed of cost inefficiency to long-run equilibrium. In particular, we employ a specification of a quadratic loss function based on forward-looking rational expectations to model the underlying dynamics of total costs in the banking industry

[12] Due to the small number of bank-year observations in some countries, we could not estimate separate persistent parameters for each banking industry for each sub-period. For this reason, we choose to

of the EU-15 countries over the period 1998-2005. Based on this specification, for a financial integration to occur, one would expect institutions from every country to *'catch up'* with the best practice at a common speed. In particular, this paper shows that the speed of adjustment is crucial for banking integration given the heterogeneity observed in inefficiency scores across countries.

Our results indicate some differences in the adjustment speed across countries, which could deter banking integration and could reflect, based on a recent paper by the Sørensen and Gutiérrez (2006), the existence of inherent barriers to cross-border trade in European banking and obstacles to the promotion of cross-country competition. Different tax regimes on retail savings, limitations on cross-border marketing of financial services, limits to hostile and cross-border takeovers in the financial services industry in general, are among the possible factors that encourage heterogeneity across countries and hinder European integration (Sørensen and Gutiérrez 2006). Moreover, regarding the evolution of adjustment speed over time, our findings suggest that the launch of the euro in 2002, along with the intensifying efforts to achieve a higher degree of financial integration did not have an impact to this day.

Overall, our analysis verifies the general notion that in retail banking, an area, which is the most visible banking activity for customers, integration seems less advanced than in other banking market segments such as wholesale and investment banking, as it is evident from the present reported heterogeneity in inefficiency levels, and in the speed of adjustment towards equilibrium across countries. These results suggest that banks, on average, could accelerate further the pace of adjustment of their cost efficiency over time, also in light of the ongoing global financial harmonization

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estimate a common persistent parameter for all EU-15 countries for the sub-periods 1998-2001 and

and liberalization. In response to growing domestic and international competitive pressures, banks are bound to further enhance their performance by minimizing their operation costs at a higher speed, employing optimal production plans, adopting new technologies, and reducing excess capacity through mergers. Since only the most efficient institutions will survive these challenges, the inefficient banks with a slow adjustment pace will either be acquired or eventually be driven out of market by the competition.

For this reason, it is of particular interest for policy makers, regulatory authorities and expert practitioners alike to have accurate information about the true underlying differences in bank performance among European countries so as to adjust to a highly evolving new and globalized environment, to undertake strategic decisions, to benchmark banking institutions performance, and to prepare for increasing competition in domestic as well as cross-border markets (Barros et al. 2007). A policy proposal for bank managers so as to raise the speed of adjustment is to employ a flexible cost structure. In addition, the challenge for policy makers is to avoid complacency and to continue addressing the structural weaknesses that are still holding back European banking integration and limit the EU capacity to make the most of a single banking market. Nevertheless, quoting Padoa-Schioppa (2005): '*political and regulatory bodies have to create the framework for financial integration but it is up to market forces to exploit this potential*'. Yet, the European financial integration provides an opportunity to accelerate structural reform efforts in the banking industry.

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2002-2005.

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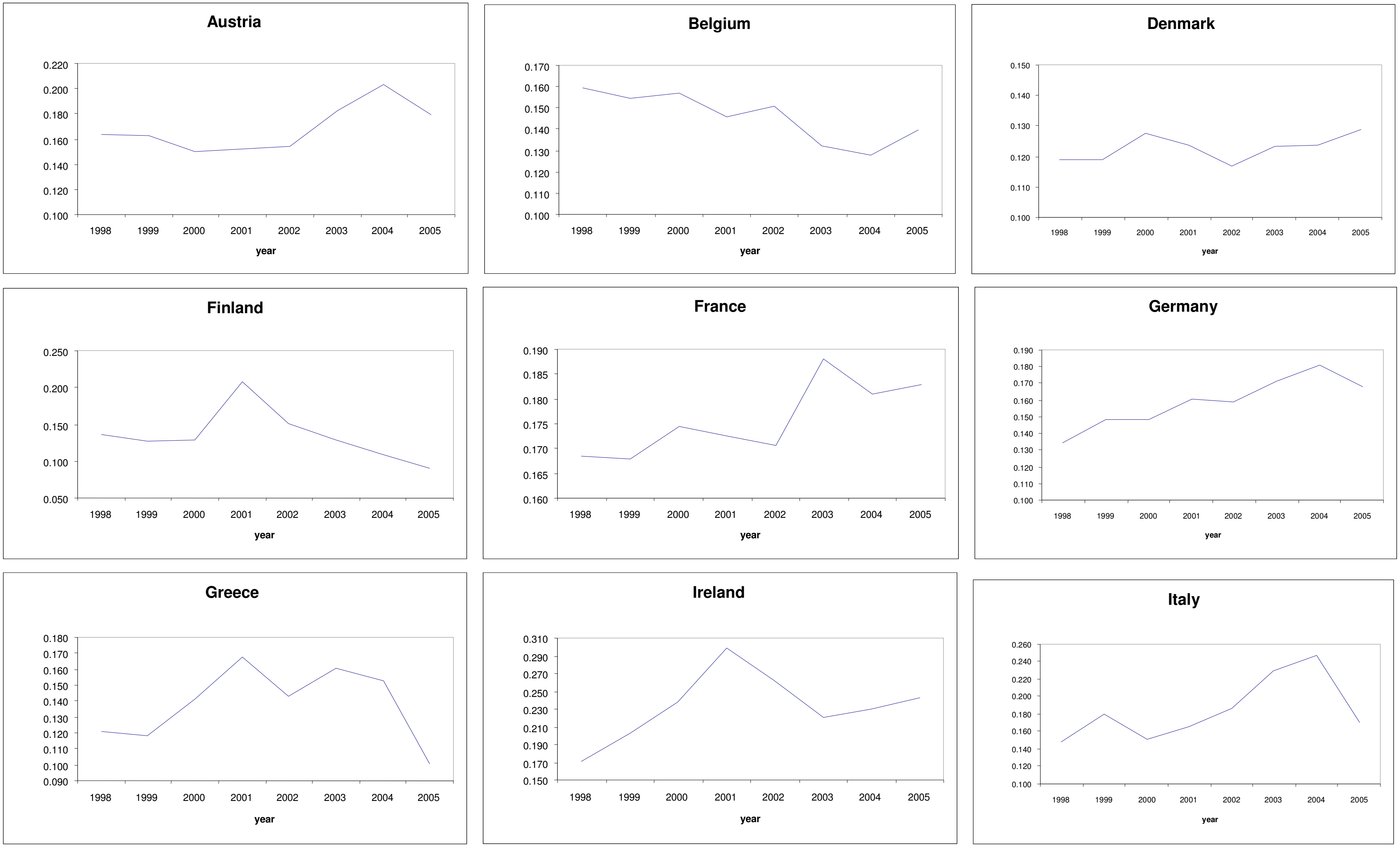
Table 1: Summary Statistics (pooled sample 1998-2005)

| | **C/A** | **$y_1$/A** | **$y_2$/A** | **$p_1$** | **$p_2$** | **$n_1$** | **$n_2$** | **Total Assets** | **GDP per capita** | **HHI** | **Capitalization ratio** | **Branch Density** | **Intermediation ratio** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Austria | 6.31 | 51.80 | 42.53 | 3.67 | 1.82 | 253 | 51.82 | 6,184 | 22,284 | 556 | 5.26 | 0.053 | 128.30 |
| Belgium | 5.53 | 36.28 | 58.80 | 3.08 | 1.55 | 1,305 | 391.68 | 38,700 | 20,954 | 1,727 | 3.37 | 0.191 | 80.19 |
| Denmark | 5.54 | 58.93 | 34.09 | 2.63 | 2.00 | 305 | 40.19 | 7,474 | 27,608 | 1,176 | 6.04 | 0.052 | 238.21 |
| Finland | 5.49 | 50.50 | 36.41 | 3.31 | 1.85 | 2,415 | 393.71 | 39,800 | 21,947 | 2,290 | 7.57 | 0.004 | 118.75 |
| France | 6.64 | 49.98 | 41.87 | 4.42 | 1.85 | 903 | 197.15 | 23,800 | 20,890 | 587 | 4.70 | 0.047 | 123.46 |
| Germany | 6.35 | 49.66 | 45.23 | 3.78 | 1.68 | 687 | 144.54 | 19,900 | 21,262 | 160 | 4.21 | 0.145 | 125.50 |
| Greece | 6.75 | 54.63 | 35.43 | 3.95 | 1.71 | 823 | 323.09 | 11,800 | 10,319 | 1,108 | 7.39 | 0.024 | 68.34 |
| Ireland | 4.28 | 36.88 | 54.72 | 4.42 | 0.37 | 933 | 125.49 | 17,900 | 24,427 | 535 | 5.60 | 0.013 | 138.44 |
| Italy | 5.77 | 54.32 | 37.34 | 3.61 | 1.63 | 963 | 250.70 | 17,000 | 17,571 | 234 | 6.91 | 0.098 | 146.21 |
| Luxembourg | 5.33 | 21.88 | 73.96 | 5.18 | 0.63 | 280 | 33.00 | 6,969 | 43,439 | 277 | 3.54 | 0.111 | 60.38 |
| Netherlands | 6.36 | 50.21 | 43.86 | 6.75 | 1.02 | 1,744 | 526.05 | 49,700 | 21,981 | 1,752 | 3.90 | 0.117 | 133.16 |
| Portugal | 5.46 | 51.24 | 40.80 | 4.40 | 1.19 | 691 | 163.08 | 10,900 | 10,168 | 911 | 10.46 | 0.059 | 121.29 |
| Spain | 5.49 | 59.19 | 31.66 | 3.07 | 1.67 | 1,349 | 338.69 | 20,700 | 13,662 | 495 | 8.49 | 0.079 | 104.99 |
| Sweden | 5.02 | 75.13 | 19.11 | 2.75 | 1.43 | 805 | 59.42 | 20,300 | 25,577 | 801 | 5.63 | 0.005 | 225.60 |
| UK | 6.46 | 43.17 | 50.35 | 4.30 | 1.52 | 2,000 | 431.15 | 42,500 | 22,940 | 311 | 4.78 | 0.059 | 116.34 |
| **EU-15** | **6.02** | **48.10** | **45.15** | **4.01** | **1.54** | **928** | **210.97** | **21,300** | **22,759** | **541** | **5.26** | **0.087** | **126.26** |

**Note:** The table presents mean values by country and for the EU-15 region over the period 1998-2005. C/A: total cost to total assets (in %); $y_1$/A: total loans net of provisions to total assets (in %); $y_2$/A: other earning assets to total assets (in %); $p_1$: price of deposits, defined interest expenses to total deposits and short-tern funding (in %); $p_2$: price of labor, defined as personnel expenses to total assets (in %); $n_1$: equity; $n_2$: physical capital defined as fixed assets. HHI: Herfindahl Index, defined as the as the sum of the squares of all the credit institutions' market shares, according to total assets; Capitalization ratio: country-level ratio of equity to assets (in %); Branch Density: branches per square kilometer (in %); Intermediation ratio: country-level ratio of total loans to total deposits (in %). All outputs and total cost are expressed as percentages of total assets for comparison reasons. Fixed netputs (n1 and n2) and total assets are expressed in million euros (€). GDP per capita is expressed in euros (€). **Sources**: Bankscope database and own calculations, ECB, World Development Indicators.

Graph 1: Average Inefficiency scores by country




**Note**: The above graphs present the average cost inefficiency scores for each country and their evolution over time, as derived from a common stochastic cost frontier, where Log likelihood function=311.94; $\sigma^2_v$=0.027; $\sigma^2_u$= 0.084; $\sigma$=Sqr[$\sigma^2_v$+ $\sigma^2_u$]=0.331. Mean inefficiency=0.166. Inefficiency is assumed to follow an exponential distribution and ranges between zero and unity.

Graph 1 (continued)

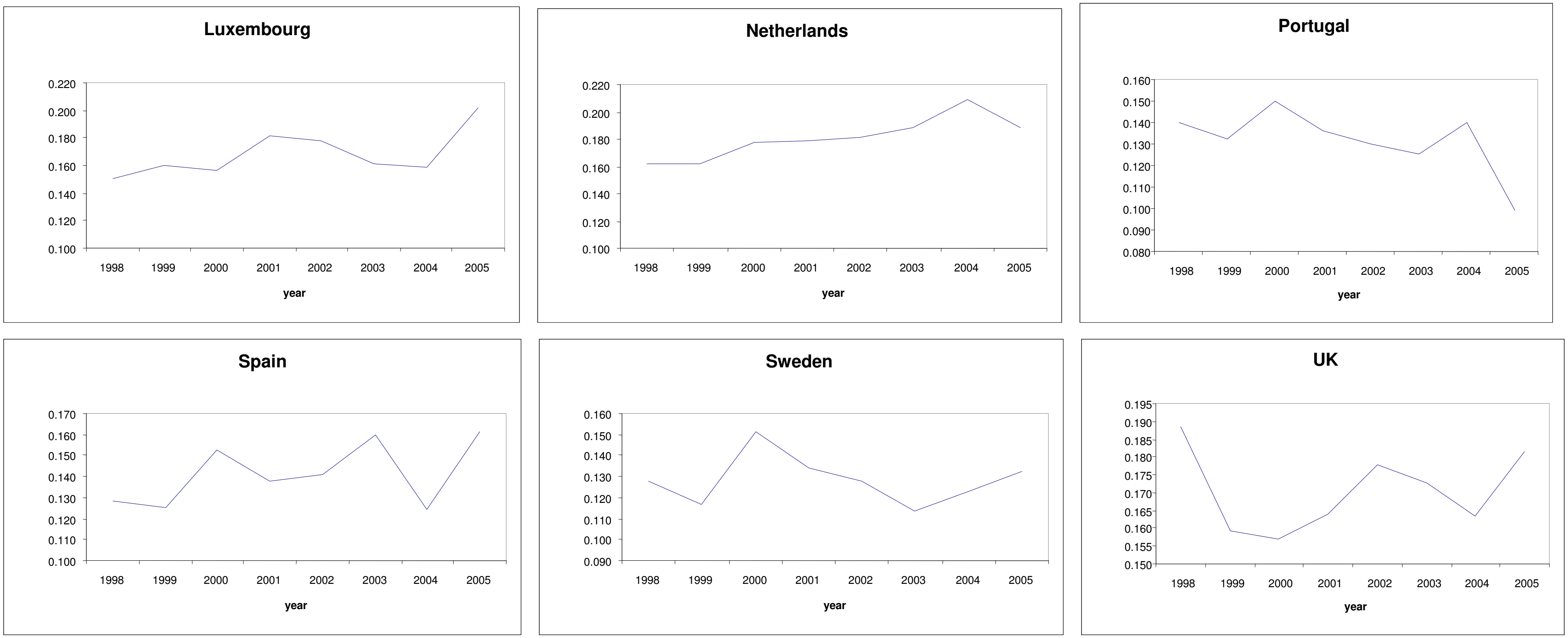


Table 2: Estimates of persistence parameter λ for each country

| **Model A (unrestricted model)** | | | | | | |
|---|---|---|---|---|---|---|
| | **λ** | **Std.Err.** | **Wald test** [a] | **Sargan test** [b] | **AR(1)** [c] | **AR(2)** [d] |
| Austria | 0.130** | 0.056 | $\chi^2(4)$=1,613 | $\chi^2(12)$=23.81 | z = -0.90 (0.3674) | z = 0.49 (0.6226) |
| Belgium | 0.020 | 0.052 | $\chi^2(4)$=1,450 | $\chi^2(12)$=28.98 | z = -1.61 (0.1084) | z = 0.51 (0.6097) |
| Denmark | 0.003 | 0.033 | $\chi^2(4)$=786 | $\chi^2(12)$=59.24 | z = -1.21 (0.2277) | z = 0.99 (0.3241) |
| Finland | 0.129** | 0.065 | $\chi^2(4)$=283 | $\chi^2(8)$=8.78 | z = -0.22 (0.8255) | z = 0.31 (0.7601) |
| France | 0.085** | 0.043 | $\chi^2(3)$=2,036 | $\chi^2(20)$=32.95 | z = -1.37 (0.1715) | z = -1.10 (0.2732) |
| Germany | 0.054*** | 0.016 | $\chi^2(4)$=13,869 | $\chi^2(12)$=27.16 | z = -2.40 (0.00164) | z = -1.60 (0.1099) |
| Greece | 0.086*** | 0.029 | $\chi^2(3)$=1,639 | $\chi^2(19)$=36.48 | z = -0.13 (0.8934) | z = -1.13 (0.2604) |
| Ireland | 0.252*** | 0.052 | $\chi^2(3)$=330 | $\chi^2(20)$=44.42 | z = -1.80 (0.0724) | z = -1.40 (0.1612) |
| Italy | 0.053* | 0.028 | $\chi^2(3)$=2,815 | $\chi^2(5)$=3.26 | z = -5.52 (0.0000) | z = -0.26 (0.7929) |
| Luxembourg | 0.072** | 0.034 | $\chi^2(4)$=3,400 | $\chi^2(3)$=28.05 | z = -0.78 (0.4358) | z = -1.09 (0.2772) |
| Netherlands | 0.094* | 0.050 | $\chi^2(3)$=1,130 | $\chi^2(14)$=11.60 | z = -2.58 (0.0100) | z = -1.76 (0.0781) |
| Portugal | 0.094* | 0.049 | $\chi^2(3)$=647 | $\chi^2(10)$=7.50 | z = -1.88 (0.0602) | z = -0.36 (0.7220) |
| Spain | 0.112*** | 0.036 | $\chi^2(4)$=3,078 | $\chi^2(8)$=11.15 | z = -1.41 (0.1593) | z = 0.46 (0.6439) |
| Sweden | 0.052 | 0.060 | $\chi^2(3)$=624 | $\chi^2(17)$=33.34 | z = 0.04 (0.9691) | z = -0.90 (0.3706) |
| UK | 0.126*** | 0.047 | $\chi^2(4)$=1,422 | $\chi^2(8)$=20.17 | z = -2.40 (0.0271) | z = -0.81 (0.4151) |
| **Model B (restricted model)** | | | | | | |
| EU-15 | 0.056*** | 0.019 | $\chi^2(4)$=12,190 | $\chi^2(3)$=15.12 | z = -3.82 (0.0001) | z = 0.01 (0.9919) |

**Note:** ***, ** and * indicate 1%, 5% and 10% significance levels, respectively. Model A is the unrestricted model, with separate persistent parameters (λ) for each country; Model B is the restricted model, with a common persistent parameter for all EU-15 countries. The speed of adjustment is defined as 1-λ.

[a]: Wald statistic is a test for the joint significance of the independent variables asymptotically distributed as $\chi^2_{(k)}$ under the null hypothesis of no relationship, where K denotes the number of slope coefficients estimated.

[b]: Sargan test is the test for over-identifying restrictions in GMM dynamic model estimation.

[c]: Arellano-Bond test that average autocovariance in residuals of order 1 is 0 ($H_0$: No autocorrelation). p-values in parentheses.

[d]: Arellano-Bond test that average autocovariance in residuals of order 2 is 0 ($H_0$: No autocorrelation). p-values in parentheses.

Table 3: Estimates of persistence parameter $\lambda$ over time

| **Time period** | **1998-2001** | **2002-2005** |
|---|---|---|
| $\lambda$ | 0.0286*** | 0.029*** |
| Std. Err. | 0.01 | 0.01 |
| Wald test [a] | $\chi^2(3) = 55348.17$ | $\chi^2(3) = 32814.97$ |
| Sargan test [b] | $\chi^2(10) = 3.81$ | $\chi^2(10) = 4.86$ |
| AR(1) [c] | z = -7.38 (0.000) | z = -5.08 (0.000) |
| AR(2) [d] | z = -0.05 (0.915) | z = -0.06 (0.952) |

**Note:** *** and * indicate 1% and 10% significance levels, respectively. We estimated separate dynamic regressions for each sub-period and for each type of ownership. The speed of adjustment is defined as 1-$\lambda$.

[a]: Wald statistic is a test for the joint significance of the independent variables asymptotically distributed as $\chi^2_{(k)}$ under the null hypothesis of no relationship, where K denotes the number of slope coefficients estimated.

[b]: Sargan test is the test for over-identifying restrictions in GMM dynamic model estimation.

[c]: Arellano-Bond test that average autocovariance in residuals of order 1 is 0 ($H_0$: No autocorrelation). p-values in parentheses.

[d]: Arellano-Bond test that average autocovariance in residuals of order 2 is 0 ($H_0$: No autocorrelation). p-values in parentheses.