Essays on the Empirics of Finance and Growth in Transition Economies

by

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Abstract

The role of finance in explaining economic growth is a pervasive topic in both theoretical and empirical literature. The increased pace of financial liberalization towards the end of the 20^{th} century has stimulated a large body of research that still contains many unresolved issues and controversial empirical findings on the existence of a positive causal link of financial development to growth. In addition, the process of financial development raises several issues regarding financial stability, which – as demonstrated by the global financial crisis that started in 2007 – is closely linked to the issues of overall macroeconomic stability and welfare. This thesis is a collection of three essays that each contribute to the literature on the role of financial development on growth, the corresponding role of international financial integration and risk assessment in the financial industry. The nature of the essays is empirical with a significant focus on transition economies of Central and Eastern Europe. The first paper is an empirical analysis of the subject, emphasizing the non-linearity of the relationship between financial development and economic growth. The second paper shifts the focus from the effect of financial development on growth to a study of the effects of financial integration on growth. While remaining in the field of empirical finance, the third paper of the thesis represents a larger departure from the first two, both in terms of a narrower research focus and the econometric methodology employed. The paper addresses the issue of financial stability and the use of appropriate methods of credit risk assessment at the firm level.

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1. Overview of the Thesis

The role of finance in explaining economic growth is a pervasive topic in both theoretical and empirical literature. The increased pace of financial liberalization towards the end of the 20th century has stimulated a large body of research that still contains many unresolved issues and controversial empirical findings on the existence of a positive causal link of financial development on growth. In addition, the process of financial development raises several issues regarding financial stability, which – as demonstrated by the global financial crisis that started in 2007 – is closely linked to the issues of overall macroeconomic stability and welfare. This thesis is a collection of three essays that each contribute to the literature on the role of financial development on growth, the corresponding role of international financial integration and risk assessment in financial industry. The nature of the essays is empirical with a significant focus on transition economies of Central and Eastern Europe. Around 1990, these countries started a transition from centrally planned economies to market economies. Two decades after, many of them form part of the European Union or even Economic and Monetary Union (EMU). During this period, all of these countries went through a process of complete change of their financial systems, from a state where money and finance represented residual variables in the functioning of the central plan, to a state in which the financial systems of the transition economies have considerably grown in size and became heavily integrated into international financial flows, both in terms of cross-border financial flows and cross-border ownership of financial institutions. In a sense, access to foreign finance has enabled transition countries to increase their pace of economic convergence, but dependence on these sources represents a risk factor for macroeconomic stability in times of systematic international financial distress.

The first two papers of the thesis address the issue of financial development and financial integration on growth in new EU member countries in the light of their process of fulfilling the Maastricht criteria and subsequent adoption of the euro. Starting with Slovenia in 2007 and followed by Slovakia a year later, it is now evident that in a relatively short period of time the most advanced countries in the transition group may soon join the EMU despite the economic crisis from 2008. Because this process is and

will be the strongest driving force of the further financial integration of these countries with the rest of the "old" EU, the likely economic consequences of this process represent a challenging subject of investigation.

The first paper deals with the empirical analysis of the relationship between financial development and economic growth. Since the seminal work by Goldsmith (1969), numerous empirical studies have analyzed the relationship between the level of financial market development and the rate of growth, by making use of large cross-country data sets. Specifically, after a series of empirical articles by King and Levine (1993a, b, c) a strong positive correlation between growth and indicators of financial development has been recurrently obtained, even after controlling for most of the factors that have been usually considered as determinants of growth (see Levine and Zervos, 1998; Beck et al., 2000; Atje and Jovanovic, 1993; Rajan and Zingales, 1998 among others).

The first paper of the thesis contributes to this literature along five lines. First, to increase precision and robustness my analysis concentrates on European countries, which narrows the analysis down to a more homogenous set of economies in terms of their institutional characteristics. This makes my analysis less affected by other unobserved determinants of growth that may affect the results in studies using large cross-country panels. To the best of my knowledge, this is the first study with such a focus. Second, in terms of specification of the empirical model, the paper relies on the methodology proposed in the influential paper by Rajan and Zingales (1998) that uses industry-level indicators of dependence on external finance to solve the problem of endogeneity between financial development and growth. However, for the transition countries in the sample reliable data on industry-level output are not available from existing databases. For this reason, I constructed industry-level data from the Amadeus database that contains firm-level data for European countries. As such, the paper makes use of unique data on industry-level output. In addition, following Edison et al. (2002), I cast the growth regressions into a panel data framework, while the literature commonly relied on cross sections. Third, my analysis considers not only formal sources of external finance, i.e. through financial institutions, but also informal sources through the use of trade credit. In this respect, I combine the works of Rajan and Zingales (1998) and Fisman and Love (2003). Fourth, following Guiso et al. (2004), the analysis is performed at two levels of data aggregation: the firm level and the industry level. Last but not least,

empirical modeling is focused on the identification of non-linearities in the effect of financial development on growth.

Several papers emphasize the presence of non-linear effects. Starting from the theoretical underpinnings (e.g. Acemoglu and Zilibotti, 1997; Greenwood and Jovanovic, 1990; Khan, 2001; Deidda and Fattouh, 2002), non-linearities of the effect across country regions and/or levels of incomes per capita have been confirmed also empirically (De Gregorio and Guidotti, 1995; Odedekun, 1996; Xu, 2000; Deidda and Fattouh, 2002; Rioja and Valev, 2004). In this paper, I extend the analysis of non-linearities in two ways. First is an explicit estimation of threshold effects using the methodology of Hansen (1999), whose use is justified in the context of the Rajan and Zingales' (1998) empirical framework. This empirical approach is an innovation in the literature. In addition, the same type of estimation of threshold effects is also extended to the effect of trade credit on growth. This is an important extension as it allows it to be flexible enough to allow for joint determination of regions where trade credit can act as substitute to bank finance (Fisman and Love, 2001) or a complement to bank finance (Demirguc-Kunt and Maksimovic, 2001), thus bridging the two opposing conclusions.

Findings on both, firm-level and industry-level data, confirm that financial sector development, both through an increase of the depth of the bank credit market and of the stock markets, would induce large growth effects. I also find that the larger effect of financial development on growth is found for countries that have a financial development ratio below the first threshold. Above that threshold, the relationship between finance and growth becomes smaller and even insignificant for levels of financial development above the second upper threshold. This suggests that growth effects are larger at lower levels of development of financial sector, a condition characterizing most transition countries. I interpret this evidence as suggesting that financial sector development affects growth mainly through a softening of liquidity constraints on enterprises. This conjecture is strengthened by the additional finding that trade credit plays a much more relevant role in substituting for official lines of financing in transition countries, since I find that trade credit may be a key channel through which credit markets affect growth. For new EU member countries (NMs) I find that the effect is as the one found by Fisman and Love (2003), as firms more dependent on trade credit tens to grow more in those NMs with less-developed financial markets. Therefore, in NMs the adverse effects of the underdevelopment of official credit markets has been partly cushioned by trade credit.

In summary, further development of financial markets is likely to stimulate growth in NMs. Such effects operate in a rather complex way, by affecting asymmetrically official sources of financing and trade credit, and by inducing changes in industrial specialization.

The second paper shifts the focus from the effect of financial development on growth to the study of the effects of financial integration on growth. In the European context, the process of monetary integrations, cumulating in the introduction of the euro, leads to the process of significant liberalization of capital flows and to the integration of financial markets. In the process of fulfilling the Maastricht criteria and the adoption of the euro, new EU member countries have become an integral part of this process. Economic consequences of this process represent a challenging subject of investigation.

It seems likely that the new EU members benefited from financial integration. It allowed them to run sizable current account deficits, facilitating faster growth and convergence of living standards. Large share of capital inflows in the form of FDI implies favorable risk sharing and transfer of technology that may represent one of the most important factors for catching up (Lane and Milesi-Ferretti, 2006b). It must be noted, however, that the process resulted in levels of negative foreign asset positions that are by international standards relatively high. As a consequence, future adjustments in the current account will be necessary (Lane and Milesi-Ferretti, 2006b). However, drawing from the recent experience of European countries and the stimulus that creation of the EMU gave to further financial integration, we may also expect even increased dynamics in terms of financial integration as most of CEE progresses on its path of euro adoption. This may increase the sustainability of observed net foreign asset position on its own, and to the extent that it promotes further financial development also increase the ability to generate surpluses in the future. While acknowledging that serious issues arise about potential adverse effects on macroeconomic stability in the face of significant international financial crises, investigation of whether such theoretical predictions are justified empirically is also at the centre of my analysis.

The significant effects of national financial development on growth are well documented in several empirical studies. In contrast, the evidence of the effect of financial integration is mixed. While it is generally acknowledged that a higher degree of openness is associated with economic success, it is also very difficult to empirically confirm a positive effect of financial integration on growth. Recent studies argue that positive effects of

financial integration on growth arise only when financial integration is combined with an appropriate institutional framework (Prasad et al., 2003). This implies that the empirical analysis of such phenomena should pay special attention to non-linearities and threshold effects.

This paper contributes to the literature along six lines. First, because I focus on the likely contribution of euro adoption to financial integration–growth relationship, my country sample includes the most comprehensive coverage of Central and Eastern European countries thus far in the literature. Second, using macroeconomic data, an analysis of growth effects of both of the development of national financial markets and that of international financial integration is offered. Third, to provide convincing evidence of the robustness of results, I augment the industry-level growth regressions of Rajan and Zingales (1998) and Guiso et al. (2004) with explicit measures of financial integration. Fourth, the analysis is cast in a panel data framework to account for the dynamics in the data. Such an approach has also been advocated by Edison et al., (2002), most importantly because it allows us to address the issue of endogeneity by choosing the appropriate GMM estimator. Fifth, the paper takes into account not only the direct effect of financial integration on growth, but also analyzes its indirect effect contributing to the development of national financial markets. Finally, for both the macro and industry-level analysis, a potential non-linearity of the effect of financial integration on growth is investigated through an analysis of threshold effects.

Using the overall level of financial development as the threshold variable, I find compelling evidence of explicit threshold effects, which also resulted in being a key factor in the analysis of financial integration on growth. The estimations show that the less-developed countries in my sample (transition countries) benefit more from the development of domestic financial markets relative to the direct effect of financial integration, as financial integration per se does not have an obvious positive effect. Financial integration becomes beneficial for growth only after the development of national financial markets passes a certain threshold, emphasizing the importance of institutional quality and domestic financial sector development. The most advanced new EU member countries have already achieved the levels of development where further financial integration stimulates growth. Overall, the main conclusions of the paper appear rather robust, as they rely on results obtained from several empirical models on data at different levels of aggregation.

I infer from these results that the process of euro adoption as a catalyst of financial integration could have a stimulative effect on growth in new EU members both directly through access to foreign finance and increased macroeconomic stability and to the extent it stimulates the development of national financial markets. Benefits will be larger if financial integration is accompanied by the fostering of an institutional framework. The process of euro adoption may again be seen as the main source of stimulus for institutional development that makes financial integration beneficial for growth.

While remaining in the field of empirical finance, the third paper of the thesis represents a larger departure from the first two both in terms of a narrower research focus and the econometric methodology employed. The paper addresses the issue of financial stability and the use of appropriate methods of credit risk assessment at the firm level. To this end, it presents a comparative analysis of modern parametric, semi-parametric and non-parametric econometric tools for predicting bankruptcy events of firms.

Financial stability is of concern to employees, investors, bankers, and government and regulatory authorities alike. The application of good methods of bankruptcy prediction in financial institutions can be seen as crucial in its procurement. Appropriate risk assessment is crucial for the allocation of resources and credit, which, in turn results in a positive growth effect and reduction of overall macroeconomic variability.

We know that the occurrence of bankruptcies in real life is relatively rare. This also is also reflected in the data available to the econometrician. As a result, models estimated on such data commonly suffer from a relatively low prediction accuracy of bankruptcy cases. This has led many researchers to use choice-based sampling in the estimation of models, which effectively balances the number of bankrupt and healthy firms in the estimation sample. While increasing the prediction accuracy of potentially bad risks, such a situation does not correspond to the data financial institutions encounter in real life. Credit applicants come from a population with heavily unequal group shares with bankrupt firms representing only a small portion of all observations. Using choice-based sampling thus leads to over-rejection of potentially good risk. This implies that choosing to minimize risk exposure should be traded off with profit maximization. Because the share of healthy firms is considerably larger, this problem should not be neglected.

In the paper, I analyze which competing econometric method addresses these trade-offs most effectively. The list of methods includes the most common parametric method for

estimation of binary choice models – logit, a semi-parametric estimator of Klein and Spady (1993) and non-parametric classification and regression tree model (CART).

The results reveal that the non-parametric CART can be a very useful complementary method of variable selection. Augmenting classic models with variables selected by CART considerably improves forecasting accuracy. The choice between the classic parametric method - logit - and the semi-parametric model of Klein and Spady (1993) interestingly induces a similar trade off as with choice-based sampling. While logit appears to be more precise in detecting bad risks, it is also true that the semi-parametric model better captures the characteristics of healthy firms. A considerably larger share of the latter group in the population also implies better overall prediction accuracy. Both the choice of sampling method and the choice of the estimation method should be thus made conditional on an explicit objective function of the financial institution in assessing credit risk.

2. Non-linear Growth Effects of Financial Development: the Role of Credit in Transition Countries

2.1 Introduction

The predominant view in the literature exploring the relationship between financial development and economic growth is that the increased availability of financial instruments and institutions reduces transaction and information costs in an economy. Well-developed financial markets help economic agents trade, hedge and pool risk raising investment and economic growth. Since the seminal work by Goldsmith (1969), numerous empirical studies have analyzed the relationship between the level of financial markets development and the rate of growth, making use of large cross-country data sets. Specifically, after a series of empirical articles by King and Levine (1993a,b,c) a strong positive correlation between growth and indicators of financial development has been repeatedly obtained, even after controlling for most of the factors that have been usually considered as determinants of growth[1]. However, the above studies all rely on the notion that the relationship between economic growth and financial intermediaries is linear.

Some recent studies explore the possible non-linear relationship between financial development and economic growth. Economic theory exploring this aspect suggests that there is a non-linear effect of financial intermediary development on economic growth. Various theoretical models of joint determination of real and financial structures (e.g. Acemoglu and Zilibotti, 1997; Greenwood and Jovanovic, 1990; Khan, 2001, Deidda and Fattouh, 2002) present a non-linear relationship between financial and economic development. In these models, endogenously emerging financial institutions have a

[1] King and Levine (1993a, b and c), Levine and Zervos (1998), Beck et al. (2000), Atje and Jovanovic (1993), Rajan and Zingales (1998).

generally positive effect on growth, with magnitude varying positively with the level of economic development.

In empirical literature, De Gregorio and Guidotti (1995) discovered that the impact of financial development on growth in high income countries is relatively small if not nil; furthermore, they even found evidence of negative effect on growth for some Latin American countries. Odedekun's (1996) conclusions were that promoting effects of financial development are more predominant in low-income than high-income less-developed countries. Xu (2000) and Deidda and Fattouh (2002), in contrast, discovered that there is no or even a negative effect of financial development in low income countries, whereas, in high-income countries, the effect turns to be significant and positive. Rioja and Valev (2004) identified three different regions of financial development and showed that the relationship between finance and growth changes depending on to which region the country belongs.

So, different studies on different groups of countries came to the conclusions that the effect of financial development on growth is non-linear; however, there is a little agreement on the form of this non-linearity. All these studies used a broad group of countries with high differences in the level of income or financial development. My main goal in this chapter is to use an econometric technique that allows for the explicit estimation of threshold effects, and to apply to the data of a more homogeneous group of countries than usually considered in the literature. Specifically, as I describe in detail below, I focus on European countries, which are much more homogeneous in term of financial development and institutional frameworks than those countries that include African, Latin American and Asian ones.

Moreover, I address not only the role of financing of financial institutions, but also financing through the trade credit. Recent work (Peterson and Rajan, 1997, Nilsen, 1999, Fisman and Love, 2001, Demirgic-Kunt and Maksimovic, 2001) suggests that implicit borrowing in the form of trade credit may provide an important alternative source of funds for firms. Fisman and Love argued that trade credit substitutes for bank credit allows firms in countries with low bank credit-to-GDP ratios to finance their growth through trade credit. However, such a degree of substitutability between bank and trade credit may vary depending on the development of financial sectors. In countries with weak contract enforcement, highly imperfect information and weak protection of creditor rights, all forms of credit may be adversely affected. Similarly, when financial markets are highly developed, bank credit and trade credit can be complementary, with their

relative weight determined by the relative costs and benefits of the two forms of credit.[2] In between these two extremes, bank credit and trade credit are likely to be substitutes at lower levels of financial development to turn complements as financial markets development. This has interesting implications for transition economies that are characterized by underdeveloped but rapidly changing financial markets.

The possible non-linearity of the finance-growth nexus could have important implications for the analysis of real convergence in countries of Central-Eastern Europe (Bulgaria, the Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Romania, Slovak Republic, and Slovenia; (NMs hereafter) that joined the European Union in 2004 and 2007). These countries are characterized by lower incomes per capita than those of older EU members. The rapid convergence in income levels is a key aspect for the success of EU enlargement. It is important to analyze the role of credit markets in the convergence process. The underdevelopment of credit markets, especially for countries that entered the EU is perhaps the main area in which NMs lag the more advanced economies of the EU. Different measures of financial development, such as domestic credit-to-GDP ratio, stock market capitalization or the share of credit to the private sector in total credit, all reveal the underdevelopment of credit markets in NMs. This gap seems to be much larger than implied by lower incomes per capita. An important question is whether the underdevelopment of financial markets may act as an obstacle for the convergence of NMs to the per capita incomes of older EU members.

By explicitly addressing the issue of non-linearity, I confirm its existence among the older EU members and NMs. Differences thus exist even though these two groups of countries exhibit differences in the level of financial development that are much less pronounced as in the sample of countries considered in the above-mentioned studies. Non-linear effects are analyzed also for the case of trade credit. As for the bank credit also for the trade credit I estimate the threshold explicitly, according to different levels of financial development. Depending on the level of financial development, trade credit can be either a substitute or a complement. Also in this case these results have an empirically plausible specification, thus bridging the two opposing conclusions found by Fisman and Love (2003) and Demirguc-Kunt and Maksimovic (2001), respectively.

All studies analyzing the possible threshold effect in relationship between financial development and growth use country-level data. In this paper, I concentrate on industry-

[2] Demirguc-Kunt and Maksimovic (2001) provided detailed empirical evidence on complementarity of bank and trade credit.

level and firm-level data to make further progress on the issue of causality and to shed light on the channels through which financial development affects economic growth. This approach also allows me, first, to take into consideration also financing through trade credit. Second, I avoid the problem of reverse causality by using Rajan and Zingales' (1998), RZ hereafter, technique. Third, since variables constructed in the RZ framework are exogenous, I can apply Hansen's threshold regression on the panel data. Until now, threshold regression was employed only in the cross-section country-level data (Daidda and Fatouh (2002). Fourth, I can test whether the effect of financial development differs between different sizes of firm (Guiso et al., 2004). And last, I test for possible non-linearity also on the firm and industry level data.

RZ solved the problem of endogeneity, constructing their test by first identifying each industry's need for external finance from firm-level data for the US, under the assumption that financial development is highest in that country. Then they interacted this industry-level 'external dependence' variable with a country-level proxy for the degree of financial development (so as to obtain a variable that measures the extent to which financial development constrains the growth of each industry in each country) and used this variable in a regression for industry-level growth. Fisman and Love (2003), FL hereafter, applied RZ's methodology, by identifying each industry's need for trade credit from firm-level data for the US, and then they interacted this industry-level 'propensity for trade credit' variable with a country-level proxy for the degree of financial development. A negative coefficient would be consistent with hypothesis that industries that are more dependent on trade credit have a relative advantage in countries with less-developed financial intermediaries. These approaches, are designed for industry-level data, but can also be applied to firm-level data (Guiso et al., 2004) and constitute the basis of my empirical tests.

Findings on both firm-level and industry-level data confirm that financial sector development, both through an increase of the depth of the bank credit market and of the stock markets, would induce large growth effects. I also find that the largest effect of financial development on growth is found for countries that have a financial development ratio below the first threshold. Above that threshold, the relationship between finance and growth become smaller and even insignificant for levels of financial development above the second upper threshold. This suggests that growth effects are larger at lower levels of development of the financial sector, a condition characterizing most transition countries. I interpret this evidence as suggesting that financial sector development affects

growth mainly through a softening of liquidity constraints on enterprises. This conjecture is strengthened by the additional finding that trade credit plays a much more relevant role in substituting for official lines of financing in transition countries, since I find that trade credit may be a key channel through which credit markets affect growth. For NMs, I find that the effect is as the one found by Fisman and Love (2003), as firms more dependent on trade credit tends to grow more in those NMs with less-developed financial markets. Therefore, in NMs the adverse effects of the underdevelopment of official credit markets has been partly cushioned by trade credit.

In summary, further development of financial markets is likely to stimulate growth in NMs. Such effects operate in a rather complex way, by affecting asymmetrically official sources of financing and trade credit, and by inducing changes in industrial specialization.

The paper contributes to the literature along seven lines. First, my analysis concentrates on European countries, and to the best of my knowledge there has not be a study analyzing non-linear effects of financial development on growth for this group of countries, which is more homogenous in terms of institutional characteristics of their economies. Second, the paper takes into account not only the formal way of financing but also the informal one, through the use of trade credit, and thus it combines work of RZ and FL. Third, non-linearities are tested, also for the case of trade credit. Fourth, I construct unique firm-level and industry-level datasets obtained from a large database of firm-level data (Amadeus database). Last but not least, both for the firm- and industry-level analysis, the possibility of threshold effects of domestic financial development are considered. As an innovation, the industry-level approach of Rajan and Zingales (1998) and Hansen's (1999) methodology to estimate financial development thresholds in the finance-growth relation is combined.

The paper is structured as follows. Section 2.2 provides some evidence on the under-development of credit markets in NMs. It reports results from cross-country estimates on market economies that indicate that NMs have credit-to-GDP ratios well below those predicted by such cross-country regressions. Section 2.3 gives a short literature review of the linkages between financial development and growth, paying special attention to the literature analyzing non-linearities or the threshold effects in the finance-growth nexus. Section 2.4 contains an empirical analysis on micro data on a sample of EU countries and NMs. Section 2.5 presents a robustness check of micro-level results on the industry

level database with different methodology. Section 2.6 concludes and summarizes the findings.

2.2 Underdevelopment of credit markets and institutions

Reforms have proceeded much further in NMs relative to transition countries of the former Soviet Union. Accession has been based on fulfillment of the so-called *acquis communautaire*, a set of laws and practices that characterize the institutional framework of the European Union. According to the European Union, completion of all the 31 chapters of the *acquis* is an indication that candidate countries have built the institutional structure for a well-functioning market economy. However, the green light for entry in the EU does not necessarily imply that NMs have completed their transition in all areas relevant for a market economy. Looking at the indicators of progress in transition constructed by the European Bank for Reconstruction and Development, one notes that there is still a gap between the score for NMs and the advanced market economy benchmark (Table 2-1).

Table 2-1: Progress in transition (Cumulative EBRD indices, 2006)

	Large-scale privatization	Small-scale privatization	Governance and enterprise restructuring	Price liberalization	Banking reform and interest-rate liberalization	Securities markets & non-bank finan. instit.	Infrastructure
Bulgaria	4	4	-3	4+	4-	3-	3
Czech R.	4	4+	3+	4+	4-	3-	3+
Estonia	4	4+	4-	4+	4	4-	3+
Hungary	4	4+	4-	4+	4	4-	3+
Latvia	-4	4+	3	4+	4-	3	4-
Lithuania	4	4+	3	4+	4-	3	3
Poland	3+	4+	4-	4+	4-	4-	3+
Romania	4-	4-	3-	4+	3	2	3+
Slovakia	4	4+	4-	4+	4-	3	3-
Slovenia	3	4+	3	4	3+	3-	3
Russia	3	4	2+	4	3-	3	3-
Ukraine	3	4	2	4	3	2+	2+

Source: Transition Report 2006

A score of 4+ indicates completion of transition. Although on average NMs display significantly higher scores than countries of the Former Soviet Union, in several areas

there is still a significant gap to be eliminated. While transition has been completed in the area of price liberalization and trade and foreign exchange liberalization, transition has not been completed in the areas of financial market reform, privatization, and competition policy and infrastructure reform.

I argue in this paper that such gap in institutional reforms may be one of the main factors behind the slow development of financial markets in NMs. In addition to the much lower income levels per capita, a low degree of financial depth is perhaps one of main distinguishing features of NMs when compared to European Union countries.

Such low degree of financial depth cannot be explained by large incomes per capita differentials. Countries involved in previous EU enlargements, like Portugal, Spain and Greece, had income per capita at the time of entry not higher than some of the most advanced NMs (Slovenia, for instance), but their credit-to-GDP ratios were more than twice as large as those of NMs.

The reasons for the underdevelopment of financial markets probably has to do with the initial design of liberalization and reform policies and with objective difficulties in developing financial markets in the midst of enormous structural changes and the transformation of the economy. Partly stimulated by the literature on transition, it is now acknowledged that institutional development plays a key role in macroeconomic performance, both on growth rates and on their volatility (Roland, 2000; Acemoglu et al., 2002 among others). One of the main channels through which institutions affect growth and volatility is that of financial markets. The latter are indeed extremely sensitive to institutional design.[3] During the period following the reforms of the beginning of 1990-91, NMs experienced major difficulties in developing financial markets. The result is that financial markets remain largely underdeveloped. Recent estimates by the IMF (Cottarelli et al., 2003) derive "equilibrium" levels for the size of the banking sector, taking into account several indicators explaining the development of the banking sector.

For NMs, the gap between predicted and actual credit-to-GDP ratios is extremely large, ranging from 25 to 54 percentage points of GDP. Similar conclusions were reached by Fries and Taci (2002), who emphasized the insufficient effort made by NMs to spur the development of their financial sector. Cotarelli et al. (2005) estimated a model of the

[3] See for instance EBRD, Transition Report 2006.

long-term relationship between the private sector credit/GDP ratio and GDP per capita and other variables for a panel of non-transition economies. Subsequently, they produced out-of-sample estimates for the private sector credit/GDP ratios of 15 CEE countries. For most of these countries, the private sector credit/GDP ratio in 2002 was still below the level that can be justified by their fundamentals.

Table 2-2: Actual and predicted value of Credit-to-GDP ratios

	Actual BCPS ratio, 2002	Predicted values	Absolute deviation
Bulgaria	15.6	52.6	-37.0
Czech Republic	42.6	69.3	-26.7
Estonia	46.0	75.4	-29.4
Hungary	29.3	70.5	-41.2
Latvia	24.8	76.7	-51.9
Lithuania	14.2	68.1	-53.9
Poland	28.1	70.4	-42.3
Romania	8.3	58.0	-49.7
Slovak Republic	31.5	59.9	-28.4
Slovenia	38.4	63.8	-25.4

BCPS = bank credit to private sector
Source: Cottarelli et al. (2003)

Accession to the European Union provided a strong impetus for such institutional change. Indeed, in recent years credit-to-GDP ratios have rapidly increased. Policy-makers in NMs and in international organizations such as the IMF are worried that the adjustment may take place too rapidly, especially in those countries in which domestic financial institutions are still inefficient.

Further on, I discuss some relevant papers analyzing finance and growth relationship, emphasizing the empirical work on potential non-linearities in this relationship.

2.3 Linkages between financial development and growth

The relationship between financial development and economic growth has received much attention in the economic literature in the last 10 years, but this relationship was first examined by economic thinkers almost hundred years ago. Bagehot (1873) and Schumpeter (1911) stressed the importance of financial development on growth. Bagehot (1873), for example, argued that the financial system was extremely important in the

industrialization of England by its collecting and producing information and in this way allocating the capital to the firms that needed it. Schumpeter's view is that a well-functioning financial system would induce technological innovation by identifying, selecting and funding those entrepreneurs that would be expected to successfully implement their products and productive processes. More recently, McKinnon (1973) and Shaw (1973) built a theoretical model, saying that government restrictions on the banking system, such as high reserve requirements, direct credit programs and interest rate ceilings, hinder financial development, and finally reduce growth.

Similar conclusions are also reached by the more recent endogenous growth literature, in which services provided by financial intermediaries are explicitly modeled. These models suggest that financial development has a positive effect on growth. The literature is quite extensive[4], and a variety of channels have been proposed, positing a positive impact of financial development on growth. Levine (2004) argued that a financial system performs five basic tasks: (1) facilitate the trading, hedging, diversifying, and pooling of risk, (2) allocate resources, (3) monitor managers and exert corporate control, (4) mobilize savings, and (5) facilitate the exchange of goods and services. Financial development occurs when financial markets, instruments and intermediaries ameliorate the effects of information, enforcements and transaction costs and therefore provide the five financial functions described above. Each of these financial functions may influence savings and investment decisions and hence economic growth. There is, however, a considerable debate on the exact channels through which financial development induces economic growth. There are many market frictions and, moreover, regulations, laws and policies vary considerably among countries and time. This means that improvements along only one dimension can have different implications for resource allocation and welfare, depending on the other frictions present in an economy.

Though most models concentrate on the positive effect of financial development on growth, empirical studies do not always supply much support of that. The results depend on the group of countries, the time span, the methodology, and the type of aggregation of the data used in the analysis. Most of the studies take into the sample as many countries as possible, including both European and Asian countries, bringing major variability because of the large differences among the countries. The main methodology

[4] For more details of the theoretical link between financial and growth, see Greenwood and Jovanovic (1990), Bencivenga and Smith (1991), King and Levine (1993a), Roubini and Sala-i-Martin (1992), Obstfeld (1994), Bencivenga et al. (1995), Acemoglu and Zilibotti (1997), and Greenwood and Smith (1997). A comprehensive survey is provided by Levine (2004).

used has been cross-section analysis, with or without instrumental variables; recently, research has moved to the panel data techniques, time series analysis and also case studies. The first analyses were made with country data; later, the researchers also explored industry and firm-level data. A newer issue in finance and growth nexus is whether the relationship between finance and growth is linear or non-linear. Since my analyses focus on testing and estimating possible non-linear effects, I will only briefly describe some more important mainstream studies that analyze the linear effects of financial development and growth, and I put more emphasis on the few studies analyzing the non-linearities in finance and growth nexus.

2.3.1 Cross-section and panel country studies of country data

Goldsmith (1969) was one of the pioneers of empirical research, exploring the causal effect of finance on growth in a cross-country study. He investigated 35 countries over the period 1860 to 1963 and graphically documented a positive correlation between financial development (the value of financial intermediary asset as share of economic output) and the level of economic activity, without taking any conclusions about the issue of causality. King and Levine (1993b) took Goldsmith's work one step further, by studying 77 countries over the period 1960-89; furthermore, they also controlled for other factors affecting long-run growth, and they constructed additional measures of financial development (share of liquid liabilities of the financial system in GDP, the ratio of bank credit divided by bank credit plus central bank domestic assets, the share of private credit to domestic enterprises in GDP). The basic equation tested, which with slight modification become standard in this kind of literature, has the following form:

$$y_i = \alpha_0 + \beta FD_i + \gamma X_i + u_i \tag{2-1}$$

where y is the rate of growth of country i (growth accumulation, or productivity growth), FD_i is indicator of financial development for country i, X_i is a set of control variables, and u_i is an error term. King and Levine (1993b) find a positive relationship between the initial value of financial development and GDP, but they do not prove the direction of causality.

Levine and Zervos (1998) advanced the idea of Atja and Jovanovic (1993), by investigating the relationship between the operation of equity markets and economic growth. They utilized data for 47 countries over the period 1976-93 and found that stock market liquidity and banking development had a positive effect on economic growth, capital accumulation and productivity, even after controlling for various other important factors such as, fiscal policy, trade openness, education and political stability. These studies did not manage to settle the issue of causality, meaning that finance might be a leading indicator and not a cause.

The influential study of Levine, Loayza and Beck (2000) finally managed to prove the causality going from financial development to growth, by using different estimators. They compare results by using an instrumental variable approach. They used La Porta et al. (1998) in evaluation measures of legal origin - whether a country's commercial/company law has British, German or French origin – as instruments for the measures of financial development. They analyzed 71 countries in the 1960-95 period. In addition to cross-section and instrumental variable approaches, they also employed a dynamic panel data technique. Using a traditional cross-section, instrumental variable procedures and recent dynamic panel techniques, they find that the exogenous components of financial intermediary development are positively associated with economic growth. Also, the data show that cross-country differences in legal and accounting systems help account for differences in financial development. Together, these findings suggest that legal and accounting reforms that strengthen creditor rights, contract enforcement, and accounting practices can boost financial development and accelerate economic growth.

2.3.1.1 Studies analyzing non-linear effects

All the models described above, as well as most of the literature, examine linear models. Results vary, depending on the time period and countries used in the sample. The variation in question might indicate a systematic non-linear relationship, with non-linearity relating to the levels of some specific economic variable. Alternatively speaking, the relationship between financial indicators and economic growth could vary according to the threshold levels of some specific economic variable, making the effect of financial development insignificant or even negative below the threshold, and significant and positive above. There are few empirical studies that analyze and estimate the possible

ear relationship between financial development and growth by estimating a threshold effect. Berthelemy and Varoudakis (1996) argued that the relationship between growth and financial depth may involve a threshold effect. That is, countries may need to reach a certain level of financial depth—a threshold—before there is a significant effect on growth. The stability of parameters with varying initial financial development levels was tested by Chow's tests, showing that equation estimates are unstable at a certain level of initial financial development. According to subsequent estimations for a different cluster of economies, increasing the size of the financial sector effectively improves the growth performances of countries with more-developed financial sectors, whereas, for those with poorly developed financial systems, a marginal increase in its size actually reduces growth performance.

De Gregorio and Guidotti (1995) examined the empirical relationship between long-run growth and financial development, which is proxied by the ratio between bank credit to the private sector and GDP. They found that this proxy is positively correlated with growth in a large cross-country sample, but its impact changes across countries, and is negative in panel data for Latin America. They argued that the latter finding is the result of financial liberalization in a poor regulatory environment.

Deidda and Fattouh (2002) analyzed the threshold effect of income levels on the finance-growth relationship. They argued that the effect of financial development on growth positively varies with the initial level of real per capita income. Estimation results indicate that there is no significant relationship between financial development and growth in low income countries, whereas, in high-income countries, the relationship is positive and strongly significant.

Rousseau and Wachtel (2002) showed that the positive impact of financial development on growth diminishes with higher rates of inflation. In other words, the results indicate that financial depth has a significant positive effect on growth only when inflation is below the threshold of approximately 6 to 8 percent.

Stengos and Liang (2004) applied the newest econometric techniques in analyzing the non-linear relationship between finance and growth. They examined the effect of financial development on growth in an additive Instrumental Variable (IV)-augmented partially linear regression model using panel data of 66 countries for the period 1961-1995. They compared three different measures of financial development. Their results show that the effect of the exogenous component of financial intermediary development index on economic growth depends greatly on the definition and measurement of that

index. Financial development affects growth in a positive but non-linear way, using a liquid liabilities index and, in almost linear way, using a private credit index. The effect becomes ambiguous when a commercial-central bank index is used.

To the best of my knowledge, the most recent paper exploring the impact of financial development on economic growth in terms of the threshold effect of economic variables is by Rioja and Valev (2004). They selected three different financial development variables as threshold variables and obtain differential effects by way of using dummies. They found evidence for the differential effect of finance on growth in the case of two distinct regions. Estimation results suggest that the effect of financial variables is positive and significant for the regions whose levels of financial development fall into the middle range. However, two of the three financial development variables in question fail to yield significant differences in the case of the regions with levels of financial development lower than those of the mid-range ones. In contrast, in the case of the regions with high levels of financial development, the differential effects of all three financial variables on growth performance are positive. While it is concluded that the specific level of financial development plays a key role vis-à-vis the differential relationship between financial development and growth, it is not clear if financial development is a significant variable in the growth equations for each of the distinct regions, especially the low regions. Definite threshold levels of financial development are also not found to cause a significant difference on finance-growth nexus.

2.3.2 Time-series studies of country data

The other line of research of country data is the time series studies, which frequently use Granger-type causality tests and vector autoregressive (VAR) procedures to examine the nature of the finance growth relationship. One of the early studies is Jung's (1986) analysis, using vector autoregressions (VARs) in levels on post-1960 annual time series data for 56 countries, showing bi-directional causality between financial and real variables in most cases.

Similar conclusions were made by Demetriades and Hussein (1996) who conducted causality tests for 16 developing countries and found little evidence that financial sector development causes economic growth, though they did find many bi-directional relationships. They concluded that causality patterns varied across countries. They also found that there have been stable long-run relationships between real per capita income

and at least one of the key financial indicators in 13 out of 16 countries, most of which have been undergoing financial reforms. In these long-run relationships, financial variables exert a positive impact on real per capita income.

Arestis et al. (2000) augmented a time-series of finance and growth by using both measures of stock market and bank development, and they showed that both measures explain economic growth, but the effect of banking sector development is much larger.

More recently, there has been a movement toward more sophisticated econometric techniques, like panel co-integration. See for example Christopoulus and Tsionas (2004) who found strong evidence of long-run causality from financial development to growth. Also in this line of research, there is evidence that the effect of financial development on growth might be non-linear.

2.3.2.1 Studies analyzing non-linear effects

Odedokun s (1996) study determined and analyzed the effects of financial intermediation on the growth of real GDP in less-developed countries by employing annual data for 71 countries over varying periods that generally span the 1960s and 1980s. Their findings were that financial intermediation promotes economic growth in about 85% of the countries; also, the growth-promoting effects of financial intermediation are more predominant in low-income than in high-income less-developed countries.

Fry (1997) found an inverted U-shaped relationship between the annual rate of economic growth and financial development measured by real interest rates. The results of this study imply that too high or too low real interest rates are deleterious for economic growth. The results also indicate that economic growth maximized when interest rates are within the range of –5 percent to +15 percent.

Xu (2000), using a VAR model, found that there is strong evidence that financial development is important to economic growth. For the low or lower-middle income countries in his sample, financial development displays a negative effect on GDP growth and investment, while the reverse is true for the high-income countries.

2.3.3 Country-case studies

Some evidence on the financial depth-growth link can also be found in country case studies. One of the most influential works is by McKinnon, which analyzed the

relationship between financial systems and economic growth in Latin American countries, South East Asia countries and Germany. He concluded that better-functioning financial systems support faster growth.

More recently, Gelbard and Pereira Leite (1999) examined the case of sub-Saharan Africa. They showed that there has be some improvement in financial sector development, but there still much be done; they also found some empirical proof of a positive relationship between finance and growth. Guiso, Sapienza and Zingales (2002) examined the differences in local financial development on economic activity throughout the regions in Italy. They discovered that local financial development enhances the probability that individual will start a business, increases industrial competition and promotes the growth of firms. [5]

2.3.4 Industry and firm-level studies

Some studies have taken a more microeconomic approach, by analyzing industry level and firm-level data. These studies try to resolve causality issues and to document in greater detail the mechanism through which finance influences (if it does) growth. Consider the influential study by Razan and Zingales (henceforth RZ, 1998): they developed a new methodology to examine the finance-growth relationship, which solves the problem of causality running from growth to financial development. Their main idea is that better financial development helps overcome market frictions that are responsible for the wedge between the price of external and internal finance. Lower costs of external finance means the formation new firms and greater growth for firms. Therefore, industries that are naturally heavy users of external finance will benefit more from financial development than industries that naturally need less external finance. Consider their formulation:

$$growth_{ik} = \sum_j \alpha_j country_j + \sum_l \beta_l industry_l + \gamma share_{ik} + \delta(external_k * FD_i) + u_{ik}, \quad (2\text{-}2)$$

where $growth_{ik}$ is the average annual growth rate of value added or the growth in the number of establishments, in industry k and country i, over the period 1980-90. Country and industry are country and industry dummies, respectively. $Share_{ik}$ is the share of industry k in manufacturing in country i in 1980. $external_k$ is the fraction of capital

[5] For additional country-case studies, see Cole and Park (1983), Park (1993), Jayaratneand Strahan (1996), Dehejia and Leras-Muney (2003), Wright (2002), and China et al. (2005).

expenditures not financed with internal funds for U.S. firms in the industry *k,* between 1980-90*,* FD_i is an indicator of financial development for country *i*. To measure financial development, RZ examined total capitalization that equals stock market capitalization, and domestic credit as share of GDP. RZ interacted the external dependence of an industry with financial development, where the estimated coefficient, δ is the focus of their analyses. Thus, if δ is positive and significant, then this implies that an increase in financial development will induce a bigger impact on industrial growth if this industry relies heavily on external finance than if this industry is not a naturally heavy user of external finance. The dummy variables for industries and countries correct for country and industry-specific characteristics that might determine growth. They practically isolated the effect that the interaction term of external dependence and financial development has on industry growth rates relative to the country and industry means. They analyzed 36 industries across 42 countries. Their main idea is that greater financial development helps overcome the market frictions responsible for the wedge between price of external and internal finance. Therefore, industries that are naturally heavy users of external finance can benefit more from financial development than industries that naturally use less external finance. If this is true, financial development increases growth by facilitating the flow of external finance. In order to test their hypothesis, there are some assumptions that should hold: (1) financial markets in the US are relatively frictionless; (2) if (1) holds the use of external factors is determined by technological factors, (3) technological factors are common across countries. By estimating the Equation (2-2) they discover that the estimate of coefficient δ is positive and statistically significant at the 1-percent level. This implies that an increase in financial development causes relatively greater growth of industries that use more external finance.

RZ's methodology stimulated the work of other authors. Cetorelli and Gambera (2001) and Claessens and Laeven (2004), for example, examined the impact of banking market structure and bank competition on industrial development. The studies found different results. Cetorelli and Gambera (2001) discovered that by using RZ methodology bank concentration promotes the growth of industries that are naturally heavy users of external finance, but the overall effect of bank concentration on growth is not positive. In contrast, Claessens and Laeven (2004) showed by using different measures of banking system competition that industries that are naturally heavy users of external finance grow faster in countries with more competitive banking sector.

Beck et al. (2004) extended RZ's approach in studying another channel linking finance and growth: removing impediments to small firms. They discovered that industries that are naturally composed of smaller firms grow faster in countries with better-developed financial systems.

Fisman and Love (2003) applied RZ's methodology to the alternative source of finance for firms-trade credit. They argued that this way of financing is an alternative source of funds for firms in poorly developed financial markets. As with RZ, they showed that industries with higher dependence on trade credit financing exhibit higher rates of growth in countries with weaker financial institutions.

Guiso et al. (2004) also applied RZ's methodology to the industry and firm-level data in order to quantify the "growth dividend" enhanced by financial integration. They exploited European countries and they use UNIDO database for industry-level and Amadeus database for the firm-level data. Their conclusions, based on the industry-level data, are that gaps in national financial development are significant for economic growth in the manufacturing sectors and that these effects had not weakened even by the early 1990s, when some financial integration occurred. This suggests that financial development can still affect growth. To a large extent, these results are also confirmed on the firm-level data.

The last aspect of literature examining the finance-growth relationship analyzes firm-level data. One of the first studies is the paper of Demirguc-Kunt and Maksimovic (1998) (DM afterwards), who tested whether financial development influences the degree to which firms are constrained from investing in profitable growth opportunities. They focused on the use of long-term debt and external equity in funding firm growth. As in RZ, DM focused on a particular mechanism through which finance influences growth: does greater financial development remove impediments to the exploitation of profitable growth opportunities? Rather than focusing on the external financing needs of an industry as in RZ, DM estimated the external financing needs of each individual firm in the sample. The firm-level data consist of accounting data for the largest publicly traded manufacturing firms in 26 countries. They discovered that banking system development and stock market liquidity are positively associated with the excess growth of firm.

Love (2003) and Beck et al. (2005) also used firm-level data to examine whether financial development eases financing constraints, although they did not explicitly examine economic growth. In sum, these firm-level studies indicate that financial

development removes impediments to firm expansion and exerts a particularly beneficial impact on small firms.

From the existing empirical literature, we can come to the following conclusions: although most studies have found a positive relationship between finance and growth, the most recent studies show that positive relationship is far from obvious and it depends on the time periods, country groups studied and variables included into the regressions. The reason behind the varying association between finance and growth in different cases could be the dependence of the relationship between financial development and growth on the economic environment. Indeed, a few of the empirical studies have suggested that both the direction and the significance of the finance-growth relation are conditional upon the specific levels of such macroeconomic variables as inflation, financial development and income. These studies are quite limited in number and they came to different results. There is still no consensus on the methodology one should use, or the variables that should be considered in the analysis. Furthermore, to the best of my knowledge, there is still no existing study analyzing the threshold effect on the industry and firm-level data.

In the next two chapters, I will attempt to isolate the role of credit in affecting growth through an analysis of micro- and industry-level data, and I will test for the presence of the threshold effects.

2.4 Credit and growth in NMs: Analysis of firm-level data

The channels through which finance affects growth are complex and thus difficult to analyze with macro data. This is also the reason why the bulk of studies in this area uses panels of industry-level or even firm-level data. Also, in such cases, the major challenge in the literature is how to address the potential endogeneity problem between growth rate of firm-level output and the degree of financial development. Using industry-level data, Rajan and Zingales (1998) proposed a solution to the problem by using the dependence on external finance by different sectors in the US as the benchmark; this makes it perhaps the most influential recent empirical analysis of the relationship between finance and growth. The idea is that the financial market in the US can be assumed to be close to perfect and thus the financial structure of firms is determined by

an optimal choice that is not constrained by supply factors. In addition, Rajan and Zingales argued that differences across firms of the same sectors are minor, and thus sectoral indicators are a good proxy for firm-level dependence on external finance. The US indicators can be considered exogenous indicators of financing needs. Cross-country analysis of growth of real sales of firms, excluding the US, can then be used to determine the role of financial development on growth. The sectoral US financial dependence indicator is multiplied by the level of financial sector development in different countries to construct what is by now a familiar indicator in the literature, the Rajan-Zingales indicator.

If the coefficient on the RZ indicator in a cross-country regression with the growth of real sales as dependent variable turns out to be positive, this indicates that financial sector development affects the growth rates of firms. Financial sector development is measured by the sum of credit to the private sector and the stock market capitalization as a percentage of GDP. A positive coefficient on the RZ indicator implies that firms that need more external finance grow faster in countries with a more-developed financial sector.

As Fisman and Love (2003) indicated, this raises the issue of sufficient financing for the firms with high returns in the countries with a less-developed financial market. From Rajan and Zingales (1998), it follows that the additional financing needed could be collected from internal financing. Petersen and Rajan (1997) argued that alternative funds could be raised by the borrowing from suppliers. Fisman and Love (2003) made a natural extension of Petersen and Rajan's reasoning by constructing a measure of trade credit using the Rajan and Zingales methodology. In order to obtain an industry-level measure of trade credit usage, they employ the ratio of accounts payable to total assets, calculated for the US firms for different sectors. Also, this measure is multiplied by the level of financial sector development in different countries. A negative sign of the coefficient is consistent with the hypothesis that firms that are more dependent on trade credit have a relative advantage in countries with less-developed financial intermediaries, which implies a substitutability between trade credit and bank credit. In contrast, if the coefficient is positive, there is a complementarity between the two forms of financing.

It is worth stressing that the level of financial development may constrain the allocation of resources across sectors, thus affecting industrial specialization of different countries. An indication of such effect is given in Table 2-3. It presents the correlation coefficients

between the industry share of value added in total manufacturing and the same measure of financial development as used above for a group of 24 countries, including some transition countries. Industries were grouped according to the Rajan and Zingales measure of external finance dependence in three categories: low, medium and high. It can be noted that the share of value added of industries that requires high levels of external finance is positively and significantly correlated to financial development. The correlation is still positive (but insignificant) for industries with a medium need for external finance, while it is negative for industries with low external-finance dependence. One could also argue that, within sectors, the choice of technology by individual firms is affected by the level of financial development, as different technologies imply different needs for external finance. I tackle these issues in the econometric analysis.

Table 2-3: Industry share in manufacturing value added and financial development in 2001 (23 European countries)

Correlation Coefficient	External finance dependence		
	Low	Medium	High
Standard	-0.22	0.30	0.39
Spearman	-0.23	0.32	0.38
p-value	0.29	0.14	0.07
Kendall s tau	-0.12	0.22	0.29
p-value	0.43	0.15	0.06

Notes: Correlation coefficient between financial development and share of value added in total manufacturing of industries grouped in three classes according to external dependence: low: -0.5-0.2; medium: 0.2-0.7; high: 0.7-1.5

2.4.1 Data

Firm-level data (sales) are drawn from the Amadeus database of the Bureau Van Dijck[6]. It includes also small and medium-sized firms, thus making the sample more representative than the sample of Guiso et al. (2004). First, the time span of data is slightly longer relative to theirs, as it covers the period 1995-2003 (compared to 1996-2001) second, I include also small and medium-sized firms, and third, I include also

[6] Database Amadeus, top 1,5 million (companies with a turnover of more than 1,5 million euro or with 20 employees) is a database with information, including standardized annual accounts (for up to 10 years) consolidated and unconsolidated, financial ratios, activities and ownership on approximately 9 million companies thoughout Europe, including Eastern Europe.

Denmark, Ireland, Norway, Russian Federation, Slovenia and UK in the analysis.[7] It is true that the Amadeus database contains data from 1993; however, I decided to omit the initial two years because this is the period for which it can be shown for a group of transition economies in the sample that the overall institutional framework (level of liberalization of financial market and of the banking sector) in the initial years of transition may be such that overall financial development as measured in this paper (namely the depth of the financial market) may negatively effect growth.

The panel is non-balanced since not all firms have data available for all periods. In the first stage of cleaning the dataset, only firms in manufacturing industries were kept and all firms with data for less than four years were excluded. This allows us to exploit more within-time relative to between-firms variation in the analysis. At this point, the database contained 3,752,352 observations that were further reduced by eliminating several outliers in the data. All observations with yearly growth rate in real sales exceeding 100% were treated as outliers and thus omitted from the sample. Sales are deflated with the producer price index obtained from the IMF IFS database.

From the initial database, I obtained the final sample of 392,142 firms, after cleaning the data and unavailability of certain variables for some countries. For this sample, there are on average observations for seven years, leading to the total number of 1,856,541 effective observations for the estimation of growth-rate equation.[8] Data on external finance dependence and trade credit at the industry level (three and four-digit ISIC Rev. 2 level) are taken from RZ (1998) and FL (2003)[9]. RZ defined external finance dependence as the share of capital expenditure that a given industry cannot finance through internal cash-flow. Data on financial market development (market capitalization of listed firms, domestic credit, all expressed as share in GDP) are taken from WDI database. These variables are then interacted with the RZ measure of external finance dependence to obtain the variable that measures the effect on growth of external financial funds provided through financial markets. Similarly, FL (2003) constructed a variable that measures the dependence on trade credit in the benchmark US case as another source of

[7] Some countries report sales in income statements as turnover (Denmark, Ireland, Norway, Russian Federation, Slovenia and UK).
[8] For the estimations of firm-level data, because of computation cumbersome, I construct a smaller random sample in which I perform the analysis.
[9] To match Amadeus database sectors expressed in NACE classification with the RZ and FL measures, I first converted sectors in RZ and FL to ISIC Rev.3 and finally to NACE classification.

external finance. I use their indicator in addition to the one by RZ. Not only is trade credit likely to play a major role in transition countries, but, more generally, it seems more appropriate to consider external finance not only for capital expenditure, but also for working capital, that is the main determinant of enterprise debt.

Table 2-4: Descriptive statistics

Country	Growth in real sales (mean)	Growth in real sales (median)	Growth in real sales (St.dev.)	Employees (median)	Domestic credit/ GDP	Market cap./GDP	Total finance (5) + (6)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Austria	0.05	0.03	0.22	332.0	126.4	15.9	142.3
Belgium	0.02	0.01	0.23	43.0	134.3	63.6	197.9
Bulgaria	0.01	-0.01	0.37	10.0	22.0	5.6	27.7
Croatia	0.02	0.01	0.32	8.0	51.4	15.1	66.5
Czech Rep.	0.02	0.00	0.27	200.0	56.9	21.8	78.7
Denmark	0.00	-0.01	0.24	31.5	155.6	57.3	212.8
Estonia	0.05	0.04	0.37	10.0	33.9	28.4	67.1
Finland	0.05	0.03	0.28	8.0	61.3	127.6	188.9
France	0.05	0.03	0.24	10.0	104.2	70.4	174.7
Germany	0.03	0.02	0.24	359.0	142.0	46.1	188.1
Greece	0.06	0.04	0.28	20.0	98.0	64.9	162.9
Hungary	0.00	0.01	0.37	105.5	61.7	22.2	83.8
Iceland	-0.03	-0.03	0.37	7.0	86.3	45.7	131.9
Italy	0.01	0.01	0.24	17.0	96.6	42.3	139.0
Latvia	0.11	0.07	0.31	91.0	23.1	5.9	29.0
Lithuania	0.15	0.13	0.30	67.0	15.7	11.6	27.2
Luxembourg	0.03	0.04	0.26	180.0	97.9	161.3	259.2
Malta	-0.03	-0.01	0.31	61.0	131.8	30.2	161.0
Netherlands	0.01	0.01	0.24	68.0	141.8	123.7	265.5
Norway	0.00	-0.02	0.26	20.0	85.5	38.6	124.1
Poland	0.02	-0.01	0.27	120.0	33.7	12.5	46.2
Portugal	0.04	0.02	0.22	58.0	121.3	40.4	161.6
Romania	-0.07	-0.08	0.45	5.0	18.5	3.6	22.1
Slovakia	0.01	0.00	0.26	150.0	55.7	6.2	61.9
Slovenia	0.03	0.03	0.32	6.0	40.8	12.1	53.0
Spain	0.06	0.03	0.26	9.0	115.9	65.8	181.7
Sweden	0.01	0.01	0.30	4.0	105.0	105.1	210.1
Ukraine	0.04	0.07	0.40	250.0	22.7	5.5	30.3
UK	0.04	0.02	0.23	203.0	134.4	152.7	287.1

Source: own calculations, Amadeus database

The major characteristics of the sample are described with some descriptive statistics in Table 2-4. There are significant differences in median firm employment across countries. To account for such heterogeneity, as a robustness check, I carried out my estimation for

different size classes of firms.[10] The distribution of employment for transition and non-transition countries is described in 2-5.

Considerable heterogeneity can also be observed by comparing the average (or median) growth of real sales that ranges from as high as 13% for Lithuania to -8% for Romania. This heterogeneity is not only due to the presence of transition countries in the sample, but can be seen also among Western European countries. The most marked differences among the countries of Western Europe and transition countries are observed for the indicators of financial development. It is true that within each group we can find significant differences; however, what is more important is the clear difference between the levels of financial development measured either by the share of domestic credit in GDP or by the stock market capitalization as the share of GDP.

Table 2-5: Sizes of firms by the employment classes and growth rates of financial market development

		West EU	Transition
Employees	**0-50**	60.58	60.62
	51-250	9.31	11.31
	251-500	1.36	3.20
	>500	28.75	24.88
Average growth rate (95-03)	**Domestic credit/GDP**	0.22	-0.04/0.02*
	Market capitalization/GDP	0.79	2.78
	Total finance/GDP	0.38	0.10

*without Bulgaria, Czech Republic and Hungary

Table 2-5 and Figure (2-1) presents further evidence on the sizes of firms in the sample and time dynamics of financial development during the 1995–2003 period. Countries in the sample are placed in two major groups. As expected, it can be seen that the average growth rate of market capitalization is clearly much higher in transition countries, as capital markets were non-existent in the previous regime. For domestic credit to private sectors, we observe much higher growth rates for the Western EU than transition countries. High average growth rates among transition countries can be detected in Estonia, Latvia in Ukraine. This is due to the fact that these countries started the transition with extremely low levels of this indicator; furthermore, Estonia and Latvia then recorded a marked increase in this ratio. Credit-to-GDP ratio rose steadily in Slovenia from the early 1990s to 2004, although the overall increase was less pronounced

[10] A purely economic motivation to check the robustness of results against the firm size is also the fact that smaller firms may be more subject to financing constraints.

than in the two Baltic countries previously mentioned. Credit growth has picked up only recently in Lithuania and Romania; for Poland, only a moderate increase can be observed during the second half of the period studied. Other transition countries, especially the Czech Republic, Slovakia and Hungary, went through restructuring of their banking system and a process of cleaning up of bad loans that reduced the credit-to-GDP ratio over time. Similarly, the banking crisis in Bulgaria in 1997 reduced the stock of bank loans as the ratio to GDP. As discussed in the last section, in the last few years, we have observed the rapid growth of credit ratios, especially in the Baltic countries and in the Balkans. Therefore, the negative growth rates for credit ratios are due to countries of the Bulgaria, the Czech Republic and Hungary. Without those three countries, we observe a positive average growth rate of domestic credit to private sectors in new EU member countries that is still below the average growth rate of the "old" EU members. This indicates major potential for future improvement in this area that could be heavily influenced by the process of financial integration within the EU.

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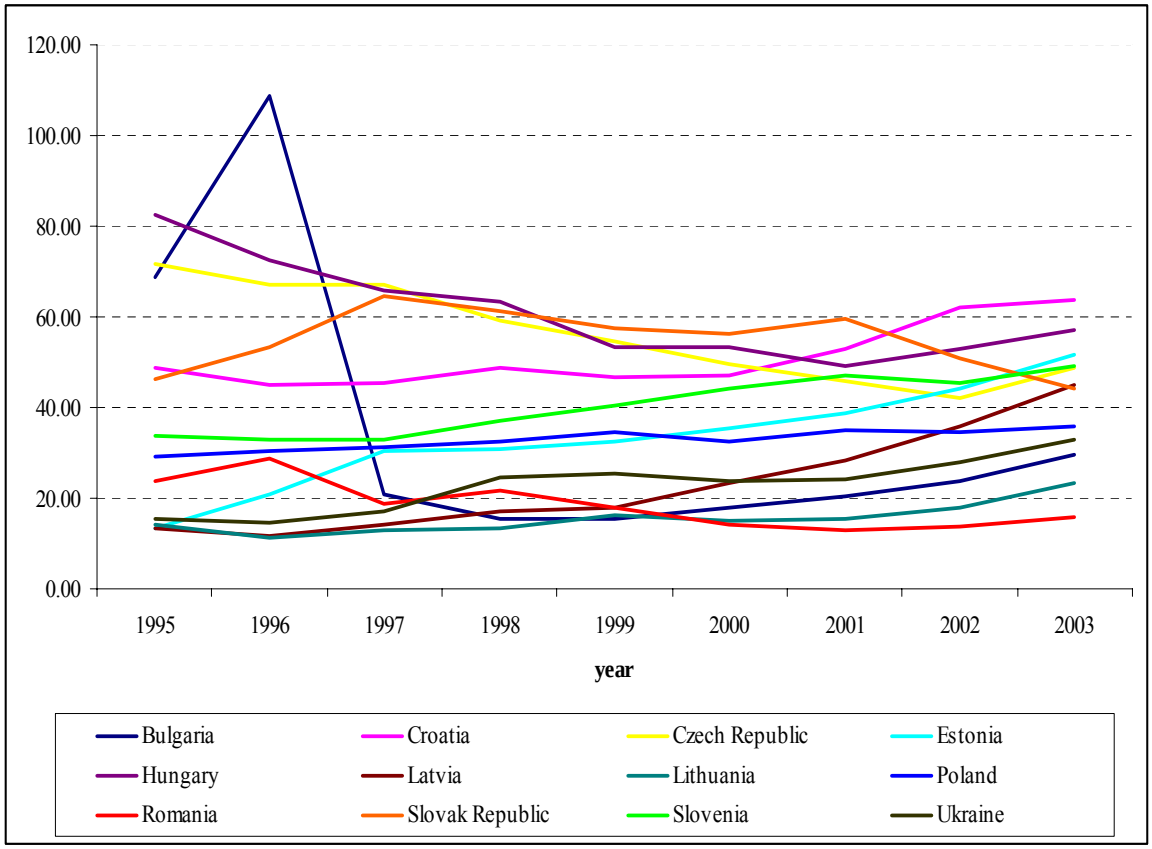
Figure 2-1: Domestic credit as percentage of GDP, 1995 to 2003



Source: own calculations, IFS database

2.4.2 Methodology

The baseline empirical model is

$$\Delta y_{jict} = \alpha_{jic} + \beta\left(RZ_i \times FD_{ct}\right) + \gamma\left(FL_i \times FD_{ct}\right) + \delta_t + u_{jict} \tag{2-3}$$

where Δy_{ict} denotes growth of real sales in firm *j*, industry *i*, country *c* and year *t*. RZ_i represents Rajan and Zingales' (1998) measure of external finance dependence, while FL_i stands for the corresponding measure of the use of trade credit assembled by Fisman and Love (2003). FD_{ct} is a measure of financial development (sum of stock market capitalization and private credit as a percentage of GDP). α_{jic} is a full set of firm-industry-country fixed effects, while δ_t denote common time effects.[11]

I tried to capture the potentially non-linear effects of financial development on growth. The first way to do this is by inte000racting explanatory variables with a dummy variable for transition countries - D_{Tr} - and its complement – D_{NTr}, i.e.

$$\begin{aligned}\Delta y_{jict} = {} & \alpha_{jic} + \beta_{Tr}\left(RZ_i \times FD_{ct}\right) \times D_{Tr} + \gamma_{Tr}\left(FL_i \times FD_{ct}\right) \times D_{Tr} \\ & + \beta_{NTr}\left(RZ_i \times FD_{ct}\right) \times D_{NTr} + \gamma_{NTr}\left(FL_i \times FD_{ct}\right) \times D_{NTr} + \delta_t + u_{jict}\end{aligned} \tag{2-4}$$

The transition dummy partitions the countries that are in the sample between those with low and high financial development. Even though the countries in each group differ in many other aspects potentially influencing differences in growth, differing levels of financial development are for the purposes of present analysis the most important dividing characteristic of the two groups. Significant differences in coefficients between the two groups of countries may thus reflect non-linearities in the effects of financial development on growth.

I also test whether there are differences in coefficients among the firms of different sizes. For this purpose, I estimate the following model:

$$\begin{aligned}\Delta y_{jict} = {} & \alpha_{jic} + \beta_{Tr}\left(RZ_i \times FD_{ct}\right) \times D_{Tr} \times D_{emp} + \gamma_{Tr}\left(FL_i \times FD_{ct}\right) \times D_{Tr} \times D_{emp} \\ & + \beta_{NTr}\left(RZ_i \times FD_{ct}\right) \times D_{NTr} \times D_{emp} + \gamma_{NTr}\left(FL_i \times FD_{ct}\right) \times D_{NTr} \times D_{emp} + \delta_t + u_{jict}\end{aligned} \tag{2-5}$$

[11] Note that the Rajan and Zingales (1999) in their original specification estimated a different model. Growth of output was measured as the average over a period, while financial development pertained was taken from the initial period.

where D_{emp} are dummy variables for different sizes of firms, measured in number of employees.

Even if RZ solve the problem of endogeneity of the financial indicator, there is still a problem of possible reverse causality from growth of output to the level of financial development. As emphasized by Guiso et al. (2004), a potential problem of RZ is that financial development may affect both the growth rate of firms and industries and the pattern of industry specialization. As a consequence, firms in financially less-developed markets may adopt technologies that make them less dependent on external finance. When estimating the effect of financial development on growth using industry-level data, Rajan and Zingales tackled this endogeneity problem by including in the estimated equations the beginning-of-period industry share in value added. This has also been used by other authors, including Guiso et al. (2004). In the estimation based on firm-level data, however, Guiso et al. do not account for the problem. Sources of endogeneity can derive from non-orthogonality of the overall cross-section-specific effects to the measures of financial development. Using initial period values of financial development only partly ameliorates the problem if the initial level of financial development may reflect, even partly, an anticipation of future growth (or lack of it).

Average values presented in Table 2-5 show significant differences in the dynamics of growth and financial development among countries within the various groups and over time. The problems discussed above and the large changes over time of financial sector indicators in transition countries suggest that the use of a panel data could improve the estimation. Using fixed effects in the panel estimation, I tackle the endogeneity problems typical of cross-section analysis. For instance, different firm-level technologies in countries with different levels of financial development are indeed fixed effects in the estimation.

2.4.3 Regression results

Table 2-6 shows the estimates of equations explaining the growth rate of firms' real sales. The explanatory variables are as follows: RZ is the interaction between industry-specific external finance dependence as measured by RZ (1998) for the US benchmark and share of total finance (market capitalization of listed firms and credit to private sector) in GDP. I concentrate on this measure of financial development because it is the

most general among the measures used in the literature. FL is the interaction between the industry-specific ratio of trade credit to total assets (industry medians of firm-level measures) as reported by FL (2003) for the US. The label "West Europe" means that this variable is additionally interacted with a dummy variable for the countries in my sample that pertain to Western Europe (EU and others). Similarly, the label "Transition" implies that the RZ variable is the dummy for the rest of the countries in the sample, all of them being transition countries. With this specification of the estimation equation, we can estimate the growth of both sources of external finance (provided through financial markets and trade credit) and differentiate the effect between two groups of countries in the sample that can be, first, characterized by significantly different levels of financial development and, second, experienced significantly different time dynamics of it during the estimation period.

Table 2-6: Regressions on growth of real sales

	(1)	(2)
$RZ \times FD \times D_{ntran}$	0.068**(0.004)	0.025**(0.004)
$RZ \times FD \times D_{tran}$	0.021(0.014)	0.203**(0.050)
$FL \times FD \times D_{ntran}$	1.091**(0.041)	0.209**(0.032)
$FL \times FD \times D_{tran}$	-1.014**(0.159)	-10.63**(0.26)
Dummies	Firm&Industry	Time
# Obs.	103,096	650,248
Method	OLS	Within panel

Notes: The dependent variable is sales in real growth in the 1995-2003period. Robust standard errors in parentheses. Constant not reported. In Column 1, mean sales growth in 1996-2002 is regressed on initial period values.
** denotes statistical significance at 1% level and * at 5%.

Column (1) of 2-6 reports the estimated coefficients for the similar specification as in Guiso et al. (2004).[12] This is essentially a cross-section in which the firm-level growth rate is regressed on industry-specific measures of external finance dependence and initial-period country measures of financial development. My sample comes from the same data source (Amadeus database) of Guiso et al.,[13] but it covers a larger set of firms. In particular, it includes also small and medium firms. My results somehow differ from

[12] Their equation does not include trade credit.

[13] They use the smaller Amadeus database (Amadeus Top 200 000) that covers the same European countries but the firms must satisfy the following criteria: for the UK, Germany, France, Italy, Ukraine and Russian Federation, operating revenue must be at least 15 million euro, total assets at least 30 million euro, and the number of employee must be at least 150. For other European countries, companies included in the database must have at least 10 million euro, total assets at least 20 million euro, and the number of employee must be at least 100.

those of Guiso et al. (2004). The RZ effect for European countries is larger, while for transition countries it is of similar size, but not significant. Moreover, the effect of trade credit on growth does not confirm the original findings by FL (2003) that implied that at the industry-level trade credit is a substitute to external finance provided by financial institutions. This is derived from the negative sign of the coefficient in their estimation that implied that industries with more exposure to trade credit in the US grew faster in countries with lower level of financial development. In this sample, I find complementarity between trade credit and financing from official institutions in Western Europe, as in my regression the coefficient is positive. Interestingly, the sign is negative, as in FL, for transition countries. This is an indication that the effect of trade credit interacted with financial development may have a non-linear effect on growth. In less-developed financial markets, firms to a large extent resort to financing through trade credit due to liquidity constraints. By contrast, in more financially developed European countries, trade credit might complement other sources of external finance, with firms selecting the optimal relative weight between the different sources of finance. Note that in the original work by Rajan and Zingales, external finance does not include trade credit that is considered part of cash-flow on a net basis (difference between payables and receivables). Based on my results, I could speculate that as the level of financial development converges to EU levels, the sign of the effect of trade credit on growth for transition countries will switch from negative to positive.

For the reasons stated above (both economic and statistical), I put more emphasis on estimation exploiting the panel structure of the data. Column (2) presents a fixed effect estimation of the growth equation. It differs from column (1) not only because of the estimation method, but also because the measure of financial development varies through time.[14]

Important differences with respect to estimates in Column (1) emerge. As regards the RZ effect, we can observe that the coefficient for Western Europe is smaller and similar to the estimates in Guiso et al. (2004). More importantly, the effect for transition countries is significant and much higher. This result is intuitive. It indicates that the growth dividend of financial market development is not linear in the measure of financial development. Countries lagging behind the most-developed markets need to close a wider

[14] Note that this is necessary in the panel framework. Initial period values are a fixed effect that would disappear using the within estimator.

gap, but also gain more from doing so. In other words, marginal returns to financial sector development are positive but decreasing in the level of financial development (more on this below).

Regarding the effect of trade credit, the difference in sign between Western European and transition countries remains. Moreover, relative to results in Column (1), the effect for transition countries is much larger.[15]

Table 2-7 breaks down the effect of financial development on growth by firm size classes measured by the number of employees. For Western Europe, we see the RZ coefficient increasing with firm size and declining only for the largest firms with the number of employees exceeding 500. For transition countries, we observe a much clearer picture. First, for each size class the effect is larger relative to the Western European counterpart. Secondly, the effect is larger for small firms.

Table 2-7: Regressions by firm size

Employees	RZ West EU	RZ Trans	FL West EU	FL Trans
0 - 50	0.022**	0.237**	0.228**	-11.20**
	(0.004)	(0.081)	(0.032)	(0.39)
50 - 250	0.030**	0.204**	0.234**	-10.20**
	(0.005)	0.061	(0.039)	(0.32)
250 - 500	0.044**	0.219**	0.287**	-10.05**
	(0.010)	(0.084)	(0.064)	(0.44)
$>$ 500	0.028**	0.098**	0.176**	-11.65**
	(0.004)	(0.080)	(0.034)	(0.40)

Notes: Observations: 650,248. The dependent variable is sales in real growth in the 1996-2003 period. Constant not reported. Robust standard errors in parentheses. Time dummies included in all regressions. Within panel estimator. **** denotes statistical significance at 1% level, ** at 5% and * at 10%

The results on the size effect are in line with Guiso et al. (2004) who performed OLS and LAD regressions[16] (should be robust to the presence of influential firms) on two split

[15] I also carried a GMM estimation that is available upon request. The procedure corrects for the endogeneity induced by the construction of the estimator and by assuming that the same set of instruments is valid also to account for other sources of endogeneity discussed above. The Arellano and Bond GMM procedure uses lagged values of variables as instruments for differenced equations. I used instruments at lags 2, 3 and 4. The results of the GMM estimation broadly confirm those in column (2).

[16] In their regressions, they did not take into the account financing through trade credit.

samples; the sample of small and medium enterprises contains firms with less than 400 employees and more than 150, and the sample of large firms consisting of those with more than 400 employees. They also discovered that regardless of the estimation method, the indicator of financial development (interacted with financial dependence) has much larger impact in the sample with small firms.

The transition process involved the emergence of a new private sector that to a large extent occurred through the growth of newly established small firms. Putting things together, this implies that during the transition the largest growth potential lies in small and medium enterprises that, in turn, are more severely constrained by unavailability of credit. For the effect of trade credit, the differences in coefficient estimates across size classes are less pronounced, but are fully consistent with the estimates reported above and uniformly confirm the conclusion about the complementarity of trade and bank credit in financially more-developed countries and their substitutability in financially less-developed countries.

2.4.3.1 Non-linear growth effects of financial development

Guiso et al. (2004) did not find any significant differences between old EU members and new EU members in the effect of financial market development on growth through the RZ term (they did not control for trade credit). In addition, they ran a simple experiment of estimating the "growth dividend" in transition economies from financial market integration with the rest of more financially developed Europe; they calculated the growth gain of sales of several EU accession countries, simply by linear extrapolation of growth by raising financial development to the US and to the average EU levels. My results show that this is a problematic exercise. The indication of the non-linearity of the effect of the depth of financial markets on growth in relation to the overall level of financial development that emerges from Table 2-6 is quite robust with regards to the choice of measure of financial depth (market capitalization and private credit entering the equation individually). The indication that, from a given increase in financial development, countries that are further away from perfectly functioning financial markets (measured by the US benchmark) benefit more in terms of growth is economically appealing, but it also poses a problem in assessing the growth effect of the financial development; namely, with financial development the coefficients measuring its effect on growth may also change, and this is not captured by a simple linear regression.

The likely non-linear time dynamics of the RZ coefficient goes from high to low, but always remains positive, whereas the trade-credit effect would go from high and negative to low and positive. Both effects would thus yield a positive growth dividend.

Table 2-8 presents an attempt to model this non-linearity in a simple parametric manner. The RZ coefficient enters the model as a decreasing function of the initial financial development and is restricted from changing the sign. In the model, I put also the standard FL term plus the ratio between normal FL term and an initial level of financial development. Hence, both the RZ and FL coefficients are allowed to vary with the initial level of financial development and with the empirically estimated form depicted in Figure 2.

Table 2-8: Non-linear effects of financial development

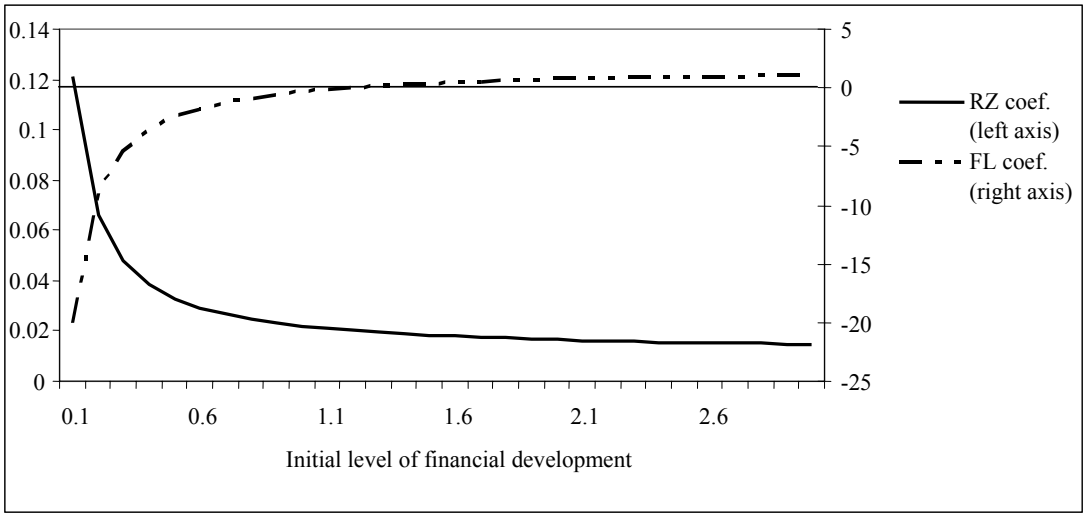
$RZ(1+1/FD_0)$	0.011^{*}(0.002)
FL	1.838^{*}(0.064)
FL/FD_0	-2.181^{*}(0.062)
Observations	650248

Notes: The dependent variable is sales in real growth. Constant not reported. Robust standard errors in parentheses. Time dummies included. Within panel estimates. FD_0 denotes initial period level of financial development. *Denotes statistical significance at 1% level.

From the estimation results, it follows that the adjusted RZ variable remains positive and highly significant. For countries with high initial financial development, the effect converges to 0.01, which is, as expected, much smaller than the effect reported above or in Guiso et al. (2004). For some countries that may have initial levels of financial development close to ten percent of GDP the effect is, of course, much higher.

While the coefficient of the standard FL term is positive (retaining high statistical significance), the coefficient of the adjusted FL term is significantly negative, implying that for countries with low initial financial development the overall effect is negative, thus indicating substitability between bank and trade credit. For levels of financial development exceeding 110 percent of GDP, the coefficient changes sign and indicates complementarity between bank and trade credit.

Figure 2-2: Dependence between financial development and RZ and FL coefficients



Source: own calculations

These estimates are rather crude and should be considered merely as further evidence on the likely non-linear effect of financial development in growth that I already obtained from standard regression results in Table 2-5. As such, they can be used as a starting point for further research in modeling non-linearity using more sophisticated methods.

2.5 Credit and growth in NMs: Analysis of industry-level data

In order to test the robustness of non-linearities, I constructed also an industry-level dataset, with which I perform similar tests as in the firm-level data; furthermore, this level of aggregation allows me also to perform more formal testing of possible thresholds in the level of financial development itself without resorting to the use of country dummies.

2.5.1 Data

The industry-level database was constructed by the integrating the firm-level database to the industry level. Growth of sales at the industry level was calculated as the mean

value of sales of all firms in the specific industry for each year.[17] The final dataset of industry data consists of 4,449 observations, comprising 638 country-industry units with seven years of time observations on average.

2.5.2 Methodology

The baseline empirical model is similar as in the firm-level analysis:

$$\Delta y_{ict} = \alpha_{ic} + \beta(RZ_i \times FD_{ct}) + \gamma(FL_i \times FD_{ct}) + \delta_t + u_{ict} \quad (2\text{-}6)$$

where Δy_{ict} denotes growth of real sales in industry i, country c and year t. RZ_i represents the Rajan and Zingales (1998) measure of external finance dependence, while FL_i stands for the corresponding measure of the use of trade credit assembled by Fisman and Love (2003). FD_{ct} is a measure of financial development (sum of stock market capitalization and private credit as a percentage of GDP). α_{ic} is a full set of industry-country fixed effects, while δ_t denote common time effects.[18]

At the industry-level, I also model potentially non-linear effects of financial development on growth in two ways: first, similar to the firm-level, by interacting explanatory variables with a dummy variable for transition countries - D_{Tr} - and its complement – D_{NTr}:

$$\begin{aligned}\Delta y_{ict} = {} & \alpha_{ic} + \beta_{Tr}(RZ_i \times FD_{ct}) \times D_{Tr} + \gamma_{Tr}(FL_i \times FD_{ct}) \times D_{Tr} \\ & + \beta_{NTr}(RZ_i \times FD_{ct}) \times D_{NTr} + \gamma_{NTr}(FL_i \times FD_{ct}) \times D_{NTr} + \delta_t + u_{ict}\end{aligned}, \quad (2\text{-}7)$$

and second, by Hansen's methodology described below.

2.5.2.1 Estimating threshold effects with Hansen's methodology

At this level of aggregation, I use more systematic approach to model non-linearities in the effect of financial development conditional on the level of financial development

[17] I also constructed a database in which the variable growth of sales are calculated as the median value of firm growth of sales of specific sector in a given year as a robustness check, but there were no significant differences in the final results.

[18] Note that the Rajan and Zingales (1999) in their original specification estimated a different model. Growth of output was measured as the average over a period, while pertaining financial development was taken from the initial period.

itself, without resorting to the use of country dummies by allowing for explicit threshold effects. Following Hansen (1999), I allow for a multiple threshold model.

The non-linear effect of financial development on growth in econometric terms means that the regression functions are not identical across all observations. This case can be properly addressed using a threshold regression technique. The threshold regression (TR) model specifies that individual observations can be divided into classes based on the value of an observed variable: financial development in my case. Since we are dealing with panel data with fixed effects present, I apply Hansen's methodology for non-dynamic panels with individual specific fixed effects (Hansen (1999)) in estimating possible thresholds. This is a systematic approach to modeling non-linearities in the effect of financial development conditional on the level of financial development itself, without using country dummies.

Following Hansen (1999), I allow for a multiple threshold model, using the measure of financial development as the threshold variable. To compactly write the multiple TR model, let $\mathrm{B}_j X_{cit}$ generically denote the right side of (2-6) or (2-7) (without deterministic terms). Then we have

$$\Delta y_{ict} = \alpha_{ic} + \delta_t + \sum_{j=1}^{k} \mathrm{B}_j X_{cit} I\left(\tau_{j-1} < FD < \tau_j\right) + u_{ict} \qquad (2\text{-}8)$$

where *I(.)* is the indicator function and u_{ict} is the regression error. Equation (2-8) in the case where *k=3* corresponds to a double threshold model with τ_0 and τ_3 unspecified. The regressor set $\mathrm{B}_j X_{cit}$ corresponds to the one of the model (2-6). A natural threshold variable that can be used in present context is the measure of financial development (FD), which must be assumed to be exogenous to comply with the assumption behind the econometric model in Hansen (1999).

For the ease of presentation, let us assume that *k=2* and that $\mathrm{B}_j X_{cit}$ contains only one coefficient and independent variable ($\mathrm{B}_j X_{cit} = \beta x_{cit}$), that (2-8) can be written in an alternative intuitive way:

$$\Delta y_{ict} = \begin{cases} \alpha_{ic} + \delta_t + \beta_1 x_{ict} + u_{ict} & FD_{ct} \le \tau, \\ \alpha_{ic} + \delta_t + \beta_2 x_{ict} + u_{ict} & FD_{ct} > \tau. \end{cases}$$

The observations are divided into two "regimes" depending on whether the threshold variable (FD) is smaller or larger than the threshold τ . The regimes are distinguished by different regression slopes, β_1 and β_2. The identification of β_1 and β_2 .requires time variation of $x_{ict.}$. Also, the threshold variable should not be time invariant, and it can be a part of $x_{ict.}$. The error tem (u_{ict}) is assumed to be independent and identically distributed (iid) with mean zero and finite variance σ^2 [19] The analysis is asymptotic with fixed T as $n \to \infty$ .Estimation of threshold levels and their confidence regions follows the multi-step procedure described in Hansen (1999).[20]

One important advantage of the threshold model is that it allows for simulation of the likely effects of financial integration on growth in the spirit of Guiso et al. (2004) in presence of the non-linearity of the growth effect. As I show that significant non-linearities are in fact present, this may give us a much more reliable estimate of the likely effect of euro adoption on growth in new EU members.

2.5.3 Regression results

Empirical results are reported in Tables 2-9 to 2-11. 2-9 replicates the original RZ and FL approaches on my data. There is no time variation in the growth of industry output and financial development. Growth is averaged over the period under investigation while the initial level of financial development is taken in 1995. Besides differences in data, I differ from RZ and FL by jointly estimating the effect of financial development through official finance and trade credit.

The RZ variable is correctly signed, but insignificant. Including the FL variable in the model reveals significant evidence of substitability between bank and trade credit, while leaving the estimate of the RZ coefficient virtually unchanged. More interesting results emerge if we allow the coefficient to differ between transition and developed European countries. The RZ variable inserted individually has a slightly higher but still insignificant effect for transition countries. Inclusion of FL variable leaves this result unaltered and confirms the previous finding of trade and bank credit being substitutes, but significantly more so in transition countries.

[19] The iid assumption excludes lagged dependent variables from x_{ict}..

[20] Hansen s (1999) method is designed for balanced panels, while I operate with an unbalanced panel. In such a case, it must be noted that it is unknown whether all the Hansen's results regarding inference carry completely through.

Table 2-9: Effect of financial development on growth: Original Rajan and Zingales specification (1995 financial development)

(1)	(2)	(3)	(4)
$RZ \times FD$	0.002(0.002)	0.002(0.002)	
$FL \times FD$		-0.070*(0.04)	
$RZ \times FD \times D_{tran}$			0.002(0.005)
$RZ \times FD \times D_{ntran}$			0.002(0.002)
$FL \times FD \times D_{tran}$			-0.37**(0.12)
$FL \times FD \times D_{ntran}$			-0.11**(0.04)
# obs	631	631	631

Note: Robust standard errors in parentheses. Constant not reported. Country and industry dummies are included in all regressions. Dummy variables Dtran and Dntran denote transition and non-transition countries, respectively

Table 2-10: Effects of financial development on growth - within estimation of model (2-4), dependent variable: growth of real sales

	(1)	(2)	(3)
$RZ \times FD \times D_{tran}$	.026 !(.019)	.026 !(.019)	.245 ** (.076)
$RZ \times FD \times D_{ntran}$			.014** (.002)
$FL \times FD \times D_{tran}$		-.401***! (.097)	-.688* (.375)
$FL \times FD \times D_{ntran}$			-.395*** (.103)
# obs	4400	4400	4400
N	631	631	631

Notes: Robust standard errors in parentheses. Constant not reported. Tests reveal significant presence of fixed effects in all specifications. Time dummies are included in all models. Dummy variables D_{tran} and D_{ntran} denote transition and non-transition countries, respectively. ! The coefficients refer to variables that are not interacted with D_{tran} and D_{ntran} respectively. *FD* is the sum of stock market capitalization and domestic credit as a percentage share of GDP

Similar findings are found when I allow for time variation in the panel. Table 2-10 shows that, when inserted individually, the RZ variable is again insignificant. Column (3) reveals that allowing the coefficients to differ between transition and other countries by interacting explanatory variables with transition and non-transition dummies considerably improves the estimation results. The effect of financial development on growth turns out to be significant and, contrary to the findings of Guiso et al. (2004), is considerably different across the two groups of countries. As expected, for transition countries, which are still characterized by considerably lower levels of economic development, the effect is much higher, in fact higher than previously found in the literature. As shown by the smaller coefficient for developed countries, the effect may decline quickly as development progresses. The coefficients of trade credit (bottom two

lines) are significantly negative. Trade credit thus acts as a substitute to external finance provided by financial intermediaries, but significantly more so in transition countries. This result can again be attributed to lower levels of financial development.

These results confirm that financial development positively affects growth. However, it is worth noting that this result is obtained only after controlling for trade credit as an alternative source of external finance and, more importantly, after we allow for non-linearity of the effect. In this respect, we find that financially less-developed countries benefit considerably more from financial development.

2.5.3.1 Non-linear effect of financial development on growth

The analysis on firm-level data reveals a presence of non-linearity of the effect between financial development and growth. Also, the inclusion of (non)transition dummies of industry-level analysis confirms previous findings. Regardless, there is a difference in interpreting the role of trade credit. Firm-level data analysis suggests that for countries with low initial financial development the overall effect is negative, thus indicating substitability between bank and trade credit. For levels of financial development exceeding 110 percent of GDP, the coefficient changes sign and indicates complementarity between bank and trade credit. In contrast, industry-level analysis shows that trade credit acts as a substitute to external finance provided by financial intermediaries, but significantly more so in transition countries.

In this part of the paper, I tried to test the non-linear relationship more formally. Evidence of non-linearity in the effect of the financial development on growth is more refined in the estimated threshold models. The model uses financial development as the threshold variable and 15% trimming of observations. I found two thresholds at levels of 53% and 70% share of market capitalization and domestic credit in GDP.
In line with the firm-level results, the largest effect of financial development on growth is found for countries that have a financial development ratio below the first threshold. Indeed, the coefficient is even larger than found for transition countries in Table 2-10. Above that threshold, the coefficient declines and it becomes insignificant and close to zero for levels of financial development above the upper threshold. All developed Western European countries in the sample were above that threshold throughout the period under investigation. It is important to note that the most advanced transition countries passed the threshold in recent years as well, implying that considerably smaller

growth dividends than those observed in the past can be expected from further financial development.[21]

Table 2-11: Threshold effects of financial development on growth – double threshold model, dependent variable: growth of real sales

Threshold	52.93		70.29
95% conf. int.	[40.94, 52.99]		[70.29,70.34]
F_2 * (p value)	25.84 (.03)		
Parameters	$FD < \tau_1$	$\tau_1 < FD < \tau_2$	$FD > \tau_2$
RZ	.308**	.052	.020
	(.113)	(.161)	(.018)
FL	-1.53**	2.78***	-.43***
	(.56)	(.78)	(.09)

* Test for presence of thresholds using 300 bootstrap replications. Standard errors of coefficients in parentheses. Time dummies included in the model. *FD* is the sum of stock market capitalization and domestic credit as a percentage share of GDP.

Regarding the effects of trade credit, I found that at lower levels of financial development, trade credit acts as a strong substitute for official finance. Between 53% and 70%, trade credit becomes a strong and significant complement. Above the second threshold, trade credit becomes a substitute to official finance, even though the effect is much smaller than the one prevailing below the first threshold. For trade credit, we can still say that it appears to be a substitute to official financing, with stronger effects in transition countries.

In summary, the effect of financial development appears to be much stronger for transition countries. Trade credit serves as a relevant substitute for official financing, softening the adverse impact on the growth of financial underdevelopment.

Threshold results on financial development are in line with the results of Rioja and Valev (2004) who, on the basis of several theoretical models, assume two thresholds in financial development. Their results suggest that financial development exerts a strong positive effect on economic growth only once it has reached a certain size threshold, i.e., in what is called the middle region. In the low region (below this threshold), the effect is uncertain as different empirical measures of bank-based financial development suggest a

[21] This statement is confined to measures of development that I use in the sample, i.e. the depth of financial markets. The effects of other, mainly institutional characteristics that may or may not be correlated with the depth of financial markets and can contribute to growth, were not accounted for in present empirical analysis.

zero effect or a positive effect. At the other end, in the high region, the growth effect of financial development declines once it reaches very high levels. Since their sample consists of countries with very different levels of financial development, countries that enter the low region (African, Latin America countries) have much lower financial development than NMs in my sample. Their middle region, thus, can be broadly equal to my lower region, and their high region broadly covers my middle and high regions.

2.6 Conclusions

Credit markets play a crucial role in the transformation of NMs from centrally planned to market economies. However, extrapolating coefficients from cross-country, static, regressions including countries with markedly different levels of financial developments, and different institutional frameworks does not provide relevant measures of the growth effects of financial development. In order to capture the growth effect of financial development, I constructed two different samples with different aggregations of the data (micro-level and industry-level data), and I performed several tests in order to find possible non-linearities in the finance-growth nexus. Indeed, I find significant differences in coefficients across transition countries and advanced market economies in both samples. Furthermore, I find possibly important threshold effects of financial development on growth with different methodologies in both level of aggregation. Finally, financial development affects different sources of finance in an asymmetrical way, especially those related to official channels (bank loans and stock markets) as opposed to those related to trade credit.

This empirical analysis suggests that financial development would lead to significant gains in terms of growth rates for transition countries. Given the constraints, in terms of both macroeconomic equilibrium and of capability in institution building, on rapid growth of credit-to-GDP ratios, it is of great importance to identify those institutional measures that may contribute to improving the efficiency of financial markets in their various dimensions, including the efficient functioning of trade credit.

Transition countries had a great opportunity for strengthening their institutions by joining the European Union. Further progress is likely to come from joining the euro zone. Contrary to the traditional optimal currency area theory, countries with large

structural asymmetries with respect to the euro zone countries (because of much lower GDP per capita) and with still underdeveloped financial markets can benefit significantly from joining the euro zone. Joining a currency union may lead to large benefits in terms of diversification of risk and access to smoothing instruments. In addition, the impact of credit growth on the external accounts is cushioned by a smaller risk of reversal capital flows.

This paper suggests that there are significant effects of national financial development on growth and that the magnitude of these effects depends on the level of financial development in a specific country. Entering the euro zone can help to improve the institutional framework of NMs and the level of financial development. This hypothesis that financial integration will improve financial development and thus bring higher growth to NMs is explicitly tested in the following chapter.

3. Non-linear growth effects of financial development: Does financial integration matter?

3.1 Introduction

The aim of this paper is to analyze the likely effects of the process of fulfilling the Maastricht criteria and euro adoption on financial development and growth in new EU member countries. About two decades ago, the new EU members started the process of transitioning to market economies, which also led to the creation of previously non-existent financial markets. Starting with Slovenia in 2007, it is now evident that in a relatively short period most advanced countries in the group are soon about to join the Economic and Monetary Union. Because this process is and will be the strongest driving force of further financial integration of these countries with the rest of the "old" EU, the likely economic consequences of this process represent a challenging subject of investigation.

Two decades of European monetary integration lead to a process of significant liberalization of capital flows and integration of financial markets. An additional impetus has been provided by the introduction of the euro (Beal et al., 2004). Progress in financial integration also brought benefits to CEE countries. Indeed, it allowed CEE countries to run sizable current account deficits, facilitating faster growth and convergence of living standards. A large share of capital inflows in the form of FDI implies favorable risk sharing and transfer of technology that may represent one of the most important factors of closing the gap with the more-developed countries (Lane and Milesi-Ferretti, 2006b). It must be noted, however, that the process resulted in levels of negative foreign asset positions that are relatively high by international standards. As a consequence, future adjustments in the current account will be necessary (Lane and Milesi-Ferretti, 2006b). However, drawing from the recent experience of European countries and the stimulus that creation of the EMU gave to further financial integration (see Figure 3 below), we may also expect even increased dynamics in terms of financial

integration as most of CEE progress on their path of euro adoption. This may increase the sustainability of the observed net foreign asset position on its own and, to the extent that it promotes further financial development, also increase the ability to generate surpluses in the future. Investigation of whether such theoretical predictions are also justified empirically is at the centre of my analysis.

Significant effects of national financial development on growth are well documented in several empirical studies. In contrast, the evidence of the effect of financial integration is mixed. While it is generally acknowledged that a higher degree of openness is associated with economic success, it is also very difficult to empirically confirm a positive effect of financial integration on growth. Recent studies argue that the positive effects of financial integration on growth arise only when financial integration is combined with an appropriate institutional framework (Prasad et al., 2003). This implies that the empirical analysis of such phenomena should pay special attention to non-linearities and threshold effects.

The paper contributes to the literature along six lines. First, my analysis concentrates on European countries. Because these countries are more homogenous in terms of the institutional characteristics of their economies, this makes my analysis less affected by other unobserved determinants of growth that may affect the results in studies using large cross-country panels. Moreover, because I focus on the likely contribution of euro adoption on financial integration–growth relation, my country sample includes the most comprehensive coverage of Central and Eastern European countries in the literature thus far. For CEE countries, I also construct a special industry-level dataset obtained from a large database of firm-level data. Second, using macroeconomic data, the analysis of growth effects of both of the development of national financial markets and that of international financial integration is offered. Third, to provide convincing evidence of the robustness of results, I follow Rajan and Zingales (1998) and Guiso et al. (2004) and analyze the effect financial development on growth by using industry-level data. Fourth, a panel estimation technique to account for the dynamics of development of national financial markets and financial integration is used. Such an approach has also been advocated by other authors (Edison et al., 2002), most importantly also because it allows us to address the issue of endogeneity by choosing the appropriate GMM estimator. Fifth, the paper takes into account not only the direct effect of financial integration on growth, but also analyzes its indirect effect contributing to the development of national

financial markets. Last but not least, both for the macro and industry-level analysis, the possibility of threshold effects of financial integration and domestic financial development is considered. As a new feature, the industry-level approach of Rajan and Zingales' (1998) and Hansen's (1999) methodology to estimate financial development thresholds in the finance-growth relation is combined.

Using the overall level of financial development as the threshold variable, I find compelling evidence of explicit threshold effects, which additionally result in being a key factor in the analysis of financial development and financial integration on growth. The estimations show that the less-developed countries in my sample (transition countries) benefit more from the development of domestic financial markets relative to the direct effect of financial integration, as financial integration per se does not have an obvious positive effect. Financial integration becomes beneficial for growth only after the development of national financial markets passes a certain threshold, emphasizing the importance of institutional quality and domestic financial sector development. The most advanced new EU member countries have already achieved the levels of development where further financial integration stimulates growth. Overall, the main conclusions of this paper appear rather robust, as they rely on results obtained from several empirical models on data at different levels of aggregation.

I infer from these results that the process of euro adoption as a catalyst of financial integration could have a stimulative effect on growth in new EU members, both directly through access to foreign finance and increased macroeconomic stability and to the extent it stimulates the development of national financial markets. Benefits will be larger if financial integration is accompanied by fostering of institutional frameworks. The process of euro adoption may again be seen as the main source of stimulus for institutional development that makes financial integration beneficial for growth.

The paper is structured as follows: Section 2 offers a brief overview of the literature and a theoretical discussion of the link between the development of national financial markets and growth on one hand, and financial integration and growth on the other. Section 3 compares the current state and recent development in financial market development between the EU15 and CEE Countries. Section 4 describes the empirical methodology and the data. Section 5 contains the discussion of estimation results. Section 6 concludes and summarizes the findings.

3.2 The effect of financial development and international financial integration on growth

The predominant view in the literature exploring the relationship between financial development and economic growth is that increased availability of financial instruments and institutions reduces transaction and information costs in the economy. Well-developed financial markets help economic agents to trade, hedge and pool risk, raising investment and economic growth. Using large cross-country data sets, many studies highlighted the importance of financial development for macroeconomic growth, even after controlling for most of the factors that have been usually considered to be determinants of growth (King and Levine, 1993a, b and c). Levine and Zervos (1998) found a positive effect of banking development and stock market liquidity, while obtaining no robust link between economic growth and the size of the stock market and price-based measures of financial integration. A very influential study by Rajan and Zingales (1998) offered an innovative solution to the endogeneity problem by using industry-level data and reached similar conclusions. Based on their approach, Guiso et al. (2004) focused on the issue of financial integration in Europe, emphasizing how financial integration can contribute both to development of domestic financial markets and higher access to finance by foreign financial intermediaries. They argued that further financial integration in Europe will yield a significant growth dividend both to old and new EU members.

An important issue in the estimation of the growth effect of financial development is the potential non-linearity of the effect across the levels of financial development; specifically, many studies showed that the effect of finance on growth is not uniform and linear. De Gregorio and Guidotti (1995) reported that financial development leads to improved growth performance. This effect, however, varies across countries and over time and can also become negative. Odedokun s (1996) findings are that growth-promoting effects of financial intermediation are more pronounced in low-income than in high-income less-developed countries. Among the first to emphasize threshold effects with respect to financial depth in the relationship between growth and financial depth are Berthelemy and Varoudakis (1996). Similarly, Rioja and Valev (2004) identified

three different regions of financial development and showed that the relationship between finance and growth changes depending on to which region the country belongs.

From theoretical point of view, financial integration may positively affect growth in several ways. Direct positive effects could come through facilitating risk sharing. Higher macroeconomic stability may stimulate demand. More importantly, it improves on the allocation of capital (Obstfeld, 1994). Financial integration can also stimulate growth through the effect on the development of national financial markets. This occurs in two ways. First, increased competition from foreign financial intermediaries leads to reduced cost of intermediation and higher efficiency (Levine, 2001). This stimulates demand for funds and increases the size of domestic financial markets. Consequently, the effect of financial integration should be reflected through size-based measures of financial development. Financial integration also affects domestic markets through improvements in institutional frameworks, i.e. improved regulation and corporate governance that enhance overall stability and reduce the problems related to asymmetric information. Demand for finance may increase as a result.

The second channel through which financial integration affects financial development is access to foreign financial markets in the form of direct lending by foreign financial intermediaries and listing on foreign stock markets. These financial flows do not show up in the size-based measures of financial development.

The positive effect of financial integration on growth has been reported, for example, by Klein and Olivei (2000) and Bekaert et al. (2001), but a more general message that emerges from the literature is that whether a positive effect of financial development on growth materializes depends on market imperfections and distortions, with weak financial institutions and the legal system playing key roles (Boyd and Smith, 1992). Empirically, these considerations seem to matter considerably. Some authors find that financial market integration is beneficial for growth in developed countries and potentially detrimental for poorer countries (Edwards, 2001). In the analysis of foreign direct investment on growth, Alfaro et al (2001) emphasized the role of sufficient financial development as a proxy of countries' absorptive capacity.[22,23] Acknowledging many difficulties providing robust results in various studies and measurement of international financial integration, Edison et al. (2001) used various measures of financial

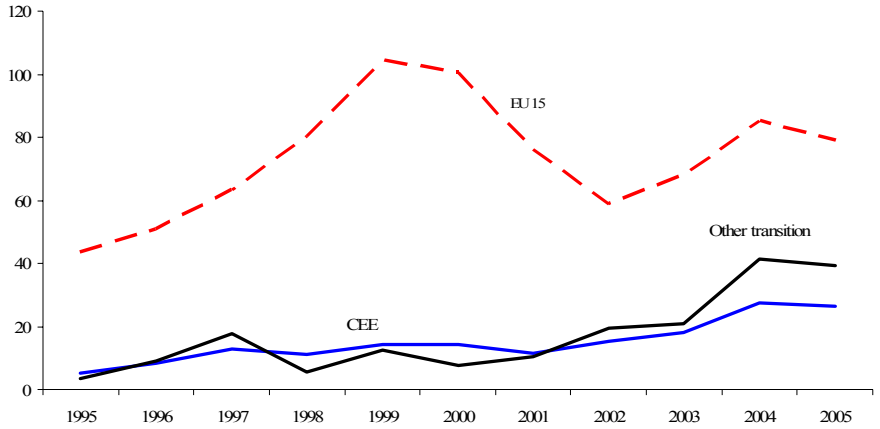
[22] See Aitken and Harrison (1999) and Bailliu (2000) for similar conclusions.
[23] A country s absorbtive capacity can be represented as depth of financial markets, human capital, quality of governance and macroeconomic policies.

integration with different econometric techniques to test how the effect of financial development on growth may depend on financial, institutional and policy factors of economic development. Their battery of tests does not produce robust results, which indicates that international financial integration does not cause higher growth per se, even though the fact that higher openness is accompanied by economic success not be overlooked. In the view of Prasad et al. (2003), the presence of threshold effects of financial integration both for growth and macroeconomic volatility demonstrates that sound macroeconomic policies and improved institutions are crucial for a country to attract less volatile and growth-enhancing capital flows.

3.3 Financial market development and degree of financial integration in transition economies

Transition countries started the transition process with levels of development of financial markets at levels much lower than in comparable emerging markets. A similar finding applies to the degree of international financial integration (Lane and Milesi-Ferretti, 2006b). A fast pace of development from the onset of transition was, for this reason, expected. Figures 3-1 and 3-2 show market capitalization and private credit as share of GDP for the EU15, CEE countries, and other selected transition countries (Russian Federation, Croatia, Bosnia and Herzegovina, Macedonia and Serbia and Montenegro). Two facts emerge. First, the level of financial development in transition countries more than fifteen years from the start of the transition still remains well below the corresponding levels in the EU15. Second, in the 1995-2005 period, the pace of development of financial markets (measured in terms of size) has not exceeded that of EU15 countries, implying that no significant convergence, in terms of financial depth, occurred during this period.

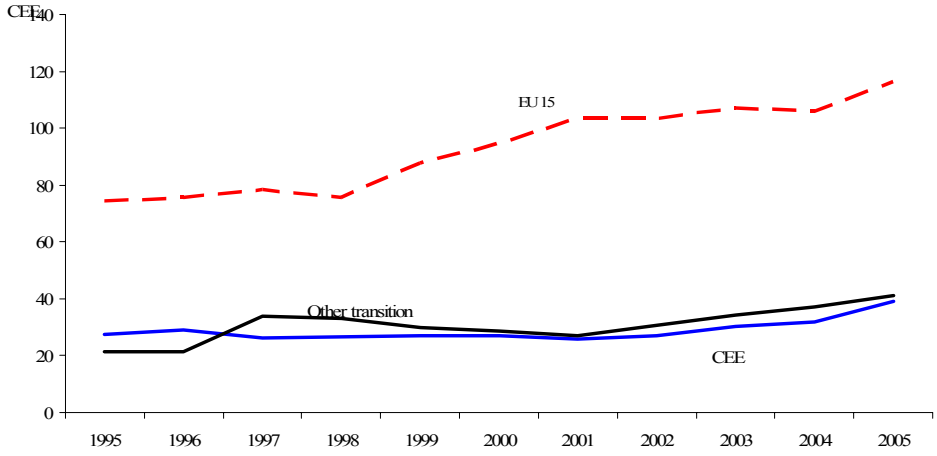
Figure 3-1: Evolution of market capitalization as % of GDP in EU15, CEE countries and other transition countries, 1995-2005 (arithmetic means)



Note: CEE countries: Bulgaria, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Romania, Slovak Republic, Slovenia; Other transition: Russian Federation, Croatia, Bosnia and Herzegovina, Macedonia and Serbia and Montenegro
Source: WDI database

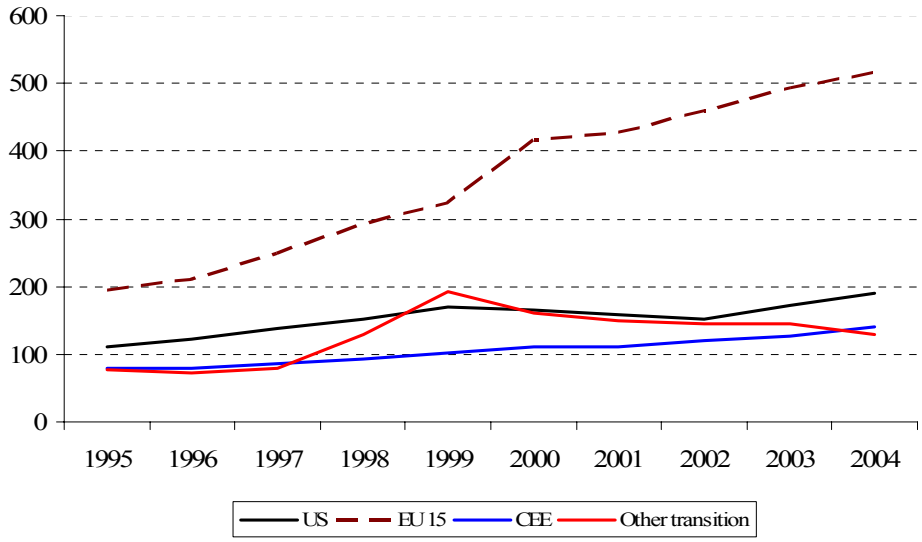
Such a low degree of financial depth cannot be explained by large differentials of income per capita. Countries involved in previous EU enlargements, like Portugal, Spain and Greece, had income per capita at the time of entry not higher than some of the most advanced NMs, Slovenia for instance, but their credit-to-GDP ratios were more than twice as large as those of NMs.

Figure 3-2: Evolution of domestic credit to the private sector as % of GDP in EU 15, CEE countries and other transition countries, 1995-2005 (arithmetic means)



Source: WDI database
See notes to Figure 1.

Figure 3-3: International financial integration measured as the percentage of total foreign assets and liabilities of GDP in EU-15, CEE countries, other transition countries and the US, 1995-2004



Source: Lane and Milesi-Ferretti (2006a), own calculations

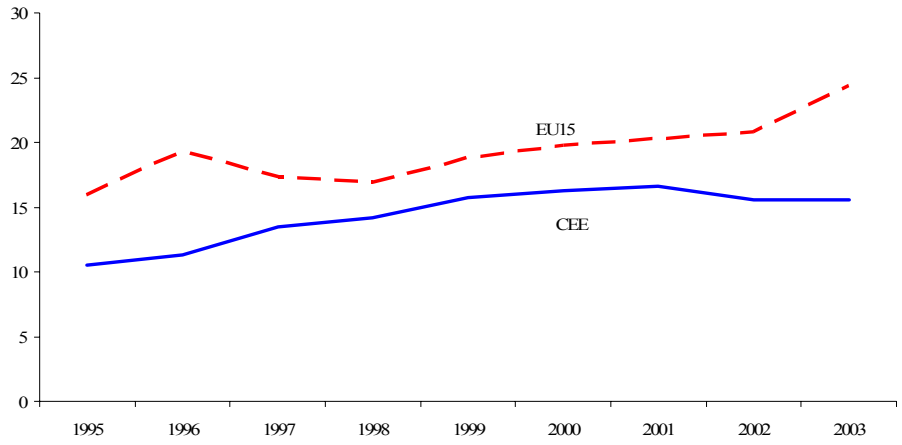
The reasons for the underdevelopment of financial markets probably has to do with the initial design of liberalization and reform policies and with objective difficulties in developing financial markets in the midst of enormous structural change and transformation of the economy. Partly stimulated by the literature on transition, it is now acknowledged that institutional development plays a key role in macroeconomic performance, both on growth rates and on their volatility (Roland, 2000; Acemoglu et al., 2002 among others). One of the main channels through which institutions affect growth and volatility is that of financial markets. The latter are indeed extremely sensitive to institutional design.[24] During the period following the reforms of the beginning of 1990-91, NMs experienced major difficulties in developing financial markets. The result is that financial markets remain largely underdeveloped, in spite of a recent acceleration in credit growth, especially for households (see Cottarelli et al., 2003, EBRD Transition Report, 2006).

Accession to the European Union provided a strong impetus for institutional change. Indeed, in recent years, we see a faster increase in credit-to-GDP ratios. An even more important stimulus may come from the process of euro adoption that is an institutional

[24] See for instance EBRD, Transition Report 2003.

obligation of all new EU members. Figure 3 suggests that the process of monetary integration culminating in the introduction of the euro has been accompanied by a marked increase in the degree of international financial integration (measured by the share of the sum of total foreign assets and liabilities in GDP) in the EU15. It virtually tripled in the 1993-2004 period, while it only roughly doubled in the CEEC even though the CEEC started from a considerably lower initial position and had a significant margin to close.[25] Note also a marked acceleration in 1999 when the euro was introduced to the financial markets. Figure 3-3 also plots the corresponding data for the US in which we observe similar dynamics as in CEE countries. This says that the high growth of international financial integration that we observe for the EU15 is not shared by the other most important developed countries. Lane and Milesi-Ferretti (2006b) reported a similar finding for other emerging markets that also observes the increase in financial integration similar to CEE countries. Simple empirical evidence thus suggests that the process of monetary unification and the establishment of EMU have played a determining role in the marked increase in financial integration we observe in the data.

Figure 3-4: Private cross-border borrowing as % of GDP in EU15 and CEE countries, 1995-2003



Source: Lane and Milesi-Ferretti (2006a), own calculations

[25] See Lane and Milesi-Ferretti (2006a) for details about the composition of these flows. The most pronounced difference is in the shares of FDI and portfolio investment. The first is dominant in the CEEC, while the latter dominates in the EU15.

The dynamics of direct cross-border borrowing of the private sector, presented in Figure 3-4, offer a similar conclusion, as it can be clearly observed that especially after 1998 – the year in which it was known which countries will form the Euro zone – growth of credit provided by foreign financial intermediaries was much larger in EU15.

Empirical evidence thus suggests that for CEEC countries convergence in incomes per capita towards EU levels has not been accompanied by convergence in the level of financial depth. I argue that further development of national financial markets and a higher degree of international financial integration may be seen as a source of future growth and a factor of further real convergence. In this respect, euro adoption may work as a catalyst, fostering both the size of national financial markets and the development of a better institutional framework.

3.4 Empirical analysis

The empirical analysis is divided in three parts. First, I use a cross-country panel of macroeconomic data to evaluate the potential effect of financial integration of growth of GDP. By controlling for depth of national financial markets, which is my measure of financial development, the analysis also provides the first evaluation of the effect of financial development on growth. Second, at the same level of aggregation of data, I also estimate the effect of financial integration on the development (depth) of national financial markets. Finally, I take the analysis of financial integration on growth one-step further and follow Rajan and Zingales (1998) in using industry-level data to asses how the increased availability of external finance stimulates growth in the economy. Because the industry-level approach has a number of methodological and conceptual advantages over the classical macro approach (see detailed discussion below), this is a robustness check that significantly strengthens my conclusions. As emphasized by Guiso et al. (2004), financial integration can notably contribute to the development of national financial markets and thus affect growth indirectly. This indirect effect is better captured in industry-level analysis. Industry-level data allow us also to explicitly evaluate the threshold effect of financial development on growth using the methodology of Hansen (1999). With regard to the estimation of threshold effects on macro level, the data allow

us to provide only tentative evidence that important threshold effects also exist in the effect of financial integration on growth.

3.4.1 Macro-level analysis of the effect of financial integration on growth and on development of national financial markets

In order to describe the impact of financial integration on growth, not only was cross-section dimension of the data exploited, but also the time dimension, so the panel data estimation technique was used. Estimation using panel data has several advantages over pure cross-section estimation. First, besides exploring the cross-country relation between growth and financial integration, we also capture how the evolution of these characteristics in time affects growth. Moreover, it is desirable to work with panel data from a purely statistical point of view, because adding the time dimension considerably increases the degree of freedom. Adding the time-series dimension of the data substantially augments the variability of the data. Second, in a pure cross-sectional regression any unobserved country-specific effect would be part of the error term, potentially leading to biased coefficient estimates. This does not happen in the panel context because we are able to control for unobserved firm-specific effects and thereby reduce the potential bias in coefficient estimates.

Although the coefficient of lagged dependent variable is not of direct interest, allowing for dynamics in the underlying process can be crucial for recovering consistent estimates of other parameters. The dynamic panel data regression is characterized by two sources of persistence over time: autocorrelation due to the presence of a lagged dependent variable among the regressors and individual effects characterizing the heterogeneity among the firms.[26]

[26] The OLS estimator is biased and inconsistent even if the error time is not serially independent, because of the correlation between the lagged endogenous variable and the error term. Standard results for omitted variable bias indicate that, at least in large samples, the OLS levels estimator is biased upwards (Baltagi, 2005). The within group estimator eliminates the source of inconsistency by transforming the equation to eliminate firm-specific effects. Specifically, the mean values of dependent and all independent variables plus the firm-specific effects and the error term across the T-1 observations for each individual are obtained, and the original observations are expressed as deviations from these individuals' means. OLS is then used to estimate these transformed equations. In contrast, for panels where cross section dimension is large and T is fixed, this transformation induces a non-negligible correlation between the

I employ the GMM dynamic panel estimator, which is specifically designed to address the econometric problems induced by unobserved country-specific effects and the joint endogeneity of the explanatory variables in lagged-dependent-variable models. In other words, this estimator allows us to simultaneously control for the endogeneity bias induced by reverse causality running from GDP growth to financial integration, the development of national financial markets and other explanatory variables[27].

The difference dynamic-panel estimator, developed by Arellano and Bond (1991) and Holtz-Eakin et al. (1990) was used. I first difference the regression equation to remove any omitted variable bias created by unobserved firm-specific effects, and second, instrument the right-hand-side variables (the differenced values of the original repressors) using the lagged values of the original repressors to eliminate potential parameter inconsistency arising from simultaneity bias).

I focus on the results of the one-step estimator, because simulation studies (Arellano and Bond (1991), Blundell and Bond (1998), Bond and Windmeijer (2000) showed very modest efficiency gains from the two-step estimator, even in the presence of considerable heteroskedasticity. Furthermore, the dependence of the two-step weight matrix on estimated parameters makes the usual asymptotic distribution approximations less reliable for the two-step estimator. Simulation studies showed that the asymptotic standard errors tend to be much too small or the asymptotic t-ratios much too big for the two-step estimator in the sample sizes, whereas the equivalent tests based on the one-step estimator are quite accurate.

Consistency of the GMM estimator depends on the validity of the instruments. To address this issue, I consider two specification tests suggested by Arellano and Bond (1991), Arellano and Bover (1995), and Blundell and Bond (1997). The first is a Sargan test of over-identifying restrictions, which tests the overall validity of instruments by analyzing the sample analog of moment conditions used in the estimation process. Since the Sargan test over-rejects in the presence of heteroscedasticity, I use a two-step Sargan test to perform inference on model specification. The second test examines the

transformed lagged dependent variable and the transformed error term (Bond, 2002). This correlation does not vanish as the number of individuals in the sample increases, so the within estimator is also biased and inconsistent. Standard results for omitted variable bias indicate that, at least in the large samples, the within estimator is biased downwards. The fact that OLS and within estimators are likely to be biased in the opposite direction imply that the candidate consistent estimator will lie between the OLS and within estimates.

hypothesis that the error term is not serially correlated. In the difference regression, we test whether the differenced error term is second-order serially correlated (by construction, the differenced error term is first-order serially correlated even if the original error term is not).

With some modifications, this part of the analysis follows the approach used by Edison et al. (2002). I estimate the following equation:

$$\Delta y_{it} = \alpha_i + \rho \Delta y_{i,t-1} + \beta IFI_{it} + \gamma_1 FD_{it} + \gamma_2 \inf_{it} + \delta_t + u_{it}, \qquad (3\text{-}1)$$

where the dependent variable, Δy_{it}, equals real GDP per capita growth in country i and period t. α_i are fixed effects that allow us to control for time-invariant determinants of growth such as human capital (the literature usually proxies this with measures of educational attainment, but given a short time period under analysis we assume it is fixed), institutional factors (protection of property rights, administrative barriers, etc.) and other time-invariant unobservable factors that may otherwise bias the coefficients. δ_t are common time effects that capture business cycle effects that may otherwise cause spurious correlation between growth and explanatory variables. *IFI* is one of the measures of international financial integration. Finally, X is a vector of control variables that includes inflation rate (*inf*) and a measure of financial development. To control for the potential effect of fiscal stance on growth, a fiscal deficit also was included in model (3-1), but since it consistently resulted as highly insignificant, it was omitted from further analysis.

3.4.1.1 Modeling non-linear effects

The potential presence of non-linear effects of financial integration on growth is investigated in two simple ways. Because transition countries in the sample differ from more-developed European countries in many aspects, ranging from significant differences in general economic development to the depth and institutional development of financial markets, and the history of transition from centrally planned to market economies, I estimate Equation (3-1) also by allowing coefficient β to differ between transition and non-transition countries. Significant differences in coefficients across two groups of countries can be seen as evidence of the non-linear effects of financial integration on growth.

In my second approach, I check whether the effect of financial integration on growth depends on the overall level of development of national financial markets and economies' absorptive capacity, which is proxied by depth of financial markets in my application. In principle, one could estimate threshold effects with the method of Hansen (1999) that I use in industry-level analysis. However, on a panel of macro-level data this would not be valid because of the dynamic specification of the model, and because in such a context one cannot assume financial development to be strictly exogenous. Nevertheless, I make a tentative estimation of threshold effects by estimating the following model:

$$\Delta y_{it} = \alpha_i + \rho \Delta y_{i,t-1} + \beta IFI_{it} + \mu IFI_{it} \times D_k + \gamma' X_{it} + \delta_t + u_{it}, \qquad (3\text{-}2)$$

where D_k is a dummy variable taking value one if the depth of national financial markets (measured as the share of market capitalization and domestic credit provided by the banking sector in GDP)[28] is larger or equal k, and zero otherwise. k ranges between 40 and 250% of GDP in steps of 10 percentage point of GDP. Coefficient β measures the effect of financial integration on growth for observations with a depth of financial markets smaller than k percent of GDP. Even though such a procedure does not yield a precise and consistent estimate of threshold values, inspection of estimates of β across different values of k yields a *prima facie* evidence of possible threshold effects.

3.4.2 Macro-level analysis of the effect of financial integration on the depth of national financial markets

As outlined in the introduction, the aim of the paper is not only to evaluate the direct effect of financial integration on growth, as is done in Equation (3-1), but also the indirect effect through stimulus that financial integration might give to development of domestic financial markets. This is done in Equation (3-3), which tests whether countries more integrated into world financial markets have also deeper financial system:

$$FD_{it} = \alpha_i + \delta_t + \sum_{l+1}^{3} \sigma_l FD_{i,t-l} + \lambda IFI_{it} + \xi' X_{it} + v_{it}, \qquad (3\text{-}3)$$

[28] In this paper, I consider only the size of financial markets as the threshold variable, because I believe that such a variable is the most appropriate measure of financial development and absorptive capacity of the economy for the purposes of my empirical analysis. Additionally, I could consider other more descriptive measures; however, this is left for my future work.

where *FD* denotes the development of national financial markets measured as the share of market capitalization and domestic credit provide by banking sector in GDP (*totfin*), and *IFI* is, similar to above, the stock of total foreign assets and liabilities as percentage of GDP (*tfinint*). Control variables contained in matrix X are openness (*openness*), measured as exports plus imports as percentage of GDP, and inflation (*inf*). The possible reverse causal effect of GDP per capita was also considered, but because of its insignificance it was excluded from the analysis. The term α_i effectively controls for all time-invariant institutional factors that determine the level of financial development. Due to same reasons as above, Equation (3-3) is also estimated by a GMM procedure developed by Arellano and Bond (1991).

Coefficient β from Equation (3-1) measures the pure effect of financial integration on growth. We interpret it as how a change in *IFI* influences Δy_{it} if everything else (also *FD*) remains unchanged. In contrast, if λ in Equation (3-3) is significant; the overall (general equilibrium) effect of financial integration on growth also operates through variable *FD* with coefficient γ in Equation (3-1). In particular, the short run overall effect of financial integration on growth is measured by $\beta + \lambda\gamma$ and long run overall effect is measured by $\frac{1}{1-\rho}\left(\frac{\lambda\rho}{1-\sigma} + \beta\right)$.

3.4.2.1 Modeling non-linear effects

Since the relationship between financial integration and financial development might also be non-linear, I apply a similar procedure as above to test possible thresholds. I estimate the following model:

$$FD_{it} = \alpha_i + \sum_{l=1}^{3} \rho_l FD_{i,t-l} + \lambda IFI_{it} + \mu IFI_{it} \times D_k + \gamma' X_{it} + \delta_t + u_{it}, \qquad (3\text{-}4)$$

where D_k is a dummy variable taking a value of one if the threshold variable is larger or equal k and zero otherwise. I considered two variables as potential threshold variables: *openness* (export plus import as percentage of GDP) and GDP per capita. For *openness*, k ranges between 50 and 190% of GDP in steps of 10 percentage point of GDP, while it ranges between 2,000 US$ and 27,000 US$ in steps of 1,000 US$ for GDP per capita

variable. Coefficient λ measures the effect of financial integration on growth for observations with openness or GDP per capita smaller than k.

3.4.3 Data and summary statistics of macro-analysis

The literature offers different approaches in measuring financial integration. In principle, we can distinguish between *de jure* and *de facto* measures. Most authors used a measure based on the official restrictions on capital flows that are collected by IMF from national authorities. This is a binary *de jure* indicator that equals one in years where there are restrictions on capital account transactions, and zero in years where there are no restrictions on these external transactions. As a binary variable, this indicator has some limitations. First, it directly measures capital controls and does not capture the differences in the intensity of this controls. By grouping countries that are partly to substantially open with countries that are completely closed, it introduces systematic measurement error in growth regressions when used as an independent variable, which might lead, as argued by Quinn and Toyoda (2006), to biased coefficient estimates. Second, this IMF measure reports only restrictions on residents; it does not contain information about non-resident capital account restrictions, on foreign direct investment for example. There are several authors who try to improve this binary measure with several modifications (Quinn, 1997, Johnston and Tamirisia, 1998, Mininane 2004), and they all made contributions in offering measures that contain more information than the original dummy. However, they still retain the dummy variable features of the original IMF measure in that they measure the presence or absence of controls in a given category. What is more, there was a structural break in 1997 in the IMF's AREAER (Annual Report on Exchange Arrangements and Exchange Restrictions) documentation of capital controls in 1997 (Edison et al. 2002). In contrast, *de jure* indices of financial globalization show one aspect of financial globalization. There are countries in Latin America where observed capital flows exceed the extent of mobility legally allowed or, in other words, where integration has occurred without capital account liberalization. There are also countries in Africa that have few capital account restrictions, but they experienced only minimal levels of capital flows, i.e. where liberalization has occurred without integration. Nevertheless, most of the countries attained a high or low degree of financial integration in both measures.

For my analysis I prefer to use non-index or *de facto* measures. As argued by Beale et al. (2004), de facto measures can be further divided between price-based, news-based and size-based measures. For the purposes of my analysis, it is important to use a measure that exhibits sufficient time variation. Bekaert and Harvey (1995), analyzing the behavior of stock-market, expected returns as a price-based measure, demonstrated that many emerging markets exhibit time-varying integration. However, I prefer to use size-based measures because their construction does not depend on an econometric methodology used in the analysis of price co-movements and can, therefore, be based on more objective statistical grounds.

In selecting my measure of financial integration, I concentrate on stock size-based measures because, as argued by Prasad et al. (2003), stock data constitute the best indication of integration. They are less volatile between years and are less prone to measurement error (assuming that such errors are not correlated over time) than measures based on capital flows. Moreover, they are closer to the theoretical concept of financial openness that emphasizes both the ability of foreigners to invest into and lend to a country, and domestic agents to borrow from and invest abroad. Precisely as a measure of financial openness, the stock data that I use were constructed by Lane and Milesi-Ferretti (2006a). In a similar analysis, their data were used also by Edison et al. (2002).

For robustness I consider several measures of financial integration. The first variable, *tfinint,* is the stock of total foreign assets and liabilities as a percentage of GDP. Secondly, I use total liabilities as a percentage of GDP (*tliab*) puts the emphasis on financial sources obtained from abroad. For CEE economies, Lane and Milesi-Ferretti (2006b) singled out FDI inflows as the most important source of capital flows. For this reason, I use also the sum of stocks of FDI inflows and outflows as a share of GDP (*tfdi)*, and the stock of FDI inflows as a share of GDP (*fdiin*). Conversely, Lane and Milesi-Ferretti find portfolio flows much more dominant for the EU15. So, the final two measures of financial integration are the sum of stocks of portfolio equity and other debt inflows and outflows as a share of GDP (*tped*), and the corresponding share of inflows (*pedin*).

Growth equals real per capita GDP growth and inflation equals the growth rate of consumer price index. Following Rajan and Zingales (1998) and Guiso et al. (2004), among others, I use the share of market capitalization and domestic credit provided by

banking sector in GDP (denoted by *totfin*) and domestic credit as share of GDP alone (denoted by *dom_cre*) as measures of financial development. [29]

These are size-based measures and they may be of limited quality in cases of poor market discipline and weak financial supervision. In such cases, high credit activity can also be seen as reflecting weaknesses in the financial system and lead to financial crises of the sort experienced by some South-East Asian countries in 1997. However, for the present sample of countries it can be argued that this is not the case. All new EU members adopted EU financial standards in the process of EU accession. The quality of the financial system in transition countries has improved, while their sizes are still converging to equilibrium levels (EBRD Transition Report 2006). Nevertheless, I included in my empirical model dummy variables corresponding to the Czech financial crisis in 1997 and Russian financial crisis in 1998 in order to check whether these two events influence my results. It was comforting to find that they do not.

3.4.3.1 Summary statistics

The sample of countries in the aggregate-level analysis contains 31 European countries (EU27, Croatia, Ukraine, Russian Federation, Iceland and Norway) for the 1996–2004 period. Table 3-1 summarizes the average and growth values of main variables. The convergence of transition countries towards the levels of development of the EU is reflected in higher-than-average growth rates of per capita output. The leaders are Baltic countries with growth exceeding 6.4 percent on average, which is more than 2.5 percentage points above the median value in the group.

Table 3-1 also presents evidence on the magnitude both in levels and time dynamics of financial development in the 1996-2004 period. Countries in the sample are grouped into three major groups. The growth rate of financial development in this eight-year period is similar in all three groups, but there are big differences in its structure. As expected, the growth rate of market capitalization is much higher in transition countries (ranging from 8% to 25% in the CEE, and from 12% to 32% in other transition countries), as capital markets were non-existent in the previous regime. Domestic credit is on average much higher in non-transition countries, for 75.6 percentage points in CEE and 77.5 percentage points in other transition countries. Among the transition countries, the Russian

[29] The data come from World Bank's World Development Indicators database.

Federation and Ukraine have much higher growth than non-transition countries, which is due to the fact that these countries started the transition with extremely low levels of this indicator. For CEE, we can detect no growth at all, mostly because transition countries, especially the Czech and Slovak Republic, went through restructuring of their banking system and a clean up process of bad loans that reduced the credit-to-GDP ratio over time. Furthermore, the crisis in Bulgaria in 1997 reduced the stock of bank loans as the ratio to GDP. In any case, in recent years, there has been a rapid growth of domestic credit that is still below the average growth rate of the EU 15. This indicates much potential for future improvement in this area that could be heavily influenced by the process of financial integration within EU. As can be seen from the fifth row in Table 3-1, the overall degree of international financial integration (measured as the sum of external assets and liabilities divided by GDP) has more than doubled in transition countries, increasing from an average 84 percent of GDP in 1994 to 155 percent of GDP in 2004.

Table 3-1: Descriptive statistics

	EU 15*		**CEE**		**other transition**	
	(1)	(2)	(3)	(4)	(5)	(6)
	mean	growth in %	mean	growth in %	mean	Growth in %
Growth in GDP p.c.	2.9	21.3#	4.1	42.3#	3.6	40.4#
Market cap./GDP	77.4	40.2	14.8	202.6	18.1	158.1
Domestic credit/GDP	113.3	73	37.7	-0.8	35.8	158.1
Total finance/GDP	190.7	24.5	52.8	25.1	54.3	42.0
tfinint	408.6	140.1	121.6	78.9	118.6	135.9
tliab	212.1	134.3	49.6	96.9	71.2	123.7
tfdi	76.3	163.3	29.6	237.7	20.9	420.8
fdiin	37.7	156.6	27.4	240.9	15.4	370
tped	320.9	139.1	73.8	43.1	85.3	76.9
pedin	171.7	126.6	49.6	51.6	55.9	84.7

Note: *Without Luxembourg, % growth of GDP per capita in constant 2000 US $ in the 1996-2004 period, CEE countries: Bulgaria, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Romania, Slovak Republic, Slovenia; Other transition countries: Russian Federation, Croatia, Ukraine

3.4.4 Industry-level analysis of financial development and growth

Although we can already estimate the effect of development of domestic financial markets on growth on the macro level in model (3-1), I also check the robustness of my findings using industry-level data. The main reason for this is the fact that different production technologies across industries imply different needs for external sources of finance. On the macro level, such differences cannot be identified and hence the effect of financial development on growth is less efficiently estimated. By the same token, such an analysis can also better capture the indirect effect of financial integrations through the development of national financial markets.

The major challenge in the literature on financial development and growth is how to address the potential endogeneity problem between the growth rate of firm-level output and the degree of financial development. Using industry-level data, Rajan and Zingales (1998) (RZ hereafter) proposed a solution to the problem by using the dependence on external finance by different sectors in the US as the benchmark, which makes it perhaps the most influential recent empirical analysis of the relationship between finance and growth. The idea is that the financial market in the US can be assumed to be close to perfect and thus the financial structure of firms is determined by an optimal choice that is not constrained by supply factors. In addition, RZ argue that differences across firms of the same sectors are minor, and thus sectoral indicators are a good proxy for firm-level dependence on external finance. The US indicators can be considered exogenous indicators of financing needs. Cross-country analysis of growth of real sales of firms, excluding the US, can then be used to determine the role of financial development on growth. The sectoral US financial dependence indicator is multiplied by the level of financial sector development in different countries to construct what is by now a familiar indicator in the literature: the Rajan-Zingales indicator. In my estimations, I interact the RZ measure of external finance dependence with the share of total finance (market capitalization of listed firms and private credit) in GDP. I concentrate on this measure of financial development, because it is the most general among the measures used in the literature.

If the coefficient on the RZ indicator in a cross-country regression with the growth of real sales as dependent variable turns out to be positive, this indicates that financial sector development affects the growth rates of firms. Financial sector development is

measured by the sum of credit to the private sector and the stock market capitalization as a percentage of GDP. A positive coefficient on the RZ indicator implies that firms that need more external finance grow faster in countries with a more-developed financial sector.

As Fisman and Love (2003) pointed out, this raises the issue of sufficient financing for the firms with high returns in the countries with less-developed financial markets. From RZ, it follows that the additional financing needed could be collected from internal financing. Petersen and Rajan (1997) argued that alternative funds could be raised by the borrowing from suppliers. FL made a natural extension of Petersen and Rajan's reasoning by constructing a measure of trade credit using a similar approach as RZ. In order to obtain an industry-level measure of trade credit usage, they employ the ratio of accounts payable to total assets, calculated for US firms for different sectors. Also, this measure is multiplied by the level of financial sector development in different countries. The negative sign of the coefficient is consistent with the hypothesis that firms that are more dependent on trade credit have a relative advantage in countries with less-developed financial intermediaries, which implies a substitutability between trade credit and bank credit. In contrast, if the coefficient is positive, there is a complementarity between the two forms of financing.

Even if RZ solve the problem of endogeneity of the financial indicator, there is still the problem of possible reverse causality from growth of output to the level of financial development. As emphasized by Guiso et al. (2004), a potential problem of RZ is that financial development may affect both the growth rate of firms and industries and the pattern of industry specialization. As a consequence, firms in financially less-developed markets may adopt technologies that make them less dependent on external finance. When estimating the effect of financial development on growth using industry-level data, RZ tackle this endogeneity problem by including in the estimated equations the beginning-of-period industry share in value added. This has also been used by other authors, including Guiso et al. (2004).

For the sample of countries in my analysis, an inclusion of industry shares in total value added was not possible because of the limited coverage of transition economies in the UNIDO database. I handle the problem by exploiting the panel structure of the data. Allowing explicitly for time-variation in variables implies that the initial period industry

shares in total value added are simple fixed effects.[30] The same holds for institutional determinants of financial development (legal origin, protection of creditor rights, financial market regulation, etc.) that many authors considered as instrumental variables in their estimations (Rajan and Zingales, 1998; Guiso et al., 2004). This means that a simple within estimator corrects for the potential bias induced by the correlation between industry specialization pattern and financial development. However, it must be noted that allowing for time variation in the panel, i.e. by analyzing the contemporaneous relation between financial development and growth (in contrast to RZ who used the initial-period level of financial development to explain average growth), induces an additional potential bias simply because financial development may be demand- and not only supply-determined. It may be argued that in this case this problem is not pernicious since the original units of observation on sales are firms who may have only a very limited effect on aggregate supply of finance. The aggregate effect of all firms together may also be limited since we concentrate on the manufacturing sector only, and that normally accounts for less that half of aggregate value added. In addition, a significant share of credit may be supplied to households. These are all indications that the endogeneity problem in these estimations may be very limited, if present at all. The baseline empirical model is

$$\Delta y_{ict} = \alpha_{ic} + \beta\left(RZ_i \times FD_{ct}\right) + \gamma\left(FL_i \times FD_{ct}\right) + \delta_t + u_{ict} \qquad (3\text{-}5)$$

where Δy_{ict} denotes growth of real sales in industry i, country c and year t. RZ_i represents the Rajan and Zingales (1998) measure of external finance dependence, while FL_i stands for the corresponding measure of the use of trade credit assembled by Fisman and Love (2003). FD_{ct} is a measure of financial development (sum of stock market capitalization and private credit as percentage share of GDP). α_{ic} is a full set of industry-country fixed effects, while δ_t denote common time effects.[31]

Guiso et al. (2004) argued that such a specification is convenient to study the effects of international financial integration on growth.[32] First, the statistical insignificance of coefficient β indicates the presence of a high degree of financial integration. Secondly,

[30] Edison et al. (2002) used the same argument in favor of using panel data techniques.
[31] Note that Rajan and Zingales (1999) estimated a different model in their original specification. Growth of output was measured as the average over a period, while financial development was taken from the initial period.
[32] In contrast to this specification, their specification does not include the effect of trade credit, which is an important alternative source of external finance.

the model can be used to identify countries and industries that benefit more from financial integration. However, there are a number of reasons why the reasoning of Guiso et al. (2004) does not so firmly apply to the process of financial integration. In relation to their first point note that significance or insignificance of coefficient β more generally signals only whether development of domestic financial markets is causal for growth or not. Financial integration may be only one, albeit very important, reasons of why it should not matter. This is also why they notice that finding a significant and positive β does not imply the absence of financial integration, but only that domestic financial development affects growth. In addition, their second conjecture is valid only to the extent that international financial integration leads to development of domestic financial markets since this is essentially the variable used in their regressions. This view does not embed cross-border borrowing as one of the very important channels through which financial integration affects growth.

For these reasons, I extend the model (3-5) to explicitly contain measures of international financial integration in two ways. The first model explicitly includes the stock of cross-border borrowing of private sector (share in GDP), denoted by *FF*, as an additional source of external finance. As the measure of the depth of national financial markets, this variable is also interacted with Rajan and Zingales' (1998) measure of external finance dependence.

$$\Delta y_{ict} = \alpha_{ic} + \beta\left(RZ_i \times FD_{ct}\right) + \mu\left(RZ_i \times FF_{ct}\right) + \gamma\left(FL_i \times FD_{ct}\right) + \delta_t + u_{ict} \qquad (3\text{-}6)$$

In this way, coefficient μ directly measures the effect of cross-border provision of finance as opposed to coefficient β, which measures the effect of development of national financial markets. Such a specification may still inadequately capture all of the effects of financial integration, which may also stimulate the development of national financial markets in a complex manner (see Section 3.3 for a discussion). For this reason, the second model augments model (3-5) with the measure of international financial integration (denoted by *FI*). I use the sum of total foreign assets and liabilities as constructed by Lane and Milesi-Ferretti (2006a).[33]

[33] They measure international financial integration as the share of the sum of total foreign assets and liabilities in GDP.

$$\Delta y_{ict} = \alpha_{ic} + \beta\left(RZ_i \times FD_{ct}\right) + \kappa\left(RZ_i \times FD_{ct} \times IFI_{ct}\right) + \tau IFI_{ct} + \gamma\left(FL_i \times FD_{ct}\right) + \delta_t + u_{ict} \quad (3\text{-}7)$$

IFI enters the model directly and interacted with the standard RZ term. In this respect, coefficient τ measures a direct effect of financial integration on growth as in Edison et al. (2002). An interaction term is needed due to the fact that financial integration may indirectly affect domestic financial markets (increased efficiency in the presence of higher competition, improved regulatory framework and corporate governance in financial institutions). In addition, the interaction term effectively captures potential non-linearities in the effects of financial integration on growth. Evidence in the literature suggests that financial integration may be even harmful if not accompanied by necessary financial and institutional development. It can be argued that the latter is successfully proxied by the size-based measures of development of national financial markets (*FD*).

3.4.4.1 Modeling non-linear effects

In each of the models above, I consider an additional extension. Each of the variables is interacted with a dummy variable that partitions the countries in the sample into the group of transition countries (ten transition economies that became members of the EU, Croatia, Ukraine and the Russian Federation) and other countries (EU-15, Malta, Norway and Iceland). The two groups of countries differ importantly both in terms of development of national financial markets and international financial integration. As demonstrated in Chapter 2, significant differences in the effect of financial development on growth between the two groups of countries may thus in a simple way reflect non-linearities in effects of financial development on growth.

A more systematic approach to modeling non-linearities in the effect of financial development conditional on the level of financial development itself without resorting to the use of country dummies can be performed by allowing for explicit threshold effects. Following Hansen (1999), I allow for a multiple threshold model, using the measure of financial development as the threshold variable. To compactly write the multiple threshold model, let ΓX_{cit} generically denote the right hand side of the following equations:(3-5), (3-6) or (3-7) (without deterministic terms). Then we have

$$\Delta y_{ict} = \alpha_{ic} + \delta_t + \sum_{j=1}^{3} \Gamma_j X_{cit} I\left(\tau_{j-1} < FD < \tau_j\right) + u_{ict} \qquad (3\text{-}4)$$

This corresponds to a double threshold model with τ_0 and τ_3 unspecified. The regressor set $\Gamma_j X_{cit}$ corresponds to the one of model (3-3). A natural threshold variable that can be used in the present context is the measure of financial development, which must be assumed exogenous to comply with the assumption behind the econometric model in Hansen (1999). Estimation of threshold levels and their confidence regions follows the multi-step procedure described in Hansen (1999).[34]

One important advantage of the threshold model is that it allows for simulation of the likely effects of financial integration on growth in the spirit of Guiso et al. (2004) in presence of the non-linearity of the growth effect. As I show that significant non-linearities are in fact present, this may give us a much more reliable estimate of the likely effect of euro adoption on growth in new EU members.

3.4.4.2 Data

The sample covers 30 European countries and 26 three-digit ISIC Rev. 2 manufacturing industries for the 1995–2003 period. The countries in the sample are EU 25 countries to which I added also data for Iceland, Norway, Croatia, the Russian Federation and Ukraine. Since the time span of data is not uniform across countries, I am dealing with an unbalanced panel of data.

Data on external finance dependence at industry level (three- and four-digit ISIC Rev. 2 level) are taken from RZ (1998). They define external finance dependence as the share of capital expenditure that a given industry cannot finance through internal cash-flow. Data on financial market development (market capitalization of listed firms, domestic credit, bank credit to the private sector, all expressed as share of GDP) are taken from the WDI database. These variables are then interacted with the RZ measure of external finance dependence to obtain the variable that measures the effect on growth of external financial funds provided through financial market. Similarly, Fisman and Love (2003) (FL hereafter) construct a variable that measures the dependence on trade credit in the

[34] Hansen s (1999) method is designed for balanced panels, while I operate with an unbalanced panel. In such a case, it must be noted that it is unknown whether all the Hansen's results regarding inference carry completely through.

benchmark US case as another source of external finance. I use their indicator in addition to the one by Rajan and Zingales. Not only is trade credit likely to play a major role in transition countries, but, more generally, it seems more appropriate to consider external finance not only for capital expenditure, but also for working capital, which is the main determinant of enterprise debt.

Growth of industry output is calculated from firm-level data on sales drawn from the Amadeus database of the Bureau Van Dijck, which also includes small and medium-sized firms[35]. Sales are deflated with the producer price index obtained from the IMF IFS database. All observations with growth of real sales that exceeded 100% were treated as outliers and thus excluded from the database. Industry-level growth of output was calculated as a simple average. This resulted in a final dataset of 4,449 observations, comprising of 638 country-industry units with seven years of time observations on average.

Data on stocks of foreign assets and liabilities needed to construct the measures of financial integration are taken from the dataset constructed by Lane and Milessi-Ferretti (2006a), while data on cross-border borrowing of the private sector are taken from the IFS database.

3.5 Results

Since there is no firm proof in empirical analysis of the influence of financial integration on growth, I try to find as robust results as possible by analyzing this effect on two different sets of data, with two different methodologies. The first two regressions in the dynamic panel framework are run on macro-data, and second, industry-level data in RZ framework are analyzed. Non-linearities are explored on both samples, with an estimating recursive coefficient on macro data and with Hansen model in the industry data.

3.5.1 Macro-level results

As explained in Sub-section 3-4, in order to capture the entire effect of financial integration on growth, two equations were estimated with macro data. First, the direct

[35] For more details about the construction of this dataset, see Chapter 2.

influence of financial integration on growth is analyzed in a growth regression framework; second, the indirect effect of financial integration via domestic financial markets deepening is explained. In order to capture possible non-linearities of direct and indirect effects, thresholds are also estimated in both regressions.

3.5.1.1 Financial integration and growth

Table 3-1 summarizes the results obtained by estimating Equation (3-1). All estimated equations appear statistically well-specified. The choice of dynamic specification is confirmed by the highly significant coefficients on lagged GDP per capita growth. At the same time, no equations show any signs of residual autocorrelation.[36] Moreover, Sargan tests for over-identifying restrictions confirmed the validity of the instrument sets used in the GMM estimation. The inflation rate as a control variable for overall macroeconomic instability is, as expected, significantly negative.

Without differentiating the effects between transition and non-transition countries, it follows from column (2) that the depth of national financial markets positively affects growth of GDP per capita only at the 10% significance level. The effect of financial integration, however, turns out to be negligible and highly insignificant. These results are in line with the findings of Edison et al. (2002), for example. In columns (3)-(8) I allow the effect of both financial development and financial integration to differ between transition and non-transition. Leaving the results regarding the control variables unchanged, we can consistently observe insignificant effects of financial development and financial integration for non-transition countries. Financial integration for transition countries, however, shows significant positive effects, regardless of which measure of financial integration we consider. The effect for the accumulated stock of FDI inflows appears larger than for the other measures of integration (see also Lane and Milesi-Ferretti (2006b) on this point).

[36] Note that I report test for first and second order autocorrelation in differenced residuals. Absence of residual autocorrelation is confirmed when the first test, m1, rejects and the second, m2, accepts. Both are asymptotically normally distributed.

Table 3-2: Financial integration and GDP growth - GMM estimates of model (3-1), dependent variable: annual GDP per capita growth

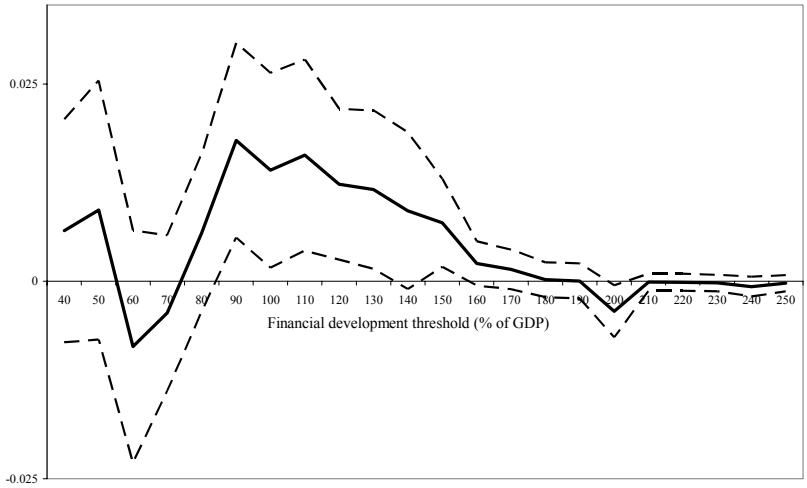
	tfinint	*tfinint*	*tliab*	*tfdi*	*fdiin*	*tped*	*pedin*
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
GDP_{pc} *growth(t-1)*	.428***	.373***	.379	.359***	.367***	.424***	.410***
	(.095)	(.050)	(.055)	(.058)	(.058)	(.057)	(.057)
Inflation	-.012***	-.014***	-.014***	-.012***	-.012***	-.012***	-.012**
	(.005)	(.003)	(.003)	(.003)	(.003)	(.003)	(.003)
FD_tran	.024* (.013)	-.014	-.005	.0026	.009	.012	-.000
		(.024)	(.025)	(.024)	(.024)	(.023)	(.024)
FD_ntran		.011	.010	.008	.006	.004	.007
		(.007)	(.008)	(.008)	(.007)	(.008)	(.008)
IFI_tran	-.0001 (.0005)	.048***	.052**	.073***	.080***	.037**	.054**
		(.012)	(.017)	(.028)	(.031)	(.015)	(.026)
IFI_ntran		-.000	-.000	.000	.000	-.001	-.001
		(.000)	(0.001)	(.001)	(.002)	(.001)	(.002)
# obs	212	212	212	212	212	212	212
N	31	31	31	31	31	31	31
Sargan test $\chi^2(102)$ prob	21.16 (1.00)	16.75 (1.00)	16.75 (1.00)	17.36 (1.00)	16.75 (1.00)	20.06 (1.00)	20.37 (1.00)
M1	-1.43	-2.60	-2.60	-2.64	-2.64	-2.39	-2.43
M2	-1.76	-1.41	-1.41	-1.42	-1.44	-1.30	-1.59

Notes: First step GMM results. All regressions include common time effects. Standard errors in parentheses. *, ** and *** denote statistical significance at 1, 5 and 10% respectively. Three lags of all variables used as instruments in the GMM procedure. Sargan's test of overidentifying restrictions (obtained from second-step results) tests the validity of the instrument set. m2 is a test for second order autocorrelation in differenced residuals. Constant not reported.
Key: *_tran* and *_ntran* endings stand for the interaction term with dummy variable for transition and non-transition countries. *tfinint* - sum of total assets and liabilities, *tliab* - total liabilities, *tfdi* - sum of FDI inflows and outflows, *fdiin* - FDI inflow, *tped* - sum of portfolio equity and other debt instruments inflow and outflow, *pedin* - portfolio equity and other debt instruments inflow. All variables are end-of-period stocks, expressed asa percentage of GDP. The measures of financial development (*FD*) are *tot_fin* - sum of stock market capitalization and domestic credit ina percentage of GDP

The effect of financial integration is further investigated in Figure 3-5, which reports estimates of the coefficient β from Equation (3-2). This coefficient measures the effect of financial integration on growth below a given threshold value of the depth of national financial markets. By plotting the recursive estimates of coefficient β, we can gain insights on the potential threshold effects in the model. As it turns out, the presence of threshold effects is clearly evident; the coefficient becomes significantly positive once the threshold value of financial development passes 90% of GDP, gradually declines, and becomes insignificant at threshold values exceeding 160% of GDP. Even though this is not a statistically rigorous test of threshold effects, we can nevertheless infer that the positive effect of financial integration on growth obtains for countries whose depths of national financial markets lie between 60 and 160% of GDP. For countries with less-developed financial markets, it may also have an adverse affect, while it does not yield any significant dividends for the most advanced economies. New EU members are

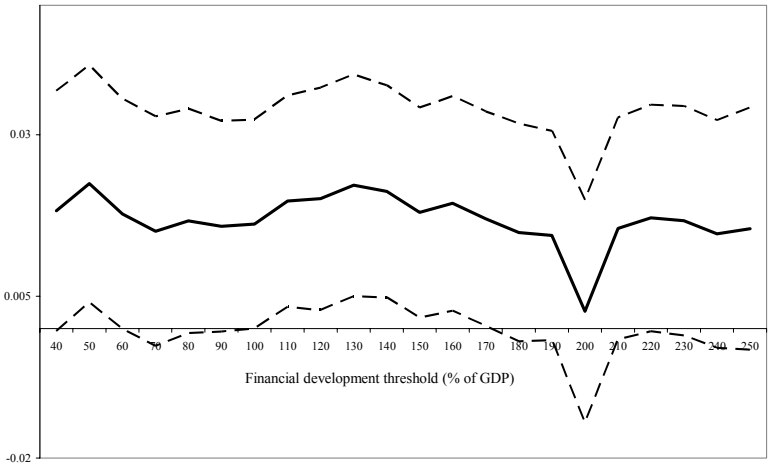
presently all in the "positive" region, which indicates that they could benefit from the process of further financial integration.

Figure 3-5: The effect of financial integration on growth below a given threshold value of financial development (stock market capitalization and domestic credit as % of GDP) - recursive β from Eq. (3-2)



Note: dashed line = 95% confidence interval.

Figure 3-6: Overall effect of financial development on growth given the threshold effect of financial integration on growth



Note: dashed line = 95% confidence interval.

It is also worth noting from Figure 3-6 that for the models with threshold values of financial development set between 90 and 170% of GDP, the effect of national financial development on growth also now becomes significant at the 5% level, while this is not

the case if a uniform effect of financial integration is assumed (see Table 3-1). Allowing for threshold effects of financial development on growth in the empirically most plausible region thus improves the empirical fit of the models to the extent that financial development positively affects GDP growth at conventional levels of statistical significance.

3.5.1.2 Financial integration and financial development

It is argued in Sub-section 3-4 that, in addition to the direct effect on growth, financial integration may also affect growth indirectly, by fostering the development of national financial markets, specifically growth in their size. Given that previous analyses already provided some evidence of the positive effect of financial development on growth, I also estimate Equation (3-3) in order to asses this indirect effect of financial integration. The results reported in Table 3-3, confirm my prior assumptions, indicating that financial integration also contributes to deepening of national financial markets with a significant long-run coefficient of 0.37. To the extent that higher supply of finance stimulates growth, this identifies another channel through which financial integration positively affects growth.

Presumably, macroeconomic conditions should affect the development of financial systems, and we can see that inflation has a significantly negative impact on financial development because of the uncertainty of financial conditions even on the short-term horizon. Trade openness, in addition to financial integration, is the other important component of openness. A significantly positive coefficient shows that all financial services involved in international transactions may promote the development of the financial system. The results are in line with De Gregorio (1998) who also found a positive significant effect of financial integration on growth.

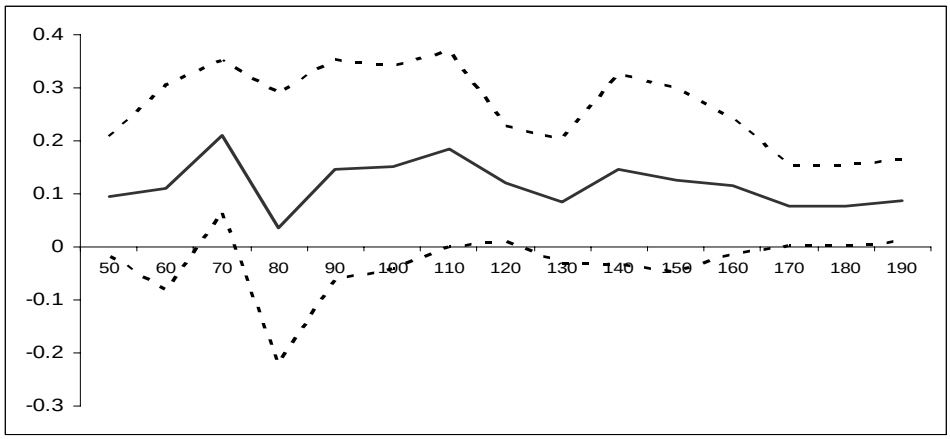
Table 3-3: Financial integration and financial development - GMM estimates of model (3-1), dependent variable: financial development

	Tfinint	**tliab**	**tfdi**	**fdiin**	**tped**	**pedin**
(1)	(2)	(5)	(6)	(7)	(8)	(9)
FD(t-1)	0.43***	0.41***	0.41***	0.41***	0.41***	0.37***
	(0.11)	(0.10)	(0.13)	(0.12)	(0.10)	(0.10)
FD(t-2)	-0.13	-0.12	-0.16	-0.15	-0.13	-0.12
	(0.10)	(0.09)	(0.10)	(0.10)	(0.10)	(0.09)
FD(t-3)	-0.20***	-0.20***	-0.22***	-0.23***	-0.19***	-0.29***
	(0.08)	(0.07)	(0.08)	(0.08)	(0.08)	(0.07)
inflation	-0.67**	-0.62**	-0.44*	-0.36*	-0.70**	-0.71**
	(0.34)	(0.32)	(0.26)	(0.24)	(0.35)	(0.36)
openness	0.85**	0.78**	0.56**	0.31	0.80**	0.82**
	(0.38)	(0.36)	(0.29)	(0.28)	(0.41)	(0.42)
FI	0.09**	0.20**	0.35***	0.59**	0.09**	0.24**
	(0.04)	(0.10)	(0.14)	(0.30)	(0.05)	(0.13)
# obs	148	148	148	148	148	148
N	31	31	31	31	31	31
Sargan test $\chi^2(102)$ **prob**	25.51 (1.00)	24.43 (1.00)	22.42 (1.00)	23.22 (1.00)	25.49 (1.00)	24.27 (1.00)
M1	-2.27	-2.23	-2.25	-2.19	-2.25	-2.25
M2	-0.15	-0.32	0.26	-0.06	-0.08	-0.24

Notes: First step GMM results. All regressions include common time effects. Standard errors in parentheses. *, ** and *** denote statistical significance at 1, 5 and 10% respectively. Four lags of all variables used as instruments in the GMM procedure. Sargan test of overidentifying restrictions (obtained from second-step results) tests the validity of the instrument set. m2 is a test for second order autocorrelation in differenced residuals. Constant not reported.
Key: *tfinint* - sum of total assets and liabilities, *tliab* - total liabilities, *tfdi* - sum of FDI inflows and outflows, *fdiin* - FDI inflow, *tped* - sum of portfolio equity and other debt instruments inflow and outflow, *pedin* - portfolio equity and other debt instruments inflow. All variables are end-of-period stocks, expressed as a percentage of GDP. The measures of financial development (*FD*) are *tot_fin* - sum of stock market capitalization and domestic credit as a percentage of GDP

Although financial integration significantly enters all the regressions, I also test for possible non-linearities. First, I wanted to test whether in more-developed countries (measured with GDP per capita) financial integration has a higher effect than in less-developed ones, and second, if the effect of financial integration varies among more and less open economies. As can be seen from the graphs below, there is no evidence of any significant thresholds, neither regarding GDP per capita nor trade openness. So, financial integration does have a positive effect on financial development and that effect appears to be quite robustly captured by a linear specification.

Figure 3-7: The effect of financial integration on growth below a given threshold value of openness (export plus import as % of GDP) - recursive β from eq. (3-4)



Note: dashed line = 95% confidence interval.

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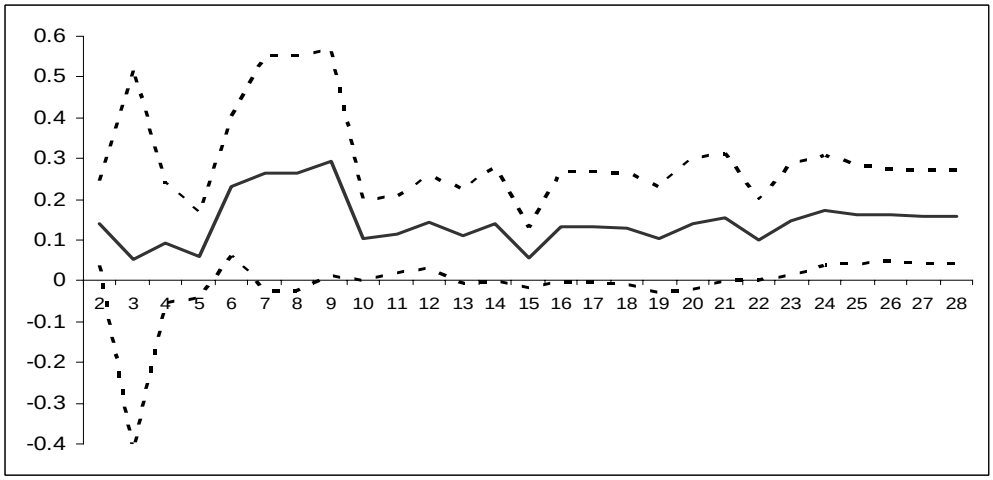
Figure 3-8: The effect of financial integration on financial development below a given threshold value of GDP per capita (constant 2000 US $) - recursive β from eq. (3-4)



Note: dashed line = 95% confidence interval.

As we have seen in the first regression, the pure effect of financial integration on growth is non-linear as it results to be positive only for countries having financial development between 90 and 170% of GDP, while it insignificant for countries with higher financial development and even possibly negative for countries with lower financial development. However, when taking this non-linearity into consideration, we can observe from Figure 3-6 that financial development also significantly and positively influences growth. This opens a channel for the indirect positive effect of financial integration that was shown in

regression (3) to stimulate the development of national financial markets. On balance, the results signal a positive effect of financial integration on growth even though the actual strength of the effect depends on the absorptive capacity of individual country.

3.5.2 Industry-level results

In line with the discussion in Sub-section 4.4, and in order to check the robustness of the positive effects of financial development on growth obtained at the macro-level analysis, I perform a similar analysis using industry-level data. Estimation results of models (3-5), (3-6) and (3-7) are reported in Table 3-4 and estimation results of model (3-8) are reported in Table 3-5

Column 1 in Table 3-4, contains the estimates of (3-5). It is immediately noticeable that a positive effect of financial development on growth found by Guiso et al. (2004) – applying the RZ (1998) methodology – is not confirmed on my dataset, not even when I control for trade credit as another source of external finance.[37] As argued in Chapter 2, this may be due to non-linearities of the effect. Specifically, transition and EU15 countries are sufficiently differently financially developed to expect considerably different effects of financial development on growth. Remaining columns, (3 - 5), confirm this finding. I allow the coefficients to differ between transition and other countries by interaction of all variables with transition and non-transition dummies.

Column (2) reveals that allowing for varying coefficients considerably improves the estimation results. The effect of financial development on growth turns out to be significant and, contrary to the findings of Guiso et al. (2004), is considerably different across the two groups of countries. As expected, for transition countries, which are still characterized with considerably lower levels of financial development, the effect is much higher, in fact higher than previously found in the literature. As shown by the smaller coefficient for developed countries, the effect may decline quickly as development progresses. The coefficients of trade credit (bottom two lines) are significantly negative. Trade credit thus acts as a substitute to external finance provided by financial

[37] Note, however, that empirical specifications in Guiso et al. (2004) and here differ. While they follow closely Rajan and Zingales (1998) and use initial period values of financial development as explanatory variable, thus essentially estimating a cross-section, I allow for contemporaneous time variation.

intermediaries, but significantly more so in transition countries. This result can be again attributed to lower level of financial development.

Table 3-4: Effects of financial development and financial integration on growth

	(1)	(2)	(3)	(4)	(5)
$RZ \times FD \times D_{tran}$	0.026!(0.019)	0. 245** (0. 076)	0.264*** (0.106)	0.282*** (0.081)	0.285*** (0.113)
$RZ \times FD \times D_{ntran}$		0. 014*** (0.002)	0.010 (0.014)	0.015 (0.020)	0.013 (0.014)
$RZ \times FF \times D_{tran}$			0.226 (0.226)		
$RZ \times FF \times D_{ntran}$			0.006 (0.029)		
$RZ \times FD \times FI \times D_{tran}$				0.021 (0.017)	0.013 (0.032)
$RZ \times FD \times FI \times D_{ntran}$				0.005** (0.002)	0.011** (0.005)
$FI \times D_{tran}$				-2.392*** (0.53)	-2.362** (0.973)
$FI \times D_{ntran}$				-0.372 (0.282)	0.059 (0.366)
$RZ \times FD \times FI \times D_{tran} \times D_{99}$					0.010 (0.022)
$RZ \times FD \times FI \times D_{ntran} \times D_{99}$					-0.004 (0.004)
$FI \times D_{tran} \times D_{99}$					0.405 (0.540)
$FI \times D_{ntran} \times D_{99}$					0.025 (0.435)
$FL \times FD \times D_{tran}$	-0.401!*** (0.19)	-0. 688* (0. 375)	-0.893* (0.485)	-0.827** (0.376)	-0.878* (0.517)
$FL \times FD \times D_{ntran}$		-0. 395*** (0. 103)	-0.302*** (0.077)	-0.364** (0.103)	-0.367*** (0.079)
# obs		4400	4087	4400	4400
N		631	610	631	631

Notes: Standard errors in parentheses. Constant not reported. Tests reveal significant presence of fixed effects in all specifications. Time dummies included in all models. Dummy variables D_{tran} and D_{ntran} denote transition and non-transition countries respectively. D_{EUR} is a dummy variable taking values one after 1999 i.e. corresponding to the introduction of the Euro. ! The coefficients refer to variables that are not interacted with Dtran and Dntran respectively.

Models that augment the basic specification with measures of financial integration are presented in columns (3) - (5). Column (3) contains the results for specification (2) that adds direct cross-border lending by financial intermediaries as an additional source of external finance. First, we note insignificant effect of cross-border borrowing. The result could be expected to some extent as we can see from comparison of Figures 3-4 and 3-5 that the process of intense financial integration exhibits considerably weaker dynamics in the segment of direct cross-border borrowing. This leads to two conjectures. First, it is

an indication that national financial markets crucially matter for growth also in the presence of significant financial integration. Second, it also implies that more important sources of growth effects of international financial integration may come through the stimulus it gives to development of domestic markets both in term of depth and institutional frameworks. This hypothesis is tested with specification 3-3 and results reported in column (5). Including measures of financial integration directly and interacted with domestic supply of finance through the RZ term leaves the effects of the development of national markets broadly unchanged. The effects of trade credit are also very similar to the ones reported in column (3). Interesting findings, however, emerge from the coefficients pertaining to the measure of international financial integration. Its direct effect seem to be significantly negative in transition countries, but it is also true that it has a positive indirect effect, which despite smaller point estimates appears to be significant only for developed (mainly EU15) countries in my sample. This finding corroborates the findings of the unclear and potentially non-linear effects of financial integration in developing countries found in the analysis of macro data. We see that it may have a negative direct effect if not coupled by necessary measures that foster a development of national financial markets and a proper and stability-oriented institutional framework. From these results, it follows that the effect of financial integration is non-linear and that could depend on the financial market development. In a following section, potential non-linearity is analyzed in more formal way, with Hansen's threshold model (1999).

In column (5) I checked whether periods of significant financial distress may have influenced the results. Specifically, the Czech Republic and Bulgaria had a financial crisis in 1997, while the Russian financial crisis in 1998 spread to the whole region. The variables containing the measure of international financial integration are interacted with a dummy variable D99 that takes a value of one after 1999. This period also overlaps with the introduction of the euro that provided an important impetus for further financial integration and financial stability in Europe. We can see that little significant changes can be observed to most coefficients.

3.5.2.1 The threshold model

Table 3-5 presents the estimates of Hansen's (1999) threshold model (3-4) using financial development as the threshold variable. Using a 15% trimming of observations, the two estimated thresholds are at levels of 44 and 70% share of market capitalization and domestic credit in GDP. As in Chapter 2, I find that the direct effect declines with the level of financial development. While it is very high and significant below the first threshold, it declines and becomes insignifcant above it. As in Chapter 2, I also find an inverse-U-shaped effect of trade credit. Substitability with official external finance at low levels of financial development is accompanied by complementarity in the middle region. Above the upper threshold, trade credit results in being a substitute but the estimated coefficient is considerably smaller than at the low level of financial development. Both results imply that the effects of development of national financial market on growth are unaffected by inclusion of measures of international financial integration to the empirical model.

Table 3-5: Threshold effects of financial development and financial integration on growth – double threshold model

Threshold	43.88		70.29
95% conf. int.	[40.24, 49.71]		[70.29, 70.39]
F_2 * (p value)	27.62 (.03)		
Parameters	$FD < \tau_1$	$\tau_1 < FD < \tau_2$	$FD > \tau_2$
$RZ \times FD$	0.392*	0.030	0.023
	(0.237)	(0.144)	(0.018)
$RZ \times FD \times FI$	0.008	-0.031	0.013**
	(0.070)	(0.024)	(0.005)
FI	-5.598***	2.618***	-0.790**
	(0.871)	(0.775)	(0.352)
$FL \times FD$	-3.611***	2.036***	-0.398***
	(0.664)	(0.677)	(0.092)

* Test for presence of thresholds using 300 bootstrap replications. Standard errors of coefficients in parentheses. Time dummies included in the model. *FD* is the sum of stock market capitalization and domestic credit as a percentage share of GDP.

Threshold effects of financial integration confirm the conclusion obtained above. A direct effect is significant in all three regions and follows an inverted-U shape. It is negative below the first threshold, positive in the middle region and again slightly negative in the upper region, which is at first glance surprising. However, to asses the overall impact of financial integration, we also need to take into account the indirect effect through national financial markets. Taken individually, the interaction term $RZ \times FD \times FI$ is

highly insignificant in the first two regions. Above the upper threshold, however, it becomes significantly positive. The overall (direct and indirect) effect of financial integration on growth also depends on the level of development of the domestic financial market, and across industries on the notional level of demand for external finance as defined by RZ (1998). Taking into account the second threshold and the range of levels of external finance development, however, we can conclude that the effect of financial integration on growth is positive in the upper threshold region. Together with the results for the middle region, this allows us to conclude that financial integration has a significantly non-linear effect on growth. While it may result in being even damaging in economies with less-developed financial markets, it is significantly positive once the development of national financial market passes a certain threshold. Using share of market capitalization and domestic credit in GDP as a measure of financial development, the threshold lies around 50 percent. This value has been already passed by all new members of the European Union. The process of euro adoption in these countries, to the extent it spurs a similar increase in the level of international financial integration as can be observed in the "old" EU, can thus be seen as an important stimulus to growth.

3.6 Concluding remarks

This study analyses the potential effects the enlargement of the euro area may have on growth in acceding countries through increased financial integration and development of national financial markets. First, I enrich a standard macro-level approach of studying the growth effect of financial integration, also analyzing indirect effect of financial integration. Second, I test the robustness of results with the use of augmented empirical approach by RZ (1998) on industry-level data. I apply this battery of tests to the data for European countries that cover both the group of developed "old" EU and several transition countries, among them all of the new EU members and hence also future members of EMU. The use of a more homogenous, though smaller sample of countries than in previous studies of financial development on growth allows us to infer better about the likely effects the process of euro adoption will have on economic performance of new EU members.

The results confirm a positive effect on growth both from development of national financial markets and financial integration. The effects are highly non-linear, though.

First, I observe that the positive effect on growth of development of domestic markets is higher in less-developed countries, represented by a group of transition countries in my case. The effect may vanish as development progresses to the levels characterizing EU15. In addition, I find that financial integration may not have a positive effect on growth per se. It rather appears that the effect is heavily conditioned by development of national financial markets, macroeconomic stability and quality of institutions. This reflects the fact that my estimates confirm a significant positive effect of financial integration on growth only for countries with sufficient absorptive capacities, measured by the level financial development. The lack of the effect for less-developed economies can be attributed to lower levels of financial development, institutional design and macroeconomic volatility. The current general level of development for most of the new EU members, however, is already sufficiently high for these countries to be able to reap the benefits of further financial integration both directly and indirectly through development of national financial markets.

Overall, these results show that the process of euro adoption may indeed have positive effect on growth in new EU member countries. Besides ensuring a higher degree of macroeconomic stability, it also leads to improved institutional design. Ensuing increases in financial integration can then be expected to contribute to the development of national financial markets and also stimulate growth through access to foreign financial markets.

Appendix A: Data description

Table 3A-1: Indicators of financial development

	Market cap./GDP (1996-2004 averages)	Domestic credit/GDP (1996-2004 averages)	Total finance/GDP (1996-2004 averages)
Austria	17.4	124.0	141.5
Belgium	82.1	126.7	208.8
Bulgaria	5.2	32.0	37.2
Croatia	18.3	53.2	71.4
Czech Republic	21.6	53.2	74.8
Denmark	55.2	112.1	167.2
Estonia	31.7	39.3	73.3
Finland	134.0	61.3	195.3
France	75.8	103.4	179.2
Germany	47.6	140.7	188.3
Greece	68.7	96.9	165.5
Hungary	24.7	58.9	83.6
Iceland	59.2	96.7	155.9
Ireland	64.1	104.3	168.4
Italy	44.5	95.7	140.1
Latvia	7.2	27.5	34.7
Lithuania	14.5	17.3	31.8
Luxembourg	151.9	92.8	244.7
Malta	35.1	134.9	170.0
Netherlands	120.8	142.9	263.7
Norway	40.3	75.8	116.2
Poland	14.9	33.3	48.2
Portugal	41.1	122.1	163.2
Romania	5.5	17.9	23.4
Russian Federation	28.9	29.5	58.5
Slovak Republic	7.7	55.3	63.0
Slovenia	15.2	42.7	57.9
Spain	70.1	116.8	186.9
Sweden	108.6	104.0	212.6
Ukraine	7.0	24.7	33.0
United Kingdom	153.3	136.0	289.3

Table 3A-2: Indicators of financial integration

	tfinint (1996-2004 averages)	fdiin (1996-2004 averages)	tfdi (1996-2004 averages)	tliab (1996-2004 averages)	pedin (1996-2004 averages)	tped (1996-2004 averages)
Austria	272.9	15.8	30.1	146.2	130.5	235.9
Belgium	608.6	85.8	157.2	283.6	197.0	444.6
Bulgaria	168.1	20.1	20.6	105.9	85.8	123.5
Croatia	132.0	21.7	27.3	83.2	61.5	84.1
Czech Republic	137.8	35.7	37.3	75.4	39.3	75.8
Denmark	303.8	33.0	68.6	160.7	121.0	208.8
Estonia	153.8	49.3	56.0	103.7	54.3	82.7
Finland	303.4	18.6	52.5	187.5	163.8	234.0
France	316.7	36.9	93.8	155.2	112.1	208.3
Germany	244.7	18.0	40.4	120.3	102.4	201.5
Greece	151.2	11.6	15.9	96.1	84.5	126.5
Hungary	150.0	49.1	52.1	111.3	61.2	76.2
Iceland	179.3	7.7	18.7	122.7	114.6	153.9
Ireland	1258.4	103.7	137.2	630.1	526.1	1112.4
Italy	190.3	9.9	24.6	100.5	90.1	162.0
Latvia	133.4	26.0	28.1	82.1	56.0	92.4
Lithuania	81.9	20.1	20.6	56.4	36.2	47.9
Luxembourg	17927.8	2360.9	4586.8	8916.0	6533.7	13297.3
Malta	535.4	63.3	71.5	259.3	194.2	411.3
Netherlands	584.0	61.3	138.2	301.8	231.3	424.2
Norway	228.5	17.9	46.6	100.0	82.2	167.6
Poland	82.5	19.7	20.4	57.9	38.2	47.5
Portugal	295.2	27.6	42.4	168.7	140.0	241.1
Romania	72.2	15.3	15.6	46.1	30.8	45.1
Russian Federation	141.6	13.7	24.6	70.5	56.7	107.7
Slovak Republic	128.9	22.9	24.6	74.6	51.6	81.2
Slovenia	107.9	15.7	20.7	58.1	42.4	66.1
Spain	215.4	28.1	52.4	123.7	95.6	156.8
Sweden	379.2	47.7	133.9	192.9	137.4	223.6
Ukraine	82.1	10.6	10.8	59.9	49.3	64.2
United Kingdom	596.5	30.0	80.4	302.5	272.5	513.6

4. Comparison of Parametric, Semi-parametric and Non-parametric Methods in Bankruptcy Prediction

4.1 Introduction

Financial stability is of concern to employees, investors, bankers and government and regulatory authorities alike. Application of good methods of bankruptcy prediction in financial institutions can be seen as crucial in its procurement. Appropriate risk assessment is crucial for the allocation of resources and credit, which, in turn results in a positive growth effect and reduction of overall macroeconomic variability.

An additional reason for the growing interest in bankruptcy prediction is also the relevant impact of unsound credit on bank balances and, consequently, the minimum regulatory capital required by Basel Committee (2001). The new Basel Proposal and its latest revision in April 2003 are based on the three-pillar approach to capital adequacy: first, minimum capital requirements; second, a review of the supervisory process of internal bank assessments of capital; and third, the market disclosure involving the quality of information provided to the market. One of the most important innovations of the first pillar is the chance for banks to develop an internal rating system. The procedure to define an internal rating system can basically be divided into three steps (Moody s, 2000). First, the bank needs to make a choice about the classification model, which assigns to each borrower a posterior probability (or a score) of belonging to groups of sound or unsound borrowers. Second, starting from posterior probabilities definition of a "splitting rule," each borrower should be assigned to one of the several discrete classes in the rating system. Finally, the evaluation of the probability of default for each class, which is one of the input variables to work out the capital requirements, is applied.

The first step of development of an internal rating system thus faces an econometric challenge of choosing and evaluating the bankruptcy prediction model. This procedure also includes the selection of relevant explanatory variables and the choice of the cut-off

point i.e. the value of posterior probability used to classify observations into classes of sound and unsound debtors. Circumstances faced by researchers in bankruptcy analysis have changed significantly in recent decades. This can be attributed to three factors. First, the availability of larger data sets with the median number of failing companies exceeding 1,000 (20 years ago the median was around 40 companies) allows for valid statistical inference where no conclusion could be reached before. Second, the spread of computer technologies and advances in statistical techniques allow for identification of more complex data structures. Basic methods may no longer be adequate for analyzing expanded data sets. Finally, there is an increased demand for advanced methods of controlling and measuring default risks due to the New Basel Capital Accord adoption. The Accord emphasizes the importance of risk management and encourages improvements in financial institutions risk assessment capabilities.

At the beginning of the research period of failure prediction (see e.g. Fitzpatrick, 1932), there were no advanced statistical methods or computers available for the researchers. The values of financial ratios in failed and non-failed firms were compared with each other and it was found that they were poorer for failed firms. In 1966, the pioneering study of Beaver presented the univariate approach to discriminant analysis, while in 1968 Altman expanded this analysis to multivariate analysis. Until the 1980s, discriminant analysis was the dominant method in failure prediction. However, it suffered from assumptions that were violated very often. The assumption of the normality of the financial ratio distributions was problematic, particularly for the failing firms. During the 1980s, the method was replaced by logistic analysis, which has been until recent years the most used statistical method for failure prediction purposes. However, the assumption of logistic distribution of default probabilities may in many empirically relevant cases be violated. The potential heterogeneity of firms may be better captured by models that do not rely on overly restrictive distributional assumptions. This led to the application of fully non-parametric data mining methods in bankruptcy prediction. During the 1990s artificial neural networks produced very promising results (Odom and Sharda, 1990, Tam and Kiang, 1991). However, no systematic way of identifying the predictive variables for the neural networks has been used in these studies. Drawing from good experience and success in several optimization problems in technical fields, genetic algorithms offer a new promising method for finding a suitable set of indicators for neural networks. Another class of data-mining methods with some desirable properties for predicting financial distress is classification and regression trees.

The latter two methods may not only improve the selection of suitable predictors, but can also be used as independent forecasting tools. The second strand of literature that also does not rely on the overly restrictive assumptions of binary-choice models are semi-parametric models. Thus far, these have had few advances in bankruptcy prediction and consequently only offer an interesting research topic. One may consider them as the middle way. While they share the property of parametric models of offering a clear interpretation of modeled processes, they are much less rigid in structure and offer more flexibility in capturing the relevant information and complexity of data.

The aim of this paper is to contribute to recent bankruptcy prediction literature and investigate the merits of using some recently developed semi-parametric and non-parametric methods in such applications. I take the classic logit model as a benchmark for comparison for a number of reasons[38].

First, the logit model is widely used and taught. Second, it is relatively easy to understand and readily available in virtually all software packages. Finally, it has been proven to be a fairly robust and reliable tool for forecasting financial distress. Comparison of models is not confined only to out-of-sample forecasting precision. I also wish to examine whether relaxing the distributional assumptions underlying the logit model also yields insights that may help us better understand the determinants of financial distress.

Among alternative methods, I concentrate on two; the first is the semi-parametric estimator of binary choice models developed by Klein and Spady (1993), which I choose because of its superior theoretical properties among the available semi-parametric estimators[39]. The second method is based on classification and regression trees (CART hereafter). From the class of non-parametric methods, I chose it because of its simplicity and clarity of interpretation and, foremost, because it does not suffer from the "black-box deficiency" that is very often the main reason for criticism of artificial neural networks as the most prominent representative of other semi-parametric methods. In addition to bankruptcy prediction, CART is used also in the phase of variables selection.

[38] The second very popular parametric method is discriminant analysis (and its multivariate extension). This method was severely criticised in the literature, see Joy and Tollefson (1975), Eisenbenis (1977), Scott (1978), Altman and Eisenbeis (1978), Ohlson (1980) and Karson and Martell (1980) among others.

[39] The second semi-parametric estimator of binary choice models with a single-index restriction is the estimator developed by Ichimura (1993).

I compare the performance of these methods on two different sample designs. Namely, the bankruptcy literature in all applications faces the problem of a low share of bankruptcy cases in the population and hence also data. A fairly common approach especially in the early studies was to use choice-based sampling of observations in order to obtain a more balanced sample of bankrupt and healthy firms (see Zmijewski 1983, for comparison). While such an approach may produce much better in-sample classification accuracy for bankrupt firms, it has a major deficiency: non-random sampling induces a bias in parameter estimates (Zmijewski, 1983; Maddala, 1983). As a consequence of the bias, it may be seriously questioned whether balancing of observations in the sample is of value for practitioners in financial institutions. Balancing of the sample puts a disproportionate weight in the likelihood function on bankrupt firms. This may increase in-sample classification and out-of-sample prediction accuracy of bankrupt firms, but it also reduces the same types of accuracy for healthy firms. Because the share of healthy firms in the population is considerably larger, this usually results in reduction of overall in-sample classification and out-of-sample prediction accuracy. Similar reasoning led the authors in many recent applications to rely on random sampling. This is especially so in applications of non-parametric methods.

Hence, choice-based sampling may be fully acceptable only if the dominant objective of financial institutions and regulators is the minimization of risk exposure of financial portfolios. If important weight is also given to overall allocation of credit and profit maximization, one should not overlook that choice-based sampling leads to over-rejection of good and profitable lines of credit. For these reasons, I decided to analyze both approaches in sample design and compare the relative performance of methods in order to see whether some methods lead to a smaller trade-off.

The methods are tested on a sample of Slovenian firms. Note that many other applications disposed with data with only a limited coverage of industries. My dataset, however, covers all industries and sizes of firms, which makes this analysis quite general. However, this also implies that the data contain various sources of real-life firm heterogeneity. These are also the circumstances that justify that use of methods that are at least theoretically better suited to account for these features of the data.

I find that choice-based sampling significantly affects prediction accuracy. Balancing group shares in the estimation sample in favor of bankrupt firms increases prediction accuracy for potentially bad risks. However, in real life financial institutions are faced

with credit applications coming from a population with heavily unequal group shares. Using choice-based sampling thus leads to over rejection of potentially good risks. This implies that choosing to minimize risk exposure should be traded off with profit maximization. Because the share of healthy firms is considerably larger, this problem should not be neglected.

With regards different estimation methods, I find non-parametric CART to be a very useful complementary method of variable selection. Augmenting classic models with variables selected by CART considerably improves forecasting accuracy. The choice between classic parametric method (logit) and the semi-parametric model of Klein and Spady (1993) interestingly induces a similar trade off as choice-based sampling. While logit appears to be more precise in detecting bad risks it is also true that the semi-parametric model better captures the characteristics of healthy firms. A considerably larger share of the latter group in the population also implies better overall prediction accuracy. Both the choice of sampling method and the choice of estimation method should be thus made conditional on an explicit objective function of the financial institution in assessing credit risk.

The paper is structured as follows. Section 4.2 describes the data and the design of estimation samples and samples on which I test out-of-sample prediction accuracy. Section 4.3 describes different modeling approaches to bankruptcy prediction used in the paper. Section 4.4 contains a detailed description of procedures used in selecting predictor variables for the models. Section 4.5 discusses the main results, while Section 4.6 concludes and summarizes the findings.

4.2 Data and sample design

The data come from two databases of Slovenian companies. The first are data of annual financial statements for all Slovenian firms for the 1995-2001 period provided by Agency for Public Legal Records and Related Services (AJPES). From the initial database, I eliminated all observations for which, due to missing data, I could not calculate all the potential predictive variables (various financial ratios). This resulted in 39,005 observations on healthy firms in the sample. The second is the database of bankrupt firms for the same time period collected by I d.o.o., from which I am able to obtain 592 bankruptcy cases in the whole period. Industries in the sample mainly cover the

manufacturing sector. I decided to omit financial institutions due to significant structural differences and different exposure to the risk of default provided by the regulatory framework.

As noted above, there are two approaches to sample design in the literature and I analyze the relative performance of both. The first approach, used less often in the literature, is to work with the sample of data as it is, i.e. with usually much larger share of healthy firms in the sample. Very similar to the majority of studies, the share of bankruptcy cases in my sample is rather small, roughly 1.5%.

The second approach uses choice-based sampling in order to obtain a more balanced share of bankrupt and healthy firms in the sample. I opted for equal shares and performed the selection in the following way. From the initial sample, I created ten sub-samples with 592 bankrupt firms and their 592 non-bankrupt mates. Matching is based on the following characteristics: size (measured by total asset), industry and year of bankruptcy. The last matching criterion ensures that financial statements of matched pairs are always of the same time period. Because matching is primarily used to obtain a balanced sample of bankrupt and healthy firms, the samples mainly consist of small and medium-sized companies, since the incidence of bankruptcy in the large-asset-size firm was quite rare.

In both approaches, 75 percent of observations were allocated to a sub sample on which the models were estimated, and 25 percent to a sub sample on which out-of-sample prediction accuracy was tested.

There is one important deviation from this general approach to sample design. In the application of the Klein and Spady (1993) semi-parametric model, the computational burden was excessive for estimation of the model on the complete dataset. For this reason, I considerably reduced the number of healthy firms entering the estimation sample. In particular, only 10% (or 3,900) of healthy firms were added to the 592 bankrupt firms. This implies that the sample contained 13.2 percent of bankrupt firms. In- and out-of-sample divisions use the same proportions as above.

From the balance-sheet and income statement data, I calculated 64 financial ratios as candidate predictors.[40] Financial ratios can be broadly classified into four categories:

[40] Financial ratios, by their nature, have the effect of deflating statistics by size, implying that their potential predictive power is not contaminated by firm size (Altman, 2000).

liquidity, profitability, solvency and activity. The ratios are chosen on the basis of their popularity in the literature and their potential relevance to the study of financial distress. A dependent variable is a binary variable that takes on value one if the firm operates in time t, and zero if the firm filed for bankruptcy in time t. All independent variables are dated t-1.

4.3 Forecasting models

In terms of basic statistical characteristics, I use three different classes of methods. The first two methods engage the binary choice probability model with a single-index restriction as a basic structure, but differ in terms of distributional assumptions of the single index. The first method assumes a fully parametric and standard logit specification. The second used milder distributional assumptions and is estimated with the semi-parametric method developed by Klein and Spady (1993). Because of their relatively common basic structure, I treat their exposition in a similar way. The third method is based on classification and regression trees. This is a fully non-parametric method, whose main properties are described below.

4.3.1 Logit model

The logit model is, together with the probit model and discriminant analysis (DA), among the most common procedures in estimating bankruptcy. Unlike discriminant analysis that begins with the conditional distribution of X given y, logit and probit models specify the conditional distribution of y given X (the explanatory variables). Interestingly, if y is dichotomous, and X follows a multivariate normal distribution, the implied form for $P(y/X)$ is the same as that for the logit model (Maddala, 1991). However, logit analysis is valid under more general distributional assumptions about X than those implied by discriminant analysis. In contrast, Ohlson (1989) claimed that logit does not avoid all the problems discussed with respect to DA. If the explanatory variables are normally distributed, then DA should be used, since it is more efficient. However, if the explanatory variables are not normally distributed, then discriminant analysis gives inconsistent estimates, and one is better off using logit analysis in this

case. These findings are supported in the literature by Maddala (1983), Amemiya (1981), Amemiya and Powell (1980), Kennedy (1991), Lo (1986) and Malhorta (1983).

As a staring point consider a single-index binary choice model:

$$y = \begin{cases} 1 \ if \ \theta' x \geq \varepsilon \\ 0 \ otherwise \end{cases}$$

where

$$P(y = 1 | x) = h(\theta' x) \tag{4-1}$$

that links the probability that the binary dependent variable equals one given the covariates is equal to a probability transformation of the single index $\theta' x$. In principle, both the parameters of the single index θ and the probability transformation function h need to be estimated. Parametric methods assume a known form of h. In this class, the most widely used model found in the bankruptcy prediction literature is the logit model. In such a case, h is a logistic cumulative distribution function

$$h(\lambda) = e^{\lambda} / (1 + e^{\lambda})$$

With this assumption, the parameter vector θ can be estimated consistently and efficiently by maximizing:

$$L = \sum \left[y_i \ln(P_i) + (1 - y_i) \ln(1 - P_i) \right] \tag{4-2}$$

Some of the first authors to applying logit methodology to the problem of bankruptcy were Santomero and Vinso (1977) and Martin (1977) who employed it to examine failures in the US banking sector. Ohlson (1980) applied it more generally to 105 bankrupt and 2,058 non-bankrupt firms. For recent examples, one can refer to Zmijewski (1984), and Wilson (1992). The accuracy of classification ranged from 76% in the work of Zmijewski (1984), where he employed probit and weighted exogenous sample likelihood models to investigate firms listed on the American and New York stock exchanges from 1972 to 1978, to 96% in the study by Pantalone and Platt (1987), where the authors used logit analysis to determine the causes of banks bankruptcy in the US after deregulation.

The logit model has one appealing feature when matched or choice-based samples are used in the analysis. In such samples the probability of an observation entering the sample depends on the value of dependent variable, which violates the random sampling

design assumption and in general causes both parameter and probability estimates to be asymptotically biased (Zmijewski, 1984). The logit model is more convenient in choice-based samples because it gives consistent results, without using any weighting procedures. The coefficients of the explanatory variables are not affected by the unequal sampling rates from the two groups. It is only the constant rate that is affected, and should be increased by *log p1-log p2*, where *p1* and *p2* are the proportions sampled from the two groups (see Maddala (1983) for a detailed discussion). Other coefficients are unaltered, and the standard errors also remain valid. Such correction of the constant was used in my application when the logit model was estimated on the choice-based sample.

4.3.2 Klein and Spady semi-parametric estimator

One important and potentially empirically relevant deficiency of the logit model is that it requires the validity of the assumption that the cumulative distribution of the error term is logistic. Consequently, it makes sense to investigate alternative specifications, which require less severe distributional assumptions. A good alternative offered by the literature in this respect are semi-parametric models.[41] These models allow for simultaneous estimation of h and θ and, as such, provide a specification that is more flexible than a parametric model but retains many of the desirable features of parametric models (Horowitz, 2001). The single-index property is crucial for good properties of semi-parametric estimators because it allows avoidance of the curse of dimensionality. This is because the index $\theta' x$ aggregates the dimensions of x. Consequently, the difference between the estimator of h and the true function can be made to converge to zero at the same rate that would be achieved if $\theta' x$ were observable. Moreover, θ can be estimated with the same rate of convergence that is achieved in a parametric model. Thus, in terms of the rates of convergence of estimators, a semi-parametric single index model is as accurate as a parametric model for estimating θ and as accurate as a one-dimensional

[41] Manski (1985) proposed a semi-parametric estimator that does not rely on a single-index restiction. Subsequently, Horowitz (1992) developed it into the smoothed maximum score estimator. Although a smoothed maximum score requires very weak distributional assumptions it has some drawbacks. Its rate of convergence is lower than ordinary parametric estimators. Moreover, it only allows one to estimate the index, but not the probability transformation.

nonparametric model for estimating *h*. This dimension reduction feature of single index models gives them a considerable advantage over nonparametric methods in applications where X is multidimensional and the single index structure is plausible.

The main estimation challenge in single index models is estimating θ. Several estimators of θ are available in the literature. Ichimura (1993) developed a non-linear least squares estimator. Theoretically the semi-parametric maximum likelihood estimator of Klein and Spady (1993) is superior, which in addition to exhibiting $N^{-1/2}$-consistency and asymptotic normality, also achieves the semi-parametric efficiency bound, assuming that the regressors and the errors are independent.

The estimate of θ is obtained by maximizing the quasi-log likelihood function given by:

$$\log L(\hat{\theta})=n^{-1}\sum_{i=1}^{n}(\sigma_i/2)[y_i\log(\hat{P}_i(\theta))^2+(1-y_i)\log(1-\hat{P}_i(\theta)] \qquad (4\text{-}3)$$

τ_i represents the trimming function as specified by Klein and Spady (1993) and is needed to weigh down the influence of observations with a very low probability and to ensure the usual convergence rate of the asymptotic distribution of the parameters. Probability $\hat{P}_i(\theta)$ is estimated using the fourth-order kernel with probability trimming. Klein and Spady (1993) showed that with these modifications the proposed estimator of θ is consistent, asymptotically normal and efficient. In addition, their Monte Carlo experiment indicates that there may be only modest efficiency losses relative to maximum likelihood estimation when the distribution of the disturbances is known, and the small sample behavior of the semi-parametric estimator in other cases is good.

Because choice-based sampling may lead to significantly biased results, I also considered a modification of the quasi-likelihood function in the spirit of Zmijewski (1994). In particular, I optimize:

$$\log L(\hat{\theta})=n^{-1}\sum_{i=1}^{n}(\sigma_i/2)[\frac{P_1}{P_2}y_i\log(\hat{P}_i(\theta))^2+\left(\frac{1-P_1}{1-P_2}\right)(1-y_i)\log(1-\hat{P}_i(\theta)] \qquad (4\text{-}4)$$

where *P1* and *P2* are proportions of bankrupt firms in the population and estimation sample, respectively. The prediction accuracy of the coefficients obtained with the sampling correction are compared to prediction accuracy of the model without such

correction to asses the influence of choice-based sampling on bankruptcy prediction accuracy.

4.3.3 CART

Datamining techniques offer a number of methods that can be successfully applied to predict bankruptcy. The most commonly used techniques in datamining are artificial neural networks and decision trees. Among the latter, the most frequently used are Classification and Regression Trees (CART) and Chi Square Automatic Interaction Detection (CHAID), and genetic algorithms (Sung, Chang and Lee, 1999). An explicit comparison of datamining techniques is very difficult since each application has different goals and circumstances, which require different data mining techniques. Also, each data mining technique has its inherent limitations as well as assumptions that limit its application to specific actual cases.

Among non-parametric methods, I concentrated on the CART method.[42] CART builds classification and regression trees for predicting continuous dependent variables (regression) and categorical predictor variables (classification). The classic CART algorithm was popularized by Breiman et al. (1984) (see also Ripley, 1996). The CART model is a flexible method for specifying the conditional distribution of a variable y, given a vector of predictor values X. Such models use a binary tree to recursively partition the predictor space into subsets where the distribution of y is successively more homogeneous. The terminal nodes of the tree correspond to the distinct regions of the partition, and the partition is determined by splitting rules associated with each of the internal nodes. By moving from the root node through to the terminal node of the tree, each observation is then assigned to a unique terminal node where the conditional distribution of y is determined. CART is nonparametric and can detect complex relationships between dependent variable and explanatory variables. Therefore, CART is

[42] Artificail neural networks were not considered in the analysis because this method suffers from the "black box problem," i.e. they cannot explain the results they obtain. In addition, the evidence of usefulness of applying ANN the literature is mixed. While some studies find it to be the preferred method relative to multivariate discriminant analysis (Salchenberger et al., 1992; Coats and Fant, 1993) other authors report less convincing evidence (Altman et al., 1994; Leshno and Spector, 1996). In some cases, decision tree algorithms proved to be better (Martinelli et al., 1999; McKee and Greenstein, 2000). The application of genetic algorithms that may also prove to be successful in bankruptcy prediction (Back, Laitine and Sere, 1999) was left for future research.

particularly suited for discovering non-linear structure and variable interactions in datasets with a large number of potential explanatory variables.

In sum, the strengths of decision tree methods are: (1) ability to generate understandable rules; (2) performing classification without requiring much computation; (3) ease of calculation at classification time; (4) ability to handle both continuous and categorical variables; (5) providing a clear indication of which fields are the most important for prediction and classification, (6) enabling validation of a model using statistical tests, so the reliability of the model can be checked.

The two pioneering studies where the technique has been used for bankruptcy prediction are those of Frydman, Altman and Kao (1985), and Marais, Patell and Wolfson (1984) who employed it to assess loan classifications. The first mentioned study compared CART to the classificatory power of two discriminant models. Overall, the classification-tree models were found to perform best. In contrast, Marais et al. (1984) compared their recursive partitioning results against those of a multinomial probit model. Interestingly, they concluded that in estimating loan classifications there was very little difference between the two procedures.

4.4 Variable selection

Many bankruptcy prediction studies were centered on the search for individual or groups of predictors (financial ratios) that lead to the lowest misclassification rate. Despite some efforts to provide theoretical economic grounds in failure prediction context, no unified theory has been generally accepted as a basis for the ratio selection. Most of the previous studies used a brute empirical approach of initial choice of variables (also based on some economic criteria) followed by step-wise procedure to select the variables in the final logit or discriminant model. This procedure is not statistically rigorous and different sequencing or initial ordering of variables need not result in a unique selection. As an attempt to overcome this deficiency, some authors started using datamining techniques (Shirata, 1998). These are also better suited to capturing potential non-linearities in the relations between financial distress and predictor variables.

I decided to use two approaches with the aim of determining which could lead to better results for my dataset. The first approach is a more traditional three-stage approach,

and the second uses CART analysis as one to the datamining techniques. Detailed descriptions of both are provided below.

4.4.1 Three-stage approach

For the first variable selection approach, I propose a three-stage strategy, which combines expert knowledge and evidence on most successful predictors found in the literature with statistical testing. In the first step, bivariate logistic regressions were run for each of the 64 ratios on each of the ten matched samples. Each of the ratios was screened for its classification precision. The ratios that classify correctly at least 60 percent of bankrupt firms and 60 percent of non-bankrupt firms on average were kept for further stages. This left a group of 27 financial ratios, 14 measuring profitability, 9 solvency and 4 liquidity of firms. There were nine ratios that classify neither bankrupt nor non-bankrupt firms at 60 percent accuracy. Seven describe firm activity and two are profitability measures. The remaining 28 ratios classified at the required precision either bankrupt or non-bankrupt firms, but not both. This also means that they were not considered in subsequent steps of variable selection.

In the second step, seven groups of highly correlated indicators were formed, using 0.5 as the correlation threshold. From each of the groups, I extracted one principal component. As a representative of each group, I then took the variable with the largest loading to the principal component. I prefer to proceed in this way of using the principal component in prediction models in order to avoid the efficiency problem due to generated regressors, and because principal components can be hardly given any direct economic interpretation.

In the last step, a logistic step-wise procedure was used to select the final variables. It starts by estimating parameters for variables forced into the model. Next, the procedure computes the adjusted chi-squared statistic for all the variables not in the model and examines the largest of these statistics. If it is significant at conventional levels, the variable enters into the model. One or more elimination steps follow each selection step, i.e. the variables already selected into the model do not necessarily stay. The step-wise selection process terminates if no further variable can be added to the model, or if the variable just entered into the model is the only variable removed in the subsequent elimination.

After step three, I obtained with four financial ratios as the most suitable variables for bankruptcy prediction. Two of the ratios measure liquidity, one solvency and one profitability.

4.4.2 CART approach

In addition to using it as a non-parametric method for bankruptcy prediction, I used CART also as the second approach to variable selection. This approach is based on fitting a regression tree, specifying the default variable as the dependent variable and using all 65 financial ratios as independent variables. The aim of this approach is to identify the variables that resulted in being the most significant in the decision tree that partitions firms into bankrupt and healthy groups. In CART-based selection, one needs to avoid over-fitting because it may lead to bad out-of-sample prediction accuracy. Specifically, some of the lower branches in a tree may be strongly affected by outliers and other artifacts of the current data set. For this reason, it is preferable to find a simpler tree. The tree pruned to the best size was obtained with the process of cross validation (see Breiman et al., (1998) for details). On the matched sample, this resulted in a tree with four terminal nodes obtained on three variables. On the complete sample, the respective figures are five and four. Estimated regression trees were subsequently used as predictors of bankruptcy as discussed above.

Alternatively, I used the final nodes identified in CART analysis for each variable to create dummy variables that take a value of one if the values of the variable fall into the regions identified by CART threshold values and zero otherwise. These dummy variables are then added to the set of explanatory variables obtained in the three-step approach in logit and semi-parametric models. The motivation to do this is quite straightforward: CART is, by definition, better suited to identify potential non-linearities in the determinants of financial distress of firms. Including dummy variables that correspond to such non-linearities may in this respect be a useful way to augment standard models. In addition, using the variables obtained under two alternative search strategies in the same forecasting directly provides an insight about the relative merits of the two selection methods in bankruptcy prediction.

4.5 Results

Table 4-1 presents the estimates of the logit model. There are two models presented. The first model uses four ratios obtained in the three-stage selection procedure as explanatory variables (model 1). The second model augments the set of explanatory variables with the dummy variables corresponding to final nodes of the estimated regression tree using CART (model 2). Note, however, that not all dummies are included due to perfect co-linearity with other explanatory variables. Both models are estimated on three different samples. The first is the matched sample with equal number of bankrupt and healthy firms in the sample. The sample labeled "Full" contains all available observations. This implies that the sample contains 592 bankrupt firms and 39,005 healthy firms. For completeness, the model is also estimated on a middle-sized (labeled "Larger") sample containing 592 bankrupt firms and 2,925 healthy firms. As explained in Section 2, construction of this sample was necessary to facilitate computational feasibility in optimization of the Klein&Spady semi-parametric model. For each of the samples, 75% of randomly selected observations are used for estimation, while the rest is retained for testing out-of-sample prediction accuracy.

Table 4-1: Estimates of the logit models 1 and 2

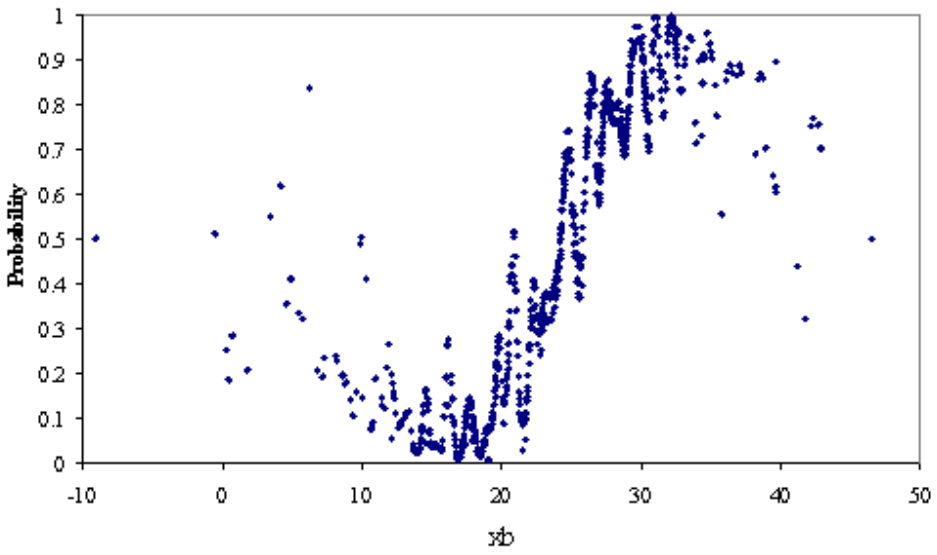
	Sample					
Coefficient	Matched		Larger		Full	
Constant	-6.98	-5.27	-5.14	-9.7	-0.87	-5.49
	-0.69	-0.77	-0.47	-1.24	-0.59	-0.55
Constant*	-11.17	-9.46	-7.16	-11.72		
Tfs	-3.86	-3.44	-3.12	-1.06	-3.42	-0.54
	-0.51	-0.66	-0.35	-0.46	-0.42	-0.32
Pppo	0.11	0.07	0.1	0.07	0.07	0.05
	-0.01	-0.01	-0.005	-0.01	-0.003	-0.003
Kol	0.6	0.5	0.85	0.81	1.1	0.78
	-0.19	-0.2	-0.15	-0.16	-0.25	-0.13
cf2d	2.54	1.28	3.01	3.1	3.5	4.22
	-0.74	-0.75	-0.7	-0.72	-1.48	-0.66
$D1_{CART}$		2.2		4.04		3.15
		-0.33		-1.08		-0.33
$D2_{CART}$		2.56		5.99		5.33
		-0.31		-1.05		-0.29

Notes:* Constant corrected by *logp1-logp2*, where *p1* and *p2* are the proportions sampled from the two groups (see Maddala, 1983).

As seen in Table 4-1, all coefficients are significant and correctly signed. Since detailed discussion of the coefficients is not at the centre of my attention, it should suffice to say at this stage that sample design does not have a negligible effect on the estimated coefficient that, according to theory, remain consistent (with exception of the constant) regardless of the sample design. Below, we shall see how this affects the out-of-sample prediction accuracy.

The motivation for considering the semi-parametric model is clearly seen from Figure 4-1. It plots the distribution function of the estimated Klein and Spady model for one of the specifications (similar results emerge for any other specification), which is significantly different from the logistic distribution.

Figure 4-1: Estimated distribution function with the semi-parametric Klein and Spady model 1 (matched sample, without Zmijewski correction, e=6)



Tables 4-2 and 4-3 contain the estimation results for the Klein&Spady semi-parametric models 4-1 and 4-2, respectively. Each model was estimated with and without Zmijewski correction for shares of bankrupt and healthy firms that do not correspond to population shares (see Section 4.3.2). In addition, I report results for two different choices of trimming intensity in optimization of the quasi-likelihood.

Table 4-2: Estimates of the Klein and Spady semi-parametric model 1

	Sample							
	Matched				Larger			
	[Zmijewski correction, trimming intensity (e)]							
	[yes, 6]	[yes, 4.3]	[no, 6]	[no, 4.3]	[yes, 6]	[yes, 4.3]	[no, 6]	[no, 4.3]
tfs	1	1	1	1	1	1	1	1
pppo	-0.84	-2.32	-5.57	-2.33	-8.46	-24.65	-2.38	-3.24
	(-0.04)	(-0.18)	(-0.13)	(-0.13)	(-0.05)	(-0.33)	(-0.01)	(-0.09)
kol	-13.41	-3.51	-4.34	-2.94	0.88	-9.5	-6.42	-1.32
	(-0.55)	(-0.25)	(-0.1)	(-0.16)	(-0.03)	(-0.13)	(-0.03)	(-0.04)
cf2d	-7.19	-2.63	-2.26	-2.81	-13.54	-10.34	-6.58	-1.34
	(-0.3)	(-0.2)	(-0.1)	(-0.24)	(-0.09)	(-0.15)	(-0.02)	(-0.05)

Notes: Standard errors in parentheses. A higher value of parameter implies less trimming and vice versa.

Table 4-3: Estimates of the Klein and Spady semi-parametric model 2

	Sample							
	Matched				Larger			
	[Zmijewski correction, trimming intensity (e)]							
	[yes, 6]	[yes, 4.3]	[no, 6]	[no, 4.3]	[yes, 6]	[yes, 4.3]	[no, 6]	[no, 4.3]
tfs	1	1	1	1	1	1	1	1
pppo	-2.37	-2.34	-4.7	-2.2	-4.34	-17.85	-3.66	-2.42
	(-0.16)	(-0.08)	(-0.12)	(-0.06)	(-0.05)	(-0.13)	(-0.05)	(-0.11)
kol	-1.85	-1.6	-4.37	-1.32	-2.73	-6.28	-1.57	-1.08
	(-0.16)	(-0.07)	(-0.1)	(-0.06)	(-0.03)	(-0.05)	(-0.06)	(-0.05)
cf2d	-0.38	-1.53	-0.51	-0.64	-3.54	-6.72	-2.47	-2.2
	(-0.02)	(-0.07)	(-0.01)	(-0.02)	(-0.04)	(-0.06)	(-0.08)	(-0.09)
$D1_{CART}$	-1.11	-0.99	-1.04	-0.01	1.25	5.8	-0.32	2.26
	(-0.15)	(-0.08)	(-0.1)	(-0.13)	(-0.03)	(-0.09)	(-0.18)	(-0.1)
$D2_{CART}$	-4.57	-4.71	-4.65	-1.82	-2.38	-7.01	-3.35	-5.7
	(-0.27)	(-0.19)	(-0.16)	(-0.11)	(-0.14)	(-0.08)	(-0.09)	(-0.32)

Notes: Standard errors in parentheses. A higher value of parameter implies less trimming and vice versa

The constant is not reported because it cannot be identified within the semi-parametric model. For the same reason, one of the coefficients needs to be normalized to unity. Virtually all coefficient results are statistically significant and with signs similar to the logit model (note that the first coefficient is normalized to unity). What clearly emerges from the tables are significant differences in estimated parameters when compared to the logit model even after taking into account the normalization of the first coefficient. A second finding is that in the present context both Zmijewski's likelihood correction and trimming intensity importantly affect the estimated coefficients. As there is no theoretical proof of which choice would be better, I consider the effect of all these features on the prediction accuracy of the model.

Table 4-4: In-sample classification accuracy

		Sample				
		Matched		Larger		Full
		Sample-size correction				
Model		yes	no	yes	no	
Logit	Healthy	15.5	89	86.2	98.1	99.8
model 1	Bankrupt	98.6	82.4	84.2	54.9	20.7
	Overall	57.5	85.7	86	92.4	98.6
Logit	Healthy	15.3	90.3	91.5	98.7	99.8
Model 2	Bankrupt	99.3	84	82.7	62.4	40.8
	Overall	14.9	87.2	90.4	93.9	99
K&S	Healthy	77.9	81.7	96.1	96.6	
model 1	Bankrupt	73.8	79.7	49.5	59.9	
e=6	Overall	75.9	80.7	89.9	91.8	
K&S	Healthy	80.4	83.6	96.4	97.1	
model 1	Bankrupt	82	83.8	43.9	55.4	
e=4.3	Overall	81.2	83.7	89.5	91.6	
K&S	Healthy	89.6	87.2	97.1	97.7	
model 2	Bankrupt	84.9	79.7	64	64.8	
e=6	Overall	87.3	83.4	92.8	93.4	
K&S	Healthy	89.2	84.8	96.6	97.7	
model 2	Bankrupt	85.4	81.8	48.6	65.8	
e=4.3	Overall	87.3	83.3	90.3	93.5	
	Healthy	97.7		98.9		99.9
CART	Bankrupt	84		69.8		39
	Overall	89.9		95.1		99

Comparison of in-sample classification accuracy of the models is given in Table 4-4. In this respect, six comments are in order. First, it must be noted that the semi-parametric Klein&Spady model does not offer a better overall fit to the data than the logit model even though logit relies on distributional assumptions that are not fully supported by the data. This is a rather surprising finding, which clearly indicates a certain robustness and reliability of the logit model. Second, the fully non-parametric CART method offers the best fit on matched and larger sample, but also does not outperform logit on the full sample. Third, choice of sampling clearly demonstrates the trade-off faced by researchers. Choice-based sampling improves the classification accuracy of bankrupt firms, but the smaller precision for healthy firms results in an inferior overall fit of the model. Fourth, looking at the effect of corrections for choice-based sampling, we can observe that constant correction results in the smaller overall fit of the model. Fifth, the Zmijewski-type correction of the quasi-likelihood of the Klein&Spady semi-parametric model

improves the fit only for model 4.2 estimated on a matched and completely balanced sample. In all other cases, it actually results in a deterioration of fit. This clearly indicates that such rather ad-hoc corrections of the likelihood in favor of the under-represented group of observations in the sample do not necessarily lead to improvement of classification accuracy of those observations. Finally, it can be noted that higher degree of both likelihood and probably trimming in the estimation of the Klein&Spady model that more intensively weighs down the influence of outlying observations in the sample improves the model s classification accuracy. The same also holds for out-of sample prediction accuracy (see below).

Table 4-5 shows the central set of results of the paper, reporting out-of-sample prediction accuracy. Depending on the estimation sample, I consider different samples on which the models are tested for prediction accuracy. As explained in Section 4.2, all three different samples of data were divided so that 75 percent of observations were used for estimation and 25 percent for testing out-of-sample prediction accuracy. The label M→M denotes estimation on the matched sample and out-of-sample prediction also on a matched sample, i.e. with equal shares of bankrupt and healthy firms. The label M→P stands on estimation on matched sample, but prediction accuracy is tested on a sample with population group shares (roughly 1.5% of bankrupt firms). With the L→P I label, estimation is on a larger sample while prediction is made on a full sample with population group shares.

First we can note that the CART method, even though attaining comparably high levels of prediction accuracy, practically never yields the best results. Inclusion of dummy variables corresponding to CART terminal nodes, however, significantly improves the performance of both logit and Klein&Spady model. Second, correction for the bias induced by choice-based sampling does not yield any measurable benefits. Third, comparison on the full sample is possible only between the logit model and the CART model. We can observe that both models deliver similar prediction accuracy for healthy firms, while CART appears to be significantly more precise for bankrupt firms. However, when CART dummies are included in the logit model, its performance becomes even slightly better. Overall, the results clearly indicate the usefulness of CART in variable selection as it appears to successfully capture potential non-linearities present in the data.

Table 4-5: Prediction accuracy

		Sample					
		Matched			Larger		Full
Model		M→M	M→P	M→P*	L→P	L→P*	
Logit	Healthy	84.8	87.9	14.7	98.1	86	99.9
model 1	Bankrupt	79.7	79.7	98.6	54.7	80.4	20.9
	Overall	82.8	87.8	16	97.5	85.9	98.7
Logit	Healthy	91.7	97.2	13.6	98.8	91.4	99.8
model2	Bankrupt	82.4	82.4	99.3	55.4	79.8	41.9
	Overall	87	96.7	14.9	98.1	91.2	98.9
K&S	Healthy	77.2	99.8	99.8	99.7	99.4	
model 1	Bankrupt	72.3	9.5	18.9	6.1	10.8	
e=6	Overall	74.7	98.5	98.6	98.3	98.1	
K&S	Healthy	80	99.7	99.7	99.8	99.3	
model 1	Bankrupt	77.7	10.8	10.8	8.1	10.8	
e=4.3	Overall	78.8	98.4	98.4	98.4	98	
K&S	Healthy	85.5	99.8	99.7	99.7	99.6	
model 2	Bankrupt	74.3	10.8	11.5	20.3	8.8	
e=6	Overall	79.9	98.5	98.4	98.5	98.2	
K&S	Healthy	84.8	99.8	99.8	99.7	99.4	
model 2	Bankrupt	81.8	12.8	10.1	8.8	12.2	
e=4.3	Overall	83.3	98.5	98.5	98.3	98.1	
	Healthy	77.2	92.4		98.4		99.8
CART	Bankrupt	85.8	79.7		67.6		39.9
	Overall	81.2	92.2		97.9		98.9

Notes:* denotes the correction of constant for the logit model (see also notes to Table 4-1) and Zmijewski-type correction for the Klein and Spady model.

Fourth, the most important observation concerns the comparison of logit and the Klein&Spady semi-parametric model. It clearly emerges from Table 4-5 that logit is better in prediction accuracy of both bankrupt and healthy firms only when prediction is done on a matched sample. Such a situation does not correspond to real-life assessment of firms' creditworthiness. The population of credit applicants is not drawn from a distribution with balanced group shares. The share of bankrupt firms is considerably smaller in the true population of credit applicants. In this respect, the most interesting comparison of models follows from prediction accuracy on the sample with population group shares (label P). Logit is better in predicting bankruptcy cases while the semi-parametric model more successfully captures the characteristics of healthy firms. Since the share of the latter group is considerably larger, this also results in better overall prediction accuracy. The difference is not large, but consistent across different model specifications. The relative merits of the two methods therefore depend on the objectives of the financial institution in credit risk assessment. If the objective is minimization of

exposure to risk, then the logit model would deliver better results as it would deliver fewer bankrupt firms to the portfolio. However, this also implies that the institution would reject a very large number of potentially good risks. With the objective of profit maximization, the semi-parametric model seems to be preferable, because it offers a better overall prediction accuracy. The difference is particularly pronounced when financial institutions estimate their models on relatively small and choice-based samples.

Finally, it must be noted that choice-based sampling induces the same type of trade-off as between parametric or semi-parametric methods. Balancing the sample in favor of bankrupt firms obviously increases the prediction accuracy of potential bankruptcy cases. However, extended credit lines in real life have highly unequal shares. Minimization of risk exposure in this respect comes at the expense of overall prediction accuracy and hence profit opportunities. In this respect, both the choice of sampling method and the choice of estimation method should be made conditional on an explicit objective function of the financial institution in assessing credit risk.

4.6 Conclusion

This paper uses data on a full sample of Slovenian firms to asses the effects of choice-based sampling and different estimation methods on bankruptcy prediction accuracy. The results reveal that choice-based sampling significantly affects prediction accuracy. Balancing group shares in the estimation sample in favor of bankrupt firms increases the prediction accuracy of potentially bad risks. However, this does not correspond to the situation financial institutions face in real life. Credit applicants come from a population with heavily unequal group shares with bankrupts firms representing only a small portion of all observations. Using choice-based sampling thus leads to over-rejection of potentially good risks. This implies that choosing to minimize risk exposure should be traded off with profit maximization. Because the share of healthy firms is considerably larger, this problem should not be neglected.

As regards different estimation methods, I find non-parametric CART to be a very useful complementary method of variable selection. Augmenting classic models with variables selected by CART considerably improves forecasting accuracy. The choice between classic parametric method - logit - and the semi-parametric model of Klein and

Spady (1993) interestingly induces the similar trade off as choice-based sampling. While logit appears to be more precise in detecting bad risks, it is also true that the semi-parametric model better captures the characteristics of healthy firms. A considerably larger share of the latter group in the population also implies better overall prediction accuracy. Both the choice of sampling method and the choice of estimation method should be thus made conditional on an explicit objective function of the financial institution in assessing credit risk.

A potential problem with these conjectures is the fact that I use 50 percent probability of default as a cut-off point in predicting bankruptcy. For this reason, in my future work I plan to include investigation of an optimal cut-off point that should correspond to the optimal choice of the trade-off described above.

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