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Perspectives on Bank Competition and the Real Economy

by

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Thesis submitted for the degree of
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30 September 2013

Declaration

I declare that this dissertation has not been submitted as an exercise for the degree of Doctor of Philosophy (Ph.D.) at this or any other university. All research contained herein that is not entirely my own but is based on research that has been carried out jointly with others is duly acknowledged in the text wherever included.

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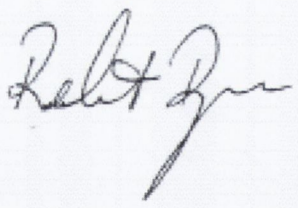

Robert M. Ryan

28th May 2014

The subject of this thesis is the empirical analysis of bank competition. An expanding collection of theoretical arguments suggests that the intensity at which banks compete with each other can influence their behaviour—and the behaviour of the economic agents with which they interact—in profound and complex ways. The implications of this evolving theory reach far beyond the traditional predictions of the industrial organisation literature as they relate to prices, quantities and economic rents. Indeed, many of these predictions have highlighted a number of previously unconsidered negative effects of increased bank competition and, as a result, the academic and public policy debate has evolved beyond the once well-established prior that competition in banking markets produces unambiguous welfare gains.

The objective of this thesis is to contribute to the empirical evidence on the relationship between bank competition and three distinct but interrelated outcomes for the firms to which banks supply credit. In the Chapter 2, I examine the relationship between bank competition and borrower risk and then test whether the strength or direction of the estimated positive relationship can be influenced by the banking supervisory framework. The existing theory predicts an ambiguous relationship: on one hand, bank competition reduces the economic rents earned by shareholders, reducing the effective cost of bankruptcy and incentivising riskier lending. On the other hand, bank competition reduces the cost of debt and thereby allows firms to reduce their risk profile while keeping expected returns stable. Using a panel dataset of 58,300 borrower firms across 28 European countries, I find evidence that increased competition is associated with riskier borrowers on average. However, I also find that where the bank supervisory authority is relatively powerful the competition-fragility relationship is dampened to the point that borrower stability is "competition-neutral."

Chapter 3 investigates the impact of bank market power on investment financing constraints experienced by small and medium enterprises (SMEs). The established wisdom suggests that as banks gain market power, credit supply is restricted, interest rates rise and firms find it increasingly difficult to raise funds. However, more recent information-based theories—in particular Petersen and Rajan (1995)—predict that strong bank competition curtails banks' ability to extract relationship rents by using the "soft" information they have collected via lending relationships. As a result, they have little incentive to invest in opaque firms with uncertain returns, including small and medium enterprises in particular. For my sample of 118,000 European SMEs, financial constraints are found to be present and strongest when banks have relatively high degrees of market power, supporting the traditional view. However, this negative effect is weaker for the smallest firms, suggesting that

the information hypothesis may well be at play yet outweighed by the market power effect on credit supply.

In Chapter 4, I establish evidence for the nature of the link between competition among banks and competition in the product markets into which they lend. A well-developed theoretical literature, with supporting evidence, indicates that bank market power has significant potential to influence firms' incentives to reduce or expand their mark-up over cost by affecting, for example, financial barriers to entry, firms' ability collude, incentives to build market share, and the returns to predatory behaviour. For my sample of approximately 208,000 firms across 378 national manufacturing sectors in 19 countries, I find that firm mark-ups are higher—and thus product market competition is softer—in markets where banks hold a greater level of market power. I also find evidence that this positive relationship between firm and bank market power is non-linear: the effect is especially strong when banks gain market power from a starting point that is relatively competitive. This evidence implies that the deadweight losses associated with imperfect competition in banking may be amplified by reducing competition in the downstream product markets to which they lend. It also suggests that pro-competitive policies in lending may be a new tool for economics seeking to achieving an internal devaluation, which is particularly relevant for Eurozone countries with limited control over exchange rate policy.

It is important to note that although the evidence produced in each of the analytical chapters of this thesis is generally indicative of important effects on the incentives, conduct and/or outcomes of banks and/or firms, conclusions regarding the welfare implications of these effects must be drawn with some caution. For example, the finding that bank market power is associated with restricted access to credit for manufacturing SMEs may be offset, hypothetically, by better access to finance in other quarters—for example for large firms, for households, or for service firms. Even if this is not the case, restricted lending to SMEs may produce welfare gains in the form of increased financial stability as banks lend to more stable, large firms or improved efficiency through a process of creative destruction. The true value of the empirical contributions presented in this thesis, as in the case with empirical analysis more broadly, is an incremental move towards a less imperfect understanding of the relationships at hand and, thereby, a sharpening of the bigger picture as it relates to welfare.

Acknowledgements

Many people have contributed to the completion of this thesis and I will always remember their help. My first and foremost acknowledgement is for my supervisors, Dr. Micheál Collins and Prof. Francis O'Toole. Throughout the writing of this thesis, both supervisors have constantly provided invaluable guidance, support and, in particular, encouragement always to keep going. For this I thank them sincerely.

I am grateful to members of the Department of Economics and Microeconomics Working Group for their comments and advice on my research, including Philip Lane, Tara Mitchell, Carol Newman, Patrick Honohan, John O'Hagan, Jacco Thijssen, Pedro Vicente and Michael Wycherley. I also thank the administrative staff: Colette, Trish and Siobhán. I would call them the unsung heroes of the Department of Economics, but I am yet to meet a member of the department who would hesitate to sing their praises for the efforts to keep the Department—and our lives—running smoothly.

This work was not completed in a vacuum. My brilliant fellow Ph.D. students made this thesis less of a task to complete and more of an experience to learn from and enjoy. Amy, Catarina, Christian, Conor, Julia, Sanna and all of the other students: thank you. I would especially like to thank two co-authors, Conor O'Toole and Fergal McCann, for their hard work and cooperation.

My sisters, Jennifer and Sharon; my brother, Peter; and my closest friends each played an enormous role in the writing of this thesis, sometimes simply by acting as a source of always-welcome distraction but often for much more than this.

Above all I thank my parents, to whom I dedicate this thesis. To my mother, Freda, of whom I am very proud. She taught me by example to face obstacles with perseverance, and that any

difficult situation will look better if you can laugh at it—loudly. And to my late father, Matt, who I know would be proud to see and read the finished work. From him I learned to look at the world and wonder, and always to be patient. These lessons helped me from the first day of the Ph.D. through to the last. This dedication is a small gesture when one considers how much they have dedicated to their children.

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CHAPTER 1

Introduction

By channeling capital from savers to entrepreneurs and firms with potentially profitable investment opportunities, banks perform a vital function in ensuring improved allocative efficiency in local, national and international economies. As such, any aspect of the banking system that can alter the incentives of banks, their borrowers or their depositors in relation to their saving, lending or investment decisions also has the potential to influence the welfare of consumers, firms and society on a very significant scale.

The subject of this thesis is the empirical analysis of one such aspect, namely, the degree of competitive rivalry between banks. An expanding collection of theoretical arguments suggests that the intensity at which banks compete with each other can influence their behaviour—and the behaviour of the economic agents with which they interact—in profound and complex ways. The implications of this evolving theory reach far beyond the traditional predictions of the industrial organisation literature as they relate to prices, quantities and economic rents. Indeed, many of these

predictions have highlighted a number of previously unconsidered negative effects of increased bank competition and, as a result, the academic and public policy debate has evolved beyond the once well-established prior that competition in banking markets produces unambiguous welfare gains.

Despite increasing efforts to model, explain and identify the effects of bank competition, significant ambiguity continues to surround the circumstances under which competition in banking can be understood to be socially desirable. For almost every economic outcome—positive or negative—understood to be affected by banks' conduct, theoretical conjectures have now been presented that imply multiple causal effects of bank competition that operate in opposing directions. Furthermore, this ambiguity is amplified by the fact that the effects of bank competition are typically heterogeneous in that they often depend on the particular characteristics of the firms, banks, markets and economies to which policymakers and academics seek to apply the aforementioned theory. These issues underline the enormous potential value of empirical analysis in attempting to disentangle these mechanics, understand the true effects of bank competition, identify the channels through which they operate and draw potentially very useful policy conclusions.

The objective of this thesis is to contribute to the empirical evidence on the relationship between bank competition and three distinct but interrelated outcomes for the firms to which banks supply credit. Specifically, I test a number of hypotheses relating to the effect of bank market power on borrower risk, financial constraints on investment for small and medium enterprises, and competition in downstream product markets. The following section provides context and motivation for this thesis by outlining both the current policy environment as it relates to the relevant academic literature. I also highlight a selection of key issues that relate to both this work and the extant research. The final section of this chapter provides an outline of the individual chapters of this thesis; their objectives, results and contributions to the literature. Finally, I provide a preview of the implications of this research for policy and future research.

1.1 Context and Key Issues

Recent events in banking sectors underline the importance of understanding the implications of competition among banks. The European banking sector—the setting for the empirical work of this thesis—is a prime example, as changes in its structure, performance and regulation have been considerable and, perhaps more importantly, are expected to persist into the near future with potentially very significant implications for the observed competitive behaviour of banks.

For instance, the European Commission (2012) reports that consolidation by European banks has continued almost without interruption for the past 10 years and beyond, and argues that this trend is likely to continue for a number of reasons. First, the presence of a number of national banking systems with relatively diluted ownership of bank assets indicates the potential for small and medium banks in these markets to consolidate in order to achieve economies of scale and other synergies. Second, banks are expected to continue to exit geographical and product markets considered to be non-strategic or capital-dilutive and expand their core business areas in order to combat continuing funding difficulties, improve on now historically-low profitability levels, and meet increasingly stringent capital requirements. Third, as government recapitalisation and state-aid measures apparently reach their end, privatisation measures should result either in increased market concentration or the entry of new competitors. Fourth, as European-level efforts to make effective arrangements for the resolution of failed banks continue, the pace of exit by weak and unstable banks is likely to accelerate.

To the extent that each of these and other developments encourage entry, exit, expansion and/or retrenchment by competitors, the degree of rivalry among banks is also likely to change. Hence, from a policymaking perspective, understanding the potential benefits and costs of these changes—and the circumstances in which those benefits and costs are most likely to arise—is of pivotal importance.

This thesis consists of three core chapters, each of which provides new empirical evidence on the channels through which bank competition influences the conduct of, and outcomes for, the firms to which they supply credit. In Chapter 2, I show that greater competition in banking systems is associated with greater credit risk among borrowers, but that this effect becomes modest when the supervisory regime is relatively powerful. In Chapter 3, I provide new evidence that small and medium enterprises suffer more restrictive credit constraints when banks' market power is greater, providing support for the traditional industrial organisation prediction of reduced supply and higher prices. However, this negative effect is also found to be weaker among the smallest subset of firms, lending support to the competing hypothesis that bank market power encourages relationship lending and is, therefore, "less bad" for relatively small and opaque firms. In Chapter 4, I provide first evidence that market power among banks tends to be associated with market power in downstream product markets.

While these chapters have been written to stand alone, some overlap in methodology and data does arise and where appropriate the relevant cross-references are provided. Similarly, while the conclusions are independently drawn on the basis of the analysis in each respective chapter, the interrelation between those conclusions does warrant discussion, which is presented in the final chapter. While I am the lead author on all chapters of this thesis, the third chapter is co-authored with Conor O'Toole and Fergal McCann. The working paper associated with that chapter has been submitted for publication to the Journal of Banking & Finance and is currently under review.

I constructed the datasets underlying each of the three analytical chapters of this thesis by combining firm and bank-level data from various sources. The firm element of each dataset is derived from data provided by the Bureau van Dijk in their AMADEUS database, which comprises financial and legal information based on standardised financial statements and records for private and public companies across Europe. The bank data—principally consisting of competition metrics—are based

on calculations by Bikker et al. (2006) for the second chapter, and are derived from the Fitch IBCA Bankscope database for the third and fourth chapters.

Before providing a fuller outline of the three main chapters of this thesis, now is a convenient point to briefly highlight some key issues relating the practical application of empirical industrial organisation methods in order establish some useful ideas and ensure clarity.

Of central importance is the measurement of competition. The empirical literature has increasingly moved away from the "structure-conduct-performance" paradigm, which holds that concentration measures capture the structure of the market and therefore are good predictors of firm conduct. Increasing recognition of possible confounding factors that blur the link between structure, conduct and performance mean that non-structural measures, which attempt to capture aspects of the actual pricing and mark-up behaviour of firms, are now much more popular. A full account of the advantages of non-structural over structural measures is provided in Section 2.2.

This thesis principally relies on two non-structural measures, namely, the Panzar and Rosse (1987) H-statistic in Chapter 2 and the Lerner index in Chapters 3 and 4. The H-statistic is effectively a revenue-cost elasticity, which should be close to unity for competitive firms (as prices and marginal costs are equal and move together) and zero or negative as firms gain market power. The Lerner index is a function of the ratio of prices to costs, designed to capture firms' market power: the ability of firms to maintain a price above marginal cost discussed in greater detail in their respective chapters.

These measures are complemented by bank concentration measures, namely, the three-bank concentration ratio and Herfindahl-Hirschman index. The three-bank concentration ratio is calculated as the share of the total market held by the three largest banks, while the latter is the sum of squared market shares for the 50 largest firms, which effectively gives greater weight to larger firms.

A related key issue for this thesis is the identification of the relevant banking sector. Allen (2011) describe the wave of financial globalisation in the mid-1990s as the third such wave in modern financial history. In the past 10 years in particular, integration of European lending markets has expanded considerably, facilitated by the introduction of the Single Banking License in 1989 and the euro in 1999. This integration has been manifested both through bank FDI flows, evidenced by significant increases in the numbers of foreign branches and subsidiaries owned by other European banks, and through direct cross-border lending.

Where banking markets are integrated in this way, competitive constraints on banks—in particular, rivalry among existing competitors and the threat of entry—are likely to be manifested not only at the national but also at the supra-national level. To the extent that international banking is captured by foreign FDI flows resulting in subsidiaries operating in the relevant national market, an assessment of national market outcomes will directly capture these supra-national competitive constraints. However, data provided by the Bank for International Settlements show that foreign claims by banks in European countries are on average divided equally between local lending by foreign subsidiaries and direct cross-border portfolio flows. As such, the assessment of competition using market outcomes—in the form of Lerner indices or H-statistics as described above—has the important advantage that it will, at least partially, capture the effect on market outcomes of competitive constraints imposed by cross-border lenders, where domestic measures of concentration would not.

Some debate may also exist as to whether local banking markets are also distinct from national ones, and whether more disaggregated measurement of bank market power would be more appropriate. In practical terms, a trade-off exists. National banking sector data is available across countries and rich cross-country variation allows for the identification of relationships with some confidence that the conclusions drawn have some generality. To the extent that useful and relevant

within-country variation in bank competition is lost, the analysis in this thesis will, on average, be biased *against* finding a statistically significant result and, therefore, the statistical significance of the results in this chapter may be understated.

1.2 Outline of the Thesis

In the second chapter, I examine the relationship between bank competition and borrower risk and then test whether the strength or direction of the estimated positive relationship can be influenced by the banking supervisory framework. The existing theory predicts an ambiguous relationship: on one hand, bank competition reduces the economic rents earned by shareholders, reducing the effective cost of bankruptcy and incentivising riskier lending. On the other hand, bank competition reduces the cost of debt and thereby allows firms to reduce their risk profile while keeping expected returns stable. Using a panel dataset of 58,300 borrower firms across 28 European countries, I capture firms' risk position using a measure of their distance to insolvency and find evidence that increased competition is associated with riskier borrowers on average. However, I also find that where the bank supervisory authority is relatively powerful the competition-fragility relationship is dampened to the point that borrower stability is "competition-neutral."

This direct testing of the subset of channels that operate through the bank-borrower relationship (rather than the bank-depositor or other relationships) adds a new perspective to the existing empirical evidence on the "competition-fragility" question, which has generally favoured testing the aggregate relationship between bank market power and stability. In addition, this is the first research to find evidence supporting the importance of supervision to this relationship and thus to highlight one avenue for policymakers to dampen the negative effects of competition without implementing anti-competitive policies. This finding is especially important in view of the establishment of a European System of Financial Supervisors and the European Systemic Risk Board;

indeed, this may alter the cost-benefit calculation in favour of greater competition between banks.

In the third chapter, we investigate the impact of bank market power on investment financing constraints experienced by small and medium enterprises (SMEs). The established wisdom suggests that as banks gain market power, credit supply is restricted, interest rates rise and firms find it increasingly difficult to raise funds. However, more recent information-based theories—in particular Petersen and Rajan (1995)—predict that strong bank competition curtails banks' ability to extract relationship rents by using the "soft" information they have collected via lending relationships. As a result, they have little incentive to invest in opaque firms with uncertain returns, including small and medium enterprises in particular. We find that for our sample of 118,000 European SMEs, financial constraints are present and strongest when banks have relatively high degrees of market power, supporting the traditional view. However, this negative effect is weaker for the smallest firms, suggesting that the information hypothesis may well be at play yet outweighed by the market power effect on credit supply.

Our results represent a significant contribution to the literature on bank market power and financing constraints on a number of fronts, principally by undertaking to correct a number of limitations that were previously unresolved in the extant empirical literature. First, we employ a well-established empirical methodology from the financing constraints literature, based on Fazzari et al. (1988). Existing identification strategies in the current wave of empirical evidence on the effect of bank market power on financing constraints variously identify firms as financially constrained if they: are relatively dependent on trade credit; exhibit low sales growth; or, do not use debt finance. We identify firms as financially constrained when their investment is sensitive to the availability of internal funds—implying some additional cost associated with using external finance—and we argue that this methodology is better suited to drawing conclusions about access to finance for long-term investment projects.

Second, we are first to examine the effect of bank market power on financing constraints while controlling for the availability of investment opportunities, a vital determinant of demand for funds that would represent an important confounding factor if ignored. Third, our study is the first investigation of bank market power and SME investment financing to exploit cross-country variation in bank market power in a developed economy setting. Fourth, our study is the first of its kind to include both cross-country and time-series elements, allowing us to control for firm-level and country-level fixed effects simultaneously.

In the fourth chapter, I establish evidence for the nature of the link between competition among banks and competition in the product markets into which they lend. A well-developed theoretical literature, with supporting evidence, indicates that bank market power has significant potential to influence firms' incentives to reduce or expand their mark-up over cost by affecting, for example, financial barriers to entry, firms' ability collude, incentives to build market share, and the returns to predatory behaviour.

I provide initial results directly assessing the aggregate effect of bank market power on market power by firms. By examining this aggregate relationship, the goal of this chapter might be considered the reverse of that of the second chapter: the latter contributes to the empirical evidence by attempting to dissect and better understand the components of an empirically-supported aggregate effect, while the fourth chapter recognises the evidence on individual channels and attempts to develop complementary evidence on their unified effect.

For my sample of approximately 208,000 firms across 378 national manufacturing sectors in 19 countries, I find that firm mark-ups are higher—and thus product market competition is softer—in markets where banks hold a greater level of market power. I also find evidence that this positive relationship between firm and bank market power is non-linear: the effect is especially strong when banks gain market power from a starting point that is relatively competitive.

The policy implications of this relationship should not be understated. This evidence implies that the deadweight losses associated with imperfect competition in banking may be amplified by reducing competition in the downstream product markets to which they lend. This is an important consideration in the analysis of the welfare implications of banking competition. This evidence also suggests that pro-competitive policies in lending may be a new tool for economics seeking to achieving an internal devaluation. This is a particularly important possibility for Eurozone countries that lack the advantage of tailored exchange rate policy.

It is important to note that although the evidence produced in each of the analytical chapters of this thesis is generally indicative of important effects on the incentives, conduct and/or outcomes of banks and/or firms, conclusions regarding the welfare implications of these effects must be drawn with some caution. For example, the finding that bank market power is associated with restricted access to credit for manufacturing SMEs may be offset, hypothetically, by better access to finance in other quarters—for example for large firms, for households, or for service firms. Even if this is not the case, restricted lending to SMEs may produce welfare gains in the form of increased financial stability as banks lend to more stable, large firms or improved efficiency through a process of creative destruction. The true value of the empirical contributions presented in this thesis, as in the case with empirical analysis more broadly, is an incremental move towards a less imperfect understanding of the relationships at hand and, thereby, a sharpening of the bigger picture as it relates to welfare.

CHAPTER 2

Bank Market Power, Borrower Risk and Supervision

RECENT empirical research into the relationship between bank competition and financial stability has focused on the impact of bank competition on bank risk, but rarely on the impact on firm risk directly. Moreover, underpinning many studies is the implicit assumption that there exists an exogenously given relationship between competition and stability, when in fact the nature of the relationship may be endogenous to the local regulatory regime. Using a dataset of 58,300 borrower firms across 22 European countries for the years 2000 to 2006, I find evidence supporting the traditional "competition-fragility view" in that borrowers are riskier where banking sectors are more competitive. However, I find that where the bank supervisory authority is very powerful the competition-fragility relationship is dampened to the point that bank stability is "competition-neutral."

The following section sets out the theoretical and empirical literature on this matter, highlighting the persistence of mixed results. Section 2.2 describes the empirical methodology used to

identify the effect of bank competition on risk, including issues surrounding the measurement of bank competition. Section 2.3 presents the empirical results and Section 2.4 concludes.

2.1 Theoretical and Empirical Context

The traditional wisdom on bank competition has long involved adherence to the "concentration-stability view," which holds that higher levels of competition resulting from the dilution of market shares in banking result in a higher likelihood of bank failures and systemic distress. One of the first formal theories in the area was proposed by Keeley (1990), who argued that as banks gain market share, the associated market power rents enhance the implicit value of owning a bank charter and, in turn, banks become increasingly conservative as they seek to protect that charter value. In the absence of this effective bankruptcy cost, and in combination with the protection provided by deposit insurance, downside risk is effectively truncated and thus risk-taking incentives are magnified.

The concentration-fragility counterpart of this "charter value hypothesis," then, is the borrower moral hazard mechanism. Critical of the existing theoretical frameworks that incorporated the deposit market only, Boyd and de Nicolò (2005) modeled the effect of market power in both deposit and lending markets, highlighting the important risk-amplifying effects of the latter. They show that, holding all else equal, bank market power and resulting higher loan interest rates imply a greater risk of default and, moreover, those higher interest rates alter borrowers' incentives such that they optimally increase the risk profile of their investments in order to increase the probability of positive returns over and above the increased cost of debt. This of course has a credit risk feedback effect on the bank. Boyd and de Nicolò point out that this borrower reaction mirrors that of banks in the deposit market under the charter value hypothesis.

The theoretical literature on this relationship has expanded well beyond these two channels

to include a wide array of potentially important links supporting both the concentration-stability and concentration-fragility views.[1] Nevertheless, these two hypotheses remain the cornerstone theoretical arguments in favour of the restriction and expansion, respectively, of bank competition for the sake of stability.

Early empirical tests of bank competition and stability depended largely on the structural approach—known as the structure-conduct-performance paradigm—which posited that firms' conduct (e.g. their pricing or risk-taking behaviour) and thus performance (e.g. their profitability or stability) could be inferred directly from the structure of the market in which they operated, typically measured using some form of concentration ratio. This approach primarily yielded support for Keeley's (1990) charter value hypothesis and the concentration-stability view more generally.

However, the simple use of concentration measures have since been challenged on a number of fronts, generally because of potential distortions to the suggested causal link between market structure and competitive behaviour. The literature now tends to draw a distinction between concentration and competition, with recent literature now focusing on the more relevant question of "*competition*-stability" versus "*competition*-fragility." The issues surrounding these concepts and measures, and details regarding the measures utilised in this and subsequent chapters, are discussed in Section 2.2.

The existing empirical literature has primarily examined the impact of bank concentration and competition on banks' stability directly. Beck et al. (2006) examine an historical sample of systemic crisis events across 69 countries and 18 years, and find that crises are less likely in countries with more concentrated banking systems. However, the data indicate that anti-competitive bank regulations simultaneously result in greater fragility. Boyd et al. (2010) look at bank level data for two samples, one US cross-section and an international panel, and find that banks' distances to

[1] Berger et al. (2004), Beck et al. (2006) and Berger et al. (2009) all provide useful reviews.

default are lower, and loan losses higher, in more concentrated markets. Berger et al. (2009) find that, although loan losses do increase as banks gain market power, this increased risk is more than offset by increased capital reserves, supporting the competition-fragility view. Beck et al. (2013) find evidence of a competition-fragility relationship, but find that this relationship varies according to the local regulatory regime.

Studies testing the impact of bank competition on firm risk profiles directly are less common. One example is Cerqueiro (2008), who finds that in a cross-section of small- and medium-sized US firms, loan applications tend to come from riskier firms in more concentrated banking systems, providing evidence for an adverse selection mechanism. However, the impact of bank competition on the nature of loan applicants says nothing of the risk level of actual borrowers, as adequate screening may mitigate any potential for an impact on the risk profile of banks' asset portfolios. Furthermore, in the absence of cross-country variation, the generality of this finding may be limited and a useful opportunity to extract practicable policy advice is missed, in that variation in financial regulatory regimes is not observed.

I argue that there exist two important gaps in the evidence. First, by testing the effect of bank market power on bank or banking system risk directly—some important information about the channels at play is forgone. This is because the aggregate evidence describes the joint reaction of borrowers and banks to changes in bank competition. However, to the extent that bank competition affects borrower risk-taking incentives, we should see firms' risk change as competition changes. To the extent that bank competition affects banks' risk-taking incentives, we should observe banks selecting riskier borrowers. Evidence for or against the presence of either or both of these sets of channels will allow for more tailored policy responses. For example, if borrower incentives prove to be a key driver of a competition-stability relationship, then in countries where banks wield significant market power, policies that encourage stricter monitoring or long-term reputational

costs of default may ameliorate the inflated credit risk. Alternatively, if changes in bank incentives are insignificant and changes in bank risk are instead driven by a reallocation of bank lending to riskier borrowers, stronger bank supervision may be a more effective solution.

Second, underpinning each of these studies is the implicit assumption that there exists a given relationship between competition and stability. However, the relationship itself is potentially endogenous to the local regulatory regime and therefore it is important to consider whether any estimate relationships exhibit heterogeneity across regulatory frameworks.

This chapter uses a dataset of 58,300 borrower firms across 22 European countries for the years 2000 to 2006 to address the two gaps in the literature outlined above. First, I test the link between bank competition and borrower risk using data from actual borrowers. This allows some characteristics of the empirically relevant channels to be identified. Second, I test the extent to which bank supervision dampens or exacerbates any competition-fragility links by exploiting the international dimension of the dataset and the variation in regulatory regimes.

In doing so, I find evidence supporting the competition-fragility view: borrowers are riskier where banking sectors are more competitive. This is contrary to the result predicted by Boyd and de Nicolò (2005). I do not argue that this is decisive evidence that the Boyd and de Nicolò (2005) risk-shifting mechanism is not at play: for a given loan portfolio, greater competition may indeed reduce interest rates and incentivise borrowers to take less risk. However, the evidence suggests that this effect, if present, is at the very least offset by other mechanisms.

The second important finding of this chapter is that bank supervision is very effective in that, in cases where the bank supervisory authority is very powerful, the competition-fragility relationship is dampened to the point that borrower risk can be considered "competition-neutral."

2.2 Empirical Methodology

The first step in this chapter is to establish whether bank competition has a statistically and economically significant impact on borrower risk. The general form of the model takes borrower risk as a function of bank competition and firm characteristics, as well as controls for the regulatory and macroeconomic environment.

Risk

The dependent variable, Risk_{it}, is measured using Z-scores.[2] In a given year, the Z-score is calculated as:

$$Z_{it} = \frac{(CAR_{it} + ROA_{it})}{\sigma(ROA_{it})}, \tag{2.1}$$

where CAR_{it} is firm i's capital-asset ratio—the ratio of shareholder's equity to total assets—at time t; ROA_{it} is the return on assets; and $\sigma(ROA_{it})$ is a measure of the variation in the return on assets ratio. In the results presented in this chapter, this measure used is the conventional standard deviation of ROA_{it}. However, those results are robust to the use of an alternative measure, the absolute deviation from mean returns in year t, calculated as $\sigma(ROA_{it}) = |ROA_{it} - T^{-1}\Sigma_t ROA_{it}|$ as per Boyd et al. (2010). These two measures of deviation give rise to two Z-scores, $Z1$ and $Z2$, respectively. The following discussion focuses on $Z1$ because the familiar measure of standard deviation aids discussion. However, as an individual firm's standard deviation is calculated as a single value over the full period, it may be argued that firm-level variation in distance to default will simply be driven by variation in the numerator that may not be related to the firm's stability. I therefore show that the results can be identified using variation in distance to default that captures volatility in terms of individual firm-year shocks to firm value.

[2]Recent papers in the competition-stability literature have employed Z-scores as measures of bank risk, including Boyd et al. (2010) and Berger et al. (2009).

The intuition behind the Z-score is as follows: as the numerator is the sum of equity capital and returns (normalised by assets), it refers to the remaining firm value held by the shareholders that can be wiped out by losses. Given that the denominator is a measure of the variation in profitability, the overall ratio refers to the number of standard deviations by which profitability would have to fall in order to fully deplete equity capital and cause the firm to become insolvent. This is why these particular Z-scores[3] are known as measures of "distance to default" and as such are inverse proxies for default risk.[4]

To illustrate the idea of distance to default, take as an example a firm with the median value for $Z1$ of 8.1. This implies that profitability must fall by 8.1 standard deviations for equity capital to be fully depleted. For the average firm in the sample, this implies a fall in return on assets from 4.4 per cent to -112.2 per cent. In other words, the average firm in a given year has a very low probability of failure.

Bank Competition: Measurement Issues

One outstanding challenge in this literature—and indeed more broadly within the field of empirical industrial organisation—lies in the measurement of competition. Existing methods for the measurement of bank competition can be categorised as either structural or non-structural in nature. Structural measures are based on the "structure-conduct-performance" paradigm, which posits that the structure of the market influences the conduct of firms, which in turn influences their outcomes. On this basis, concentration was seen as an adequate proxy for the competitive behaviour of firms.

[3]Note that within this and related literatures, the term Z-score is used to refer to many different measures relating to stability and probability of default. For example, Altman's (1968) Z-score is a score assigned to individual firms based on the weighted sum of various indicators shown empirically to be good predictors of default, and as such Altman's Z-score is not a measure of *distance* to default, but is nevertheless a predictor of default probability. Altman's Z-score is not employed in this study as the empirically-founded weights used in its construction were estimated using manufacturing firm data, which corresponds only to a subset of this dataset sample.

[4]In the case of a private company, the shareholder's equity includes the market value of assets, but not the market value of future profit flows. As such, the Z-score of a private firm technically describes its distance to insolvency rather than distance to default. However, evidence by Davydenko (2012) indicates that insolvency is nevertheless the single biggest factor explaining the timing of default.

However, the use of concentration ratios as a proxy has declined in popularity due to the fact that it can misrepresent the true degree of competitive behaviour for a number of reasons. First, the efficient structure hypothesis argues that the observed positive relationship between concentration and market power (measured by profitability) may be reverse-caused by firms' conduct if better-performing firms gain market share. Second, Leuvensteijn et al. (2008) point out that when competition necessitates consolidation, a positive relationship may be observed between the two.

Third, Baumol (1982) outlines how, in markets that are "perfectly contestable", a firm's competitive behaviour is not determined solely by its current competitors but also by potential entrants, which do not factor into typical metrics describing the existing market structure. Indeed, current studies highlight the central role of the potential for market entry in determining the degree of competitive rivalry in the banking sector specifically (e.g. Bikker et al. (2007)). Moreover, other frictions, such as switching costs, geographic constraints on customers and suppliers, and competition from non-financial firms all affect the degree to which market power is exercised (OECD, 2010), implying that structural measures are really only a first step in the assessing the level of competition in a given banking sector.

Fourth, Oliveira Martins et al. (1996) shows that the relation between concentration and competition depends on the *type* of concentration. Competition, for example, is found to be fiercer in "fragmented" than "segmented" industries, where both are equally diluted but the latter nevertheless includes a small number of large players.

Finally, Bos et al. (2010) point out that concentration measures suffer from the "fallacy of division," which, in relation to competition measurement, refers to the idea that even though firms are seen to exhibit monopolist behaviour when their market share approaches 100 per cent, and perfectly competitive behaviour when it approaches zero, this does not necessarily imply that concentration ratios are good predictors of firm behaviour between these two extremes.

An OECD (2010) report on concentration and competitive conditions in a selection of national banking sectors provide some useful illustrations of these measures. In particular, the Italian banking system provides a case where concentration is a poor predictor of competitive behaviour due to non-structural influences. Notwithstanding extensive privatisation and regulatory reform, Italy's banking sector is among the least concentrated in the sample, with the three largest banks holding 50.2 per cent of total banking system assets. Despite this relative dilution, it remains comparatively uncompetitive. The OECD highlight an inquiry by the Italian Competition Authority, which found that certain aspects of the corporate governance environment—"interlocking directorates" and shareholder pacts in particular—were acting as important impediments to competition.

For these reasons, this thesis favours non-structural measures of bank behaviour. Non-structural approaches use "realised" measures, typically algebraically related to return on assets, that describe the observed control of a given firm over its prices and profitability. The fact that these measures can be derived from banks' behaviour rather than the current status of the market allows them to take into account the fact that banks may be competing with potential foreign entrants as well as cross-border lenders, rather than just their current competitors. This is particularly important when dealing with European banks.

Notwithstanding the advantages of the non-structural approach, the structural approach should not be discounted entirely. Carbó et al. (2009) show empirically that both structural and non-structural measures appear to capture related but different phenomena. Beck et al. (2006) provide first evidence that concentration and competition (as measured by regulatory proxies for contestability) measure separate phenomena vis-à-vis stability in that both are significant in determining the probability of systemic banking distress in a country.

One possibility is that bank concentration proxies for bank size effects, in particular when already controlling for competitive conditions. Theoretical models and empirical evidence variously

demonstrate how bank size can impact bank incentives and behaviour beyond its reflection of market power effects. The most well known of these is the "too-big-to-fail" hypothesis. As banks become larger, they tend to fall under implicit guarantees of their respective states, as the economic repercussions of their failure become larger than the cost of their rescue. Under this guarantee, moral hazard affects banks' lending decisions, as their downside risk is truncated by a taxpayer safety net. Conversely, Stein (2002) argues that larger banks may be at a comparative disadvantage in small business lending because the information about such borrowers is typically "soft" and, without the ability to codify it, can only be transmitted through larger banking organisations with difficulty. From an SME risk perspective, this implies that as concentration increases and banks become larger, only the most established and secure small firms will be able to secure credit.

The fact that many recent papers have employed only one class of measures (i.e. structural or non-structural, but not both) may well be a contributing factor in the persistence of mixed results in the literature on the competition-stability nexus. As such, it is important to avoid unnecessary selectivity in terms of the class of measures tested, if only to identify or rule out one potential source of empirical contradiction. For this reason, the effect of concentration is accounted for in each of the following chapters.

In this chapter, the primary measure used to capture bank competition is the H-statistic.[5] The H-statistic, originally proposed by Panzar and Rosse (1987),[6] is derived from a general banking market model where banks are profit-maximising and, in equilibrium, the zero-profit constraint holds at market level. H equals the sum of the elasticities of bank revenues with respect to input prices. This elasticity should approach unity as competitive behaviour moves closer to perfect competition, because under this market structure an increase in input prices pushes up marginal costs and total revenue by the same proportion as the two should be equal. Conversely, under

[5]Other studies using the H-statistic as a measure of bank competition include Demirgüç-Kunt and Peria (2010), Bikker and Haaf (2002) and Claessens and Laeven (2004).

[6]Bikker et al. (2006) provide a survey of the literature on the Panzar and Rosse approach.

monopoly or perfect collusion, an increase in input prices pushes up marginal costs, resulting in falling output and revenues, implying a negative or zero-valued H. Intermediate values of H reflect monopolistic competition, as demonstrated by Panzar and Rosse.

I also employ the three-bank concentration ratio, $CR3$, as a structural measure of bank competition.

Controls

A primary goal of the regression analysis is to isolate any effect of bank competition on firm risk. I therefore incorporate controls for macroeconomic and institutional characteristics that may simultaneously affect both bank competition and firm risk positions.

Theory does not offer any strict expectation with regard to the sign on the coefficients of these macro controls. Strong macroeconomic conditions should result in sounder firm balance sheets. Conversely, more benign economic conditions may cause entrepreneurs to take investment decisions with less certain payoffs, as downside risk is cushioned. Alternatively, in a strong growth environment, positive sentiment may play a greater part in portfolio choice, also resulting in riskier portfolios. Claessens and Laeven (2004) and Bikker and Spierdijk (2009) also identify price and output fluctuations as important determinants of bank competition, reflecting a response among banks to changes in aggregate demand as well as economic stability. Therefore, GDP growth, the standard deviation of GDP growth and inflation are all included as controls. I also control for Eurozone membership,[7] in order to take into account probable simultaneous effects of Euro area membership on banking sector competition (e.g. due to single market and regulatory reforms) and on the performance and stability of firms (e.g. due to improved trade links).

[7]Eurozone countries included in the sample are Belgium, Finland, Germany, Greece, Ireland, Italy, Luxembourg, Portugal and Spain. Greece is coded as a member country as they adopted the euro on 1 January 2001 and thus were members for 6 of the 7 years in the sample. Some other countries in the sample were later admitted to the Eurozone, but in all cases this occurred after 2006. France is excluded as one of the key assumptions of the Panzar-Rosse model is that banking markets are in a state of long-run competitive equilibrium and, in a test of countries for which they provide the H-statistic, Bikker et al. (2006) cannot reject the null hypothesis that France is in disequilibrium.

The index used for economic freedom is that designed by the Wall Street Journal and The Heritage Foundation based on a composite of scores for the extent to which policies adhere to a laissez-faire model, specifically in the areas of business, trade, fiscal and monetary policy, investment and the financial sector as well as the strength of property rights and freedom from corruption.

Firm riskiness and risk preferences may be correlated with firm size. In particular, larger firms are better able to diversify and thus can be expected to have more stable returns. Firm size is also correlated with bank competition: Cetorelli and Strahan (2006) find that market power in the banking sector acts as an impediment to firm entry, giving rise to the existence of larger firms on average, potentially as banks attempt to safeguard their debtors' profitability. I employ operating revenues as a control for firm size.

2.2.1 Data

In order to test the relationship between bank competition and borrower risk, I construct a dataset of financial information on a sample of 58,300 borrower firms across 22 European countries for the years 2000 to 2006 from the AMADEUS database of standardised annual accounts, provided by the Bureau van Dijk. For reasons explained in Section 2.2, this panel is compressed into a cross-section of 14,600 timely averages.

In constructing this sample, I begin with all borrowers, which are identified as all firms with long-term debt on their balance sheets. Importantly, I first exclude large corporations because, when seeking to establish a link between the level of competitive behaviour in national banking sectors and the risk profile of borrower firms, it is important to restrict the sample to those firms likely to be constrained primarily to borrowing domestically. As large corporations' debt financing arrangements are less likely to face such constraints, for example due to greater access to international bond markets, I exclude all firms with average annual turnover in excess of EUR 1

million. The choice of upper limit is selected conservatively; indeed, even with a much greater size limit, it would remain a sensible assumption to make that firms would be constrained to borrowing domestically.

The sample includes firms from a wide array of NACE industrial categories. Firms engaged in financial or insurance activities are excluded as any link between their risk-taking behaviour and bank competition are unlikely to operate strictly through a lender-borrower relationship. Enterprises operating in the construction and real estate sector are also excluded to maximise the generality of the empirical findings, given that the nature of the relationship between bank competition and borrower risk in these sectors in particular may have been heavily influenced by the speculative behaviour observed in many European countries between 2000 and 2006.[8] The distribution of the remaining firms by sector is shown in Table A.1 in the Appendix.

The 22 countries in the sample, plus 6 additional countries that are not included in the main specification, are listed in Appendix Table A.2. Note that later robustness checks are employed to examine whether the results are driven by the inclusion of countries that are represented either relatively heavily (e.g. Spain). The six countries not included in the base regression are those that are represented sparsely (e.g. Malta and Moldova), but the results are generally robust to their inclusion.

Country-level data on banking, macroeconomic and institutional characteristics are taken from various sources and incorporated into the dataset. Specifically, banking competition and regulatory measures are taken both from estimations in Bikker et al. (2006) and the detailed survey of bank regulation carried out by Barth et al. (2008). Macroeconomic data are provided by the IMF World Economic Outlook database, while a set of indices of economic freedom constructed by the Wall Street Journal and the Heritage Foundation is employed to control for institutional differences.

[8]Indeed, the characteristics of this relationship may well warrant specific investigation but the dynamics of bubble-driven lending and risk-taking practices lies outside the scope of this chapter.

The H-statistic data used in this chapter are calculated by Bikker et al. (2006) for 101 national banking sectors.[9] H-statistics for this chapter's sample are presented in Figure 2.1.

The sample statistics show that the most common market structure is monopolistic competition. The H-statistics of four banking systems, namely in Portugal, Finland, Malta and Iceland, reflect effectively collusive behaviour, while Ireland's banking sector appears to most closely reflect perfect competition.

Sample values for $CR3$ are graphed in Figure 2.2. Casual inspection of the H-statistic and $CR3$ ratio does indeed suggest a relationship between concentration and competition. The least competitive banks, according to the H-statistic, tend to be found in the most concentrated banking systems: out of 28 countries, Portugal, Finland, Malta and Iceland—those countries with the lowest H-statistics—rank 1st, 2nd, 6th and 12th, respectively, in terms of concentration. Furthermore, with a 54 per cent share of total banking system assets, the top three banks in Ireland exhibit the lowest dominance in the sample, and Ireland's is the most competitive banking sector according to the H-statistic.

Nevertheless, the imperfect matching of the rankings[10] still appears to reflect the arguments that concentration is an imperfect measure of competition between the extremes of perfect competition and monopoly, and/or that there are other important, non-structural influences at play.

Firm-level and macro-level summary statistics for the dataset are provided in Tables 2.1 and 2.2, respectively. Looking at the dependent variables, the median values for $Z1$ and $Z2$ are 7.5 and 21.2, respectively. Some firms with stable rates of return boast very high Z-scores (resulting from a denominator close to zero), which in turn produces a strong negative skew in the dependent variable. In order to ensure the standard errors are correct, I transform both Z-scores to a symmetric

[9] Shaffer (1982) demonstrates that if the sample of banks is in disequilibrium, the H-statistic can no longer identify monopoly (although positive values can be used to reject it). It should be noted that for each of the countries in this sample that are found to be in disequilibrium, the H-statistic has a positive value and the null hypothesis of monopoly is rejected by Bikker et al. (2006).

[10] the correlation between $CR3$ and the H-statistic is -32.5 per cent.

Figure 2.1: Sample H-statistics

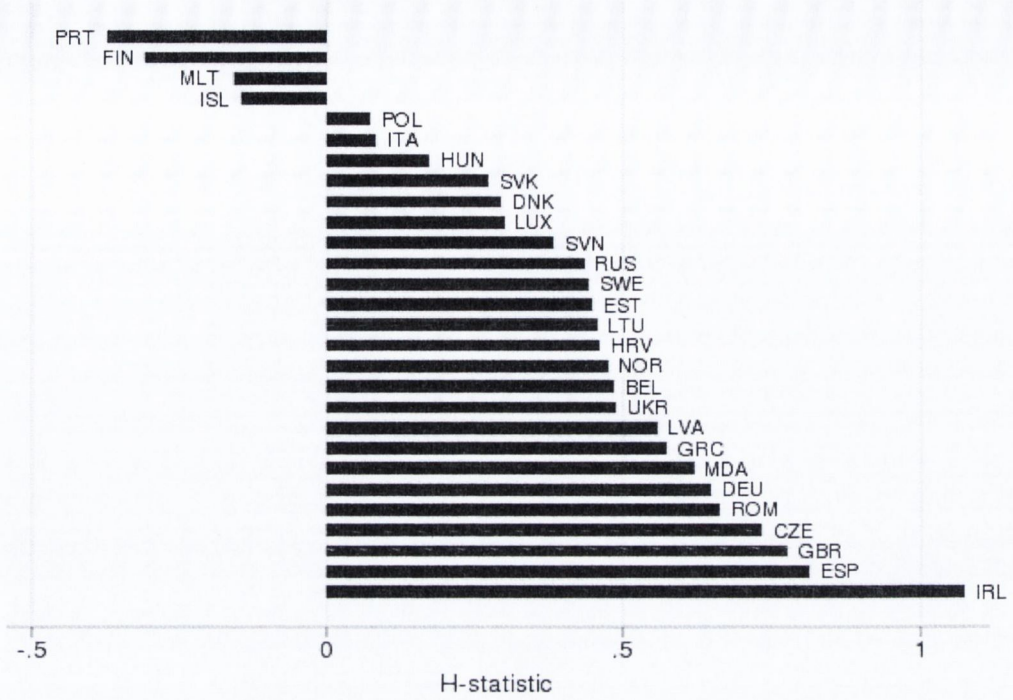
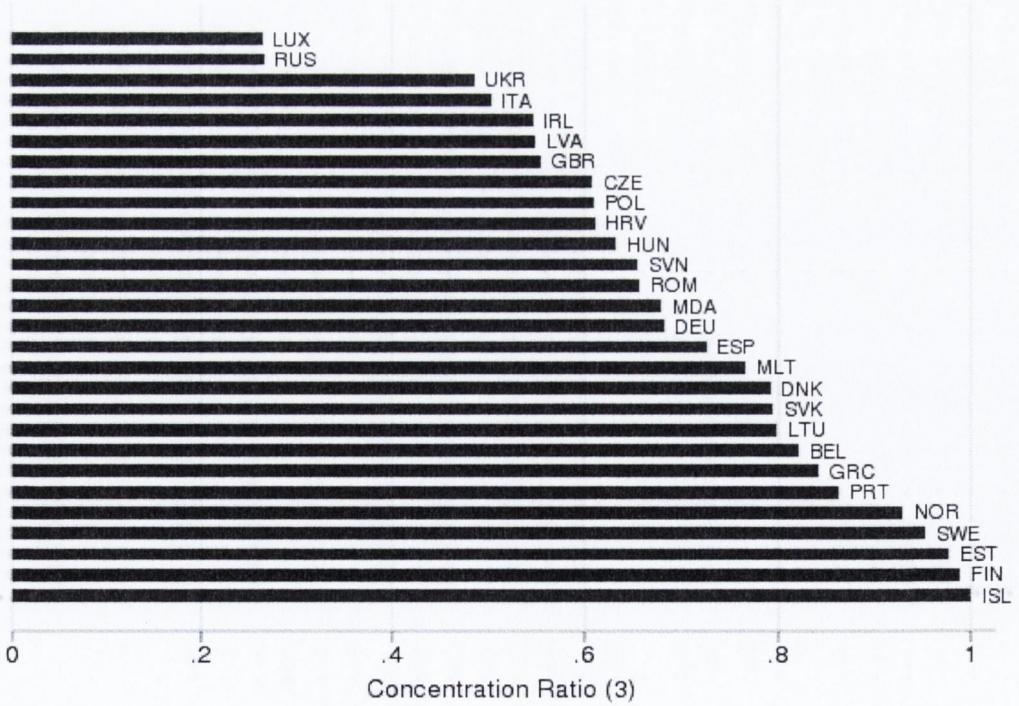


Figure 2.2: Sample Concentration Ratios



distribution using natural logs.

Table 2.1: Summary statistics: firm-level variables

	Minimum	Maximum	Median	Mean	Std. Deviation
Gearing Ratio (%)	0.0	100.0	29.8	34.2	26.4
Return on Assets (%)	-91.3	2,142.0	2.8	4.9	15.6
Capital Asset Ratio (%)	0.0	100.0	32.7	37.3	24.6
Turnover (000 EUR)	-2.2	999.8	621.3	583.9	276.2
Z1	0.0	108,748.0	7.5	38.2	900.5
Z2	0.0	3,520,101.2	21.2	322.2	19,216.1
log Z1	-6.6	11.6	2.0	2.1	1.2
log Z2	-6.3	15.1	3.1	3.2	1.5
Observations	58,808				

Table 2.2: Summary statistics

	Minimum	Maximum	Median	Mean	Std. Deviation
H-statistic	-0.4	1.1	0.5	0.4	0.3
CR 3	0.2	1.0	0.7	0.7	0.2
GDP growth (%)	1.1	9.2	4.4	4.5	2.3
GDP per capita (PPP)	2.2	67.2	21.8	23.5	13.5
St. dev. of GDP growth	0.6	3.1	1.4	1.6	0.6
CPI inflation (%)	1.4	17.9	2.9	4.3	4.0
Business freedom	52.9	98.2	72.7	73.0	10.7
Trade freedom	59.4	84.3	80.1	77.6	5.4
Government spending	1.4	72.8	41.5	42.6	18.4
Fiscal freedom	32.5	87.2	64.6	63.1	13.9
Monetary freedom	53.9	88.9	83.5	79.9	8.8
Investment freedom	36.5	90.0	70.0	66.0	16.1
Financial freedom	30.0	90.0	67.6	66.6	16.9
Property rights	30.0	90.0	70.0	67.3	21.7
Freedom from corruption	22.1	97.7	53.8	58.1	24.2
Observations	22				

In terms of financial characteristics, the sample provides significant cross-sectional variation in financial leverage: firm gearing ratios range from approximately zero up to 100 per cent, with a median of 34.2 per cent, mean of 29.8 per cent and standard deviation of 26.4 percentage points.

Having restricted the sample to small and medium enterprises with turnover of less than EUR 1 million, the resulting firms have an average turnover of EUR 583,900, with a standard deviation of EUR 276,200.

Given that profitability, in terms of *ROA*, ranges from -91.3 per cent up to 2,142.0 per cent, it is clear that some firms exhibit very high profits relative to total assets, but these are relative outliers

considering a mean return on assets of 4.9 percent with a standard deviation of 15.6 percentage points.

Average GDP growth ranges from 1.1 per cent (Portugal) to 9.2 per cent (Latvia). The United Kingdom observed the most stable growth; GDP expanded at an average rate of 2.1 per cent with a standard deviation of 0.6 percentage points. Ukraine, on the other hand, exhibited the greatest macroeconomic volatility, with a standard deviation of 3.1 percentage points about its average growth rate of 7.6 per cent. Average annual CPI inflation over the period ranged from 1.5 per cent (Finland) to 18.1 per cent (Romania) around a mean of 4.1 per cent.

2.3 Results

I proceed with OLS estimation on a cross-sectional basis—i.e., using timely averages—with a base specification as follows:

$$\begin{aligned} \log Z_i = \quad & \beta_0 \quad + \beta_1 BankComp_k + \beta_2 BankComp_k^2 + \beta_3 BankConc_k \\ & + \quad \beta_4 BankConc_k^2 + \beta_5 Size_i + \sum_{j=6}^{J} \beta_j Sector_{ji} + \sum_{n=J+6}^{N+J+6} \beta_n M_{nk} + \epsilon_i, \end{aligned} \tag{2.2}$$

where Z_i is the average Z-score of firm i; $BankComp_k$ is bank competition in country k as measured by the H-statistic (H_k); $BankConc_k$ is the average three-bank concentration ratio ($CR3_k$) in country k; $Size_i$ is firm i's size, measured as the log of annual turnover; $Sector_{ji}$ is a fixed effect dummy based on whether firm i belongs to NACE industrial category j; and the M_n refer to N country-level macroeconomic and institutional controls discussed in Section 2.2. Squared terms for $BankComp_k$ and $BankConc_k$ are included to allow for possible non-linear relationships.

Timely averages are used because the main variable of interest, H_k, is an elasticity estimated using a series of annual data and as such is broadly descriptive of competitive conditions but does not vary over time. As fixed effects estimation involves transforming data to deviations from the mean, this approach would preclude estimation of the coefficient on H_k. Hausman-Taylor estimation—a two-stage approach that involves using transformations of the time-variant, exogenous regressors

as instruments for the time-invariant ones—is sometimes proposed as a solution; however, for this sample, and as is often the case with this methodology, a Sargen-Hansen test indicates that these instruments are invalid.

I argue that each individual firm is too small in size to affect the competitive behaviour or market structure of the banking system, and so the possibility of reverse causality running from borrower risk to banking market structure is discounted. In order to avoid reverse causality on firm size, initial values of turnover are used rather than timely averages.

Considering the fact that a subset of the theoretical channels potentially underpinning this empirical relationship operate through borrower-lender relationships, gearing—i.e. debt as a proportion of total capital—may have an effect on the extent to which borrowers react to bank behaviour. The behaviour of a borrower firm whose gearing ratio is 5 per cent will not be expected to be as sensitive to changes in competitive behaviour in bank lending markets as a firm with 80 per cent leverage. However, an explicit control for gearing would be strongly endogenous, as firms with more stable returns and stronger balance sheet positions will be more capable of raising debt finance and may also find debt more attractive if they enjoy more favourable terms. Thus, in order to control for capital structure, I exploit the size of the dataset and variation in leverage to split the sample into four sub-samples based on gearing ratio quartiles. I thus run separate regressions for firms with less than 11.0 per cent, 11.0 to 29.8 per cent, 29.8 to 52.9 per cent, and greater than 52.9 per cent debt finance.[11]

The inclusion of the sectoral fixed effect dummies, $Sector_{ji}$, will account for general conditions in a given industry and thus will help to isolate individual firms' internal risk-taking decisions. A similar dummy-based strategy cannot be employed at the country level, however, because the variation that would remain in the base category may be incorrectly assigned to other country-level variables, including H_k, giving rise to potentially spurious results. As such, it is necessary to control for country-level factors explicitly. Included as regressors, therefore, are $GDP\ per\ capita_k$, $GDP\ growth_k$, GDP volatility ($\sigma(GDP\ growth)_k$), $Inflation_k$, and a full set of measures of the level of economic freedom for country k, discussed in Section 2.2.

One final important feature of the empirical model is that the sample of firms are grouped at the country level. Given that these firms share not only observable but also unobservable

[11] Each gearing quartile contains approximately 14,702 firms.

characteristics, the error terms are highly likely to have a group structure. As such, even modest levels of intra-class correlation of the errors introduce a strong downward bias in OLS standard error estimates (Moulton, 1990). However, the standard asymptotic approximation typically used to adjust for bias of this nature is not a viable option for this particular sample given the finite number of groups (22 in the main specification). Donald and Lang (2007) explain that with a finite number of groups, the corrected t-statistics will not converge to the normal distribution but rather retain a t-distribution, and therefore the standard application of a normal distribution assumption in interpreting the t-statistics will result in a strong overstating of the statistical significance of the point estimates. In order to correct for clustering and take the small number of clusters into account, I implement a parametric correction based on the Moulton factor.

Angrist and Pischke (2008) show that the Moulton factor—the ratio between the correct standard error estimate $V(\hat{\beta})$ and the OLS estimate $V_{OLS}(\hat{\beta})$—is given by

$$\frac{V(\hat{\beta_1})}{V_{OLS}(\hat{\beta_1})} = 1 + (n-1)\rho, \tag{2.3}$$

where ρ is the intra-class correlation coefficient and n is the cluster size. For a sample of fixed size, as individual clusters get larger (higher n), the overall number of clusters falls and the OLS variance estimate becomes downward biased. This bias is further compounded the greater the within-group correlation—i.e., the correlation between firms in a given country. The Moulton factor can be used to correct for this bias by inflating the conventional OLS standard errors based on estimates of the intra-class correlation coefficient and is appropriate for estimation even in cases where the number of clusters is as small as two, such as in difference-in-difference modelling (Donald and Lang, 2007).

2.3.1 Bank Competition and Borrower Risk

Tables 2.3 and 2.4 report the results of OLS regressions of firms' average Z-scores on country H-statistics using measures $Z1$ and $Z2$, respectively. The results and interpretation for $Z1$ and $Z2$ are broadly similar.

Generally speaking, the fit of the model as measured by the adjusted R-squared is relatively low. This is to be expected given the goal and nature of the econometric model. The aim is to test for the presence and magnitude of a causal effect of a group-level variable (bank competition)

Table 2.3: Regression Results for H-statistic, robust to clustering by country (Moulton SEs)

	Gearing			
Depvar: *Z1*	<11%	11-30%	30-53%	>53%
H-statistic	0.313	-0.839****	-1.447****	-1.199****
	(0.225)	(0.235)	(0.204)	(0.189)
H-statistic squared	0.288	1.433****	2.104****	1.529****
	(0.267)	(0.270)	(0.240)	(0.245)
CR-3	1.975***	-0.897	-1.502**	-2.190***
	(0.659)	(0.641)	(0.590)	(0.674)
CR-3 squared	-1.809***	0.352	0.960**	1.041**
	(0.557)	(0.538)	(0.489)	(0.530)
GDP growth	-0.0794****	0.0283	0.0213	0.0177
	(0.0231)	(0.0244)	(0.0219)	(0.0211)
GDP per capita (PPP)	-0.0141**	-0.000606	0.00468	-0.00567
	(0.00671)	(0.00752)	(0.00790)	(0.00801)
σ(GDP growth)	0.213****	-0.0128	-0.0344	-0.174**
	(0.0552)	(0.0646)	(0.0666)	(0.0676)
Inflation	-0.0365**	-0.0862****	-0.0939****	-0.0618***
	(0.0153)	(0.0191)	(0.0188)	(0.0209)
Eurozone	0.503****	0.196**	-0.288****	-0.316****
	(0.0928)	(0.0893)	(0.0799)	(0.0716)
log Turnover	0.00590	0.0769****	0.0718****	0.0697****
	(0.00882)	(0.00852)	(0.00807)	(0.00765)
Constant	3.212***	4.867****	5.944	3.653****
	(1.085)	(0.963)	(33903.1)	(0.923)
Sector dummies	Yes	Yes	Yes	Yes
Institutional controls	Yes	Yes	Yes	Yes
Number of observations	14601	14577	14564	14558
Number of clusters	22	22	22	22
Adjusted R-squared	.0676	.0787	.0585	.0572

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$, **** $p < 0.001$

Table 2.4: Regression Results for H-statistic, robust to clustering by country (Moulton SEs)

	Gearing			
Depvar: *Z2*	<11%	11-30%	30-53%	>53%
H-statistic	-0.0941	-1.375****	-1.607****	-1.887****
	(0.275)	(0.273)	(0.255)	(0.240)
H-statistic squared	0.482	1.483****	1.493****	1.637****
	(0.326)	(0.313)	(0.301)	(0.311)
CR-3	4.440****	0.905	1.589**	-2.467***
	(0.808)	(0.762)	(0.738)	(0.858)
CR-3 squared	-3.806****	-0.980	-1.266**	1.271*
	(0.684)	(0.645)	(0.612)	(0.674)
GDP growth	-0.00688	0.112****	0.0561**	0.105****
	(0.0284)	(0.0292)	(0.0274)	(0.0268)
GDP per capita (PPP)	-0.0188**	-0.00122	-0.00342	-0.00766
	(0.00822)	(0.00909)	(0.00988)	(0.0102)
σ(GDP growth)	0.00122	-0.197**	-0.179**	-0.441****
	(0.0673)	(0.0765)	(0.0833)	(0.0860)
Inflation	-0.0336*	-0.102****	-0.102****	-0.124****
	(0.0188)	(0.0228)	(0.0236)	(0.0266)
Eurozone	0.294***	-0.00340	-0.399****	-0.549****
	(0.113)	(0.106)	(0.100)	(0.0911)
log Turnover	0.0280**	0.0986****	0.0995****	0.101****
	(0.0109)	(0.0105)	(0.0101)	(0.00973)
Constant	4.980****	8.038****	8.685	9.367****
	(1.324)	(1.119)	(42441.5)	(1.175)
Sector dummies	Yes	Yes	Yes	Yes
Institutional controls	Yes	Yes	Yes	Yes
Number of observations	14601	14577	14564	14558
Number of clusters	22	22	22	22
Adjusted R-squared	.0511	.0531	.0508	.0489

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$, **** $p < 0.001$

on an individual-level variable (risk), controlling for principally group-level phenomena. There are many individual-level characteristics that strongly determine risk-taking behaviour that could be included in the model that would increase predictive power; however, it is only necessary to control for those that may be correlated with the regressor of interest, bank competition. By virtue of the fact that the latter is a group-level variable, there is often no reason to suspect that any such correlation may arise and thus these firm-level controls are safely omitted. This results in a model with relatively low predictive power, but this carries no negative implications in terms of causal inference.

H-statistic

These results provide evidence for a statistically significant relationship between bank competition and borrower risk. For borrower firms with a gearing ratio in the highest three quartiles—namely, with gearing in excess of 11 per cent—the null hypothesis of no relationship is rejected for both $Z1$ and $Z2$.

The point estimates for the coefficients on the H-statistic suggests that the relationship is non-linear as H_k enters negatively and significantly, while H_k^2 enters positively and significantly. The marginal effect of competition on risk therefore depends on the levels of H_k. Overall, higher levels of competition are associated with *greater* risk among borrowers, but this competition-fragility relationship is dampened as competition levels increase and, depending on the relative strength of its non-linear component, becomes positive at very high levels of competition. In order to more precisely determine the character of this relationship, it is worth examining more closely the predicted changes in bank competition implied by the fitted regression model. Figures 2.3 and 2.4 graph these predicted changes.

Figure 2.3 shows that, holding all else equal, the change in $Z1_i$ is positive if H_k (i) falls, or (ii) increases by at least 0.78 (0.69; 0.59) for firms in the first (second; third) gearing quartile.[12] To put these values into context, consider a hypothetical firm in the highest gearing cohort for whom the values for the explanatory and dependent variables equal the sample means. The banking sector H-statistic faced by this firm would be 0.556, approximately that of Latvia. The firm has gearing of 71.7 per cent, an initial turnover of EUR 587,000 and a Z-score ($Z1$) of 30.2. If the level of bank

[12]Or, for $Z2$, if H_k increases by at least 1.15 (1.08; 0.93) for the first (second; third) quartile, as shown in Figure 2.4.

Figure 2.3: Predicted Change in $Z1$ for Changes in H

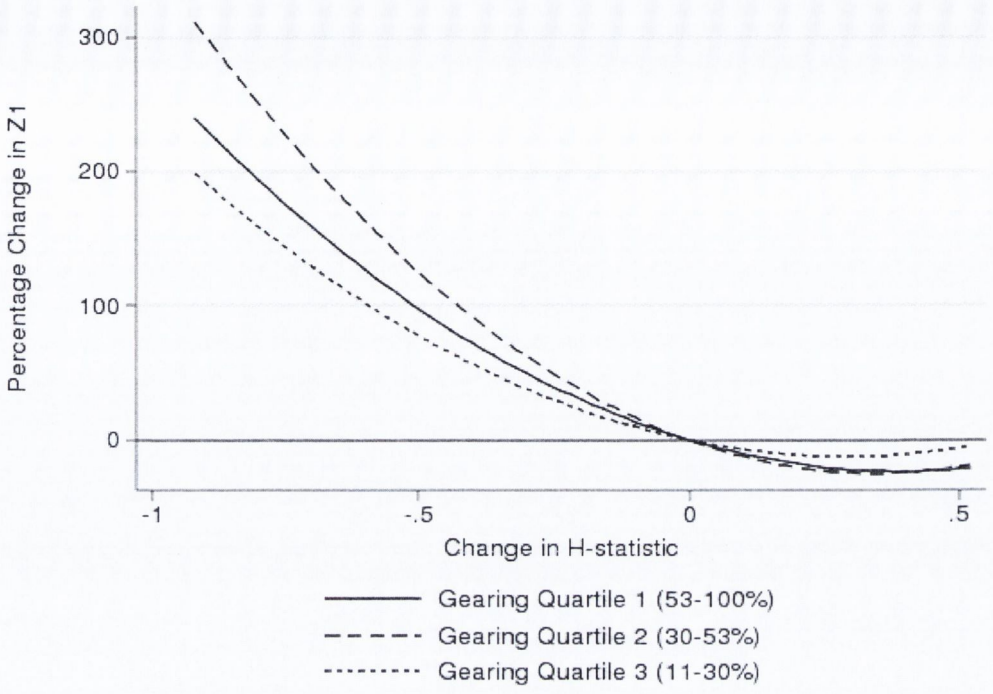
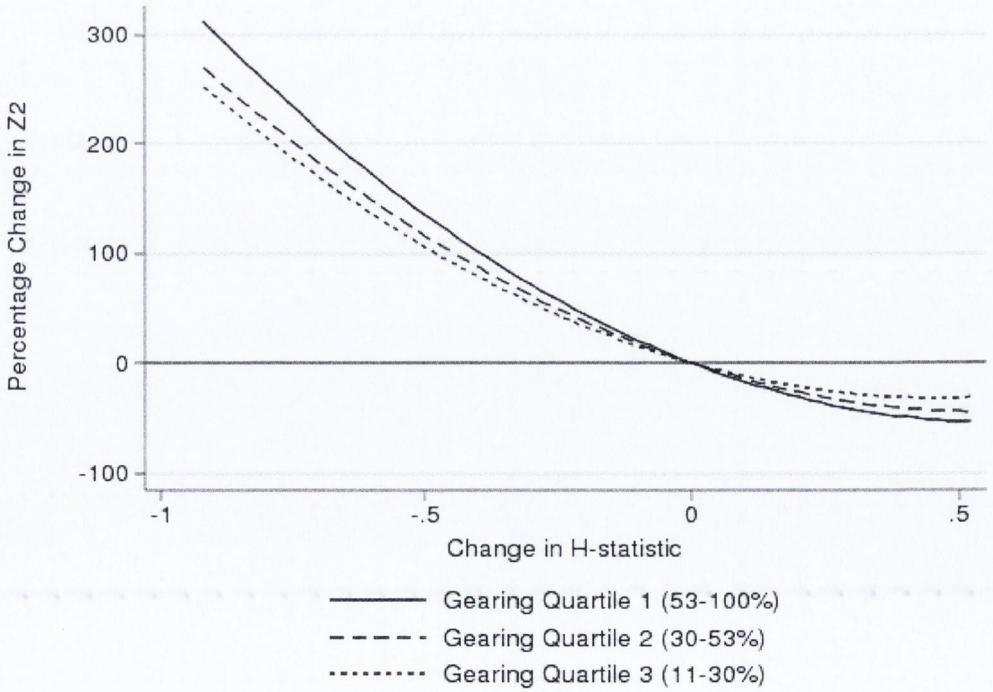


Figure 2.4: Predicted Change in $Z2$ for Changes in H



competition were to rise three ranks from 0.556 to that of Germany ($H_{DEU} = 0.646$), the predicted *ceteris paribus* change in the distance to default would be a fall of 9 per cent.[13] This implies moving from 30.2 to 27.3 standard deviations from default. The most drastic shift possible within the sample range would be an increase of 0.517 to Irish levels of competition ($H_{IRL} = 1.073$), which would result in a much larger expected fall of 21.1 per cent from 30.2 to 23.8 standard deviations.

The statistical significance of the marginal effect of a change in competition depends on the initial level of H_k. For example, the effect on $Z1$ of a one standard deviation change in H (0.3) is significant at the 5 per cent level at either end of the distribution of values of H_k, but is not significant at central values between around 0.3 and 0.4 (for the three top gearing quartiles).

Three important observations emerge from this analysis. First, it appears that the most important element of the relationship is the negative, linear component. Even with the most drastic increases in bank competition, the net effect on borrower behaviour remains negative in most cases.[14] Moreover, with the exception of "big bang" type shifts in regulatory policy or a long-term, strongly pro-competitive policy stance, such drastic changes are seldom observed in the short run. Nevertheless, this is not to say the non-linear component is irrelevant. Indeed, it has a strong and significant dampening effect on the negative bank competition-borrower risk relationship as banking systems move towards perfect competition.

Second, the economic significance of changes in bank competition in terms of their effect on default risk is ostensibly small for the hypothetical "average firm." Intuitively, a drop to 23.8 standard deviations in returns away from insolvency would not appear to imply a sharp increase in firm default probabilities. Indeed, where firms maintain a distance to default of this magnitude, marginal changes in the Z-score should be interpreted as more or less inconsequential from a credit risk perspective. However, that is not to say the economic significance of this relationship is universally small. It is of course not necessary for *average* Z-scores to fall below say 3 standard deviations for default probabilities to increase. As the mean Z-score falls, an increasingly large proportion of firms distributed to the left of the mean will face an increasing risk of default. Furthermore, the average Z-score in individual countries often begins at a much lower starting

[13] $\frac{\Delta(Z1)}{Z1} = (((0.646 - 0.556) * -1.199 + (0.646 - 0.556)^2 * 1.529) * 100)\% = -9.0\%$

[14] The only exception to this is the 11 to 30 per cent gearing cohort, for which an increase in the H-statistic of 0.517—the maximum within the sample range—results in a marginal increase in $Z1$ of 0.1 per cent.

point than in the above example.[15] Thus, the correct interpretation of these results is not that the effect is trivial, but rather that the degree of concern about this competition-stability dynamic should be tempered by the condition of the firms that rely on the banking system in question. In particular, policymakers should be more wary of increases in bank competition in countries where Z-scores are already low or falling, and high default rates are likely to cause excessive instability in the real economy—or indeed within certain critical sectors of the economy.[16]

Third, the use of firm data aids identification. That borrower firms—i.e. firms carrying debt on their balance sheets—tend to be riskier when their domestic banking sector is more competitive can be explained by two main effects: either that firm incentives change and, therefore, firms with debt take greater risk, or that bank incentives change and riskier firms are granted credit more frequently. In the case of the former, we would expect the effect to be stronger the more debt the firms hold on their balance sheets. Conversely, in the case of the latter, we would expect this effect to arise across all firms with debt, but would not anticipate a difference between gearing quartiles. In fact, we observe the latter, as there is no statistical difference between the magnitudes of the effects across gearing quartiles. This offers tentative evidence that the competition-fragility relationship is more likely to manifest through bank than firm incentive effects.

Concentration

The concentration ratio enters significantly in a number of specifications, including some of those where the H-statistic is significant. This finding of simultaneous significance is in line with current evidence, as mentioned in Section 2.2. Given that competition is controlled for by the H-statistic, this potentially points towards a size effects of banks independent from market power considerations.

Additionally, however, an interesting pattern emerges. For $Z1$ and $Z2$, the unit and squared terms enter significantly for the two highest gearing quartiles as well as the lowest quartile. For both measures, the relationship begins with a positive slope in the lowest gearing quartile, which then decreases as one moves into higher gearing quartiles and eventually turns negative in the

[15] Five countries' average Z-scores were less than 10, namely Latvia (9.1), Sweden (7.9), Estonia (7.6), Norway (6.5) and Iceland (5.5). Hungary and Romania also had low Z-scores but are excluded from this list due to small sample size.

[16] There was a number instances of low Z-scores within sub-sectors of more stable economies; the Polish arts, entertainment and recreation sector (7.0), the Finnish information and communication sector (6.0), and the Croatian mining sector (4.4), for example.

highest gearing quartile. This trend is illustrated in Figures 2.5 and 2.6, which graph the predicted change in Z-score for given changes in the concentration ratio.[17]

In summary, in a concentrated banking system debt tends to be held by riskier firms. This pattern is consistent with the too-big-to-fail-hypothesis referred to in Section 2.2 as, controlling for competition, concentration may still affect banks' incentives through the size channel. As bank liabilities become more concentrated, the probability that banks will be protected in the event of distress increases and thus the expected downside risk of selecting a riskier borrower pool is truncated. In this scenario, we would expect to see a transfer of debt from secure to less stable firms.

Notwithstanding this interesting pattern, the economic significance is evidently very minor indeed. Most realistic outcomes—i.e., abstracting from the unlikely scenario of perfect dilution of the banking system—at most result in a one per cent change in the Z-score. This may suggest that the H-statistic captures competitive behaviour effectively and that the residual (e.g. size-related) effects captured by the concentration ratio are small.

Controls and Robustness Checks

The controls enter significantly in some specifications, often with the expected sign. Larger firms are sounder, potentially due to diversification benefits and also as size may be correlated with age and thus the establishment of stable profit bases.

Interestingly, Eurozone firms are sounder than their non-Eurozone counterparts but this is only true of firms that hold relatively little debt; borrowers on the other hand were riskier in the Eurozone.

Some countries report data for very few firms and as a consequence have no data points in certain leverage brackets. As such, their inclusion would result in the gearing cohorts having different sizes and, potentially, results that are sensitive to the countries included. For this reason, the above-presented results exclude these countries; namely, Denmark, Hungary, Luxembourg, Malta, Moldova, and Romania. Nevertheless, in regressions not reported here I find the results to be highly robust to their inclusion.

The most heavily represented country in the sample is Spain, which makes up 38.1 per cent

[17]Note that the third quartile is not plotted here as, given the insignificance of H, the predicted change is zero.

Figure 2.5: Predicted Change in $Z1$ for Changes in CR3

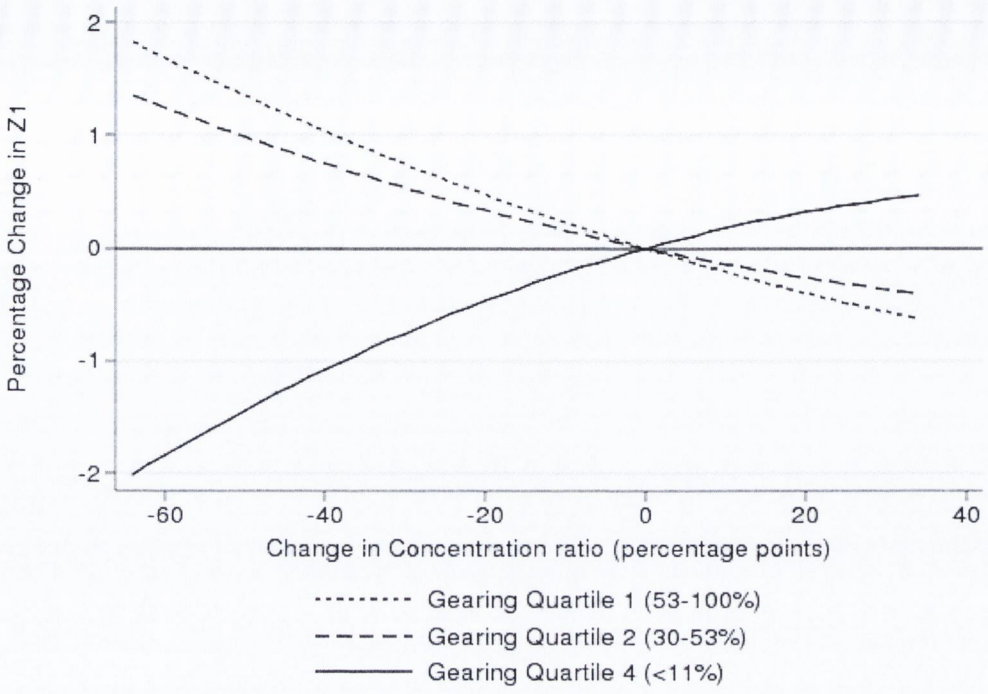
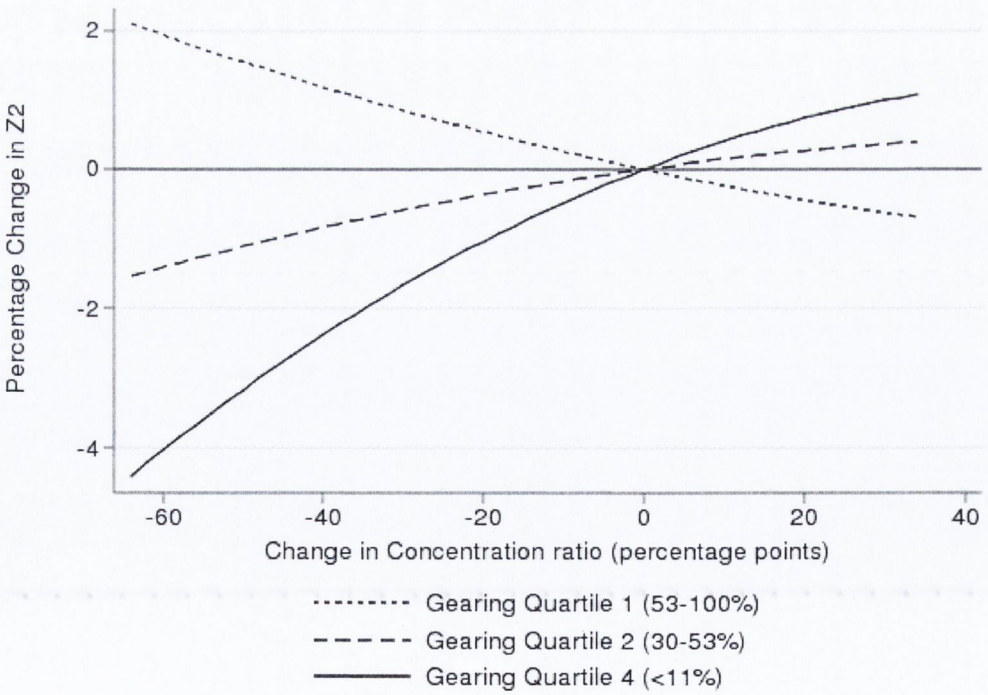


Figure 2.6: Predicted Change in $Z2$ for Changes in CR3



of the total number of firms (see Table A.2). Non-representativeness in the sample is not an issue for OLS estimation, as long as all of the relevant characteristics are controlled for. As already explained in Section 2.2, this is achieved using explicit controls for potentially relevant macroeconomic conditions and institutional differences. To test whether this estimation strategy has been effective in ensuring that the individual characteristics of highly represented countries do not drive the results, I rerun the previous regressions while restricting the sample to exclude Spain. The results in Appendix Tables A.3 and A.4 indicate that the main findings are largely robust to its exclusion. This lends support to the choice of the included controls and thus the overall estimation strategy.

2.3.2 Supervision, Competition and Risk

Apart from selectivity in the approach to competition measurement, one other potential reason for the persistence of mixed results in the literature is the assumption that competition-stability relationships in different banking markets are assumed to be exogenously given and homogenous in terms of strength and direction. However, the relationship between competition and stability may well be endogenous to local structural characteristics; in particular, individual channels through which the above-found competition-fragility relationship operates may be susceptible to regulatory intervention. Based on initial conclusions outlined in Section 2.3.1, which argue that the competition-fragility relationship is bank- rather than borrower-driven, I test for the extent to which the strength of the above-described link is correlated with the legal powers of the official supervisor.

To illustrate this point, I incorporate the interactive effect of supervisory power with bank competition into the regression model given in equation 2.2. Thus the model becomes:

$$\begin{aligned}\log Z_i = \quad & \beta_0 \quad + \beta_1 BankComp_k + \beta_2 BankComp_k^2 + \beta_3 BankConc_k + \beta_4 BankConc_k^2 \\ & + \quad \beta_5 OSP_k + \beta_6 OSP_k * H_k + \beta_7 OSP_k * H_k^2 + \beta_8 Size_i + \sum_{j=9}^{J} \beta_j Sector_{ji} \\ & + \quad \sum_{n=J+9}^{N+J+9} \beta_n M_{nk} + \epsilon_i, \end{aligned} \tag{2.4}$$

where OSP_k is an index of official supervisory power, taken from the detailed survey of bank regulation carried out by, and described in, Barth et al. (2008). The index is constructed based on 16 questions that together describe the extent to which bank supervisory bodies have the authority to take specific actions to prevent and correct problems. While the possible values range from 0 to 16 (with the latter implying the widest range of supervisory powers), the actual values for the same range from 5 to 14, with a mean value of 9.33.

Table 2.5: Regression Results for H-statistic, robust to clustering by country (Moulton SEs), controlling for Supervisory Power

	Gearing			
Depvar: *Z1*	<11%	11-30%	30-53%	>53%
H-statistic	-1.919*	-3.505****	-2.930***	-3.258****
	(0.986)	(0.968)	(0.964)	(0.986)
H-statistic squared	8.488****	11.64****	6.633****	7.718****
	(1.619)	(1.611)	(1.668)	(1.813)
CR-3	1.019	-1.223*	-2.660****	-2.405***
	(0.779)	(0.742)	(0.725)	(0.822)
CR-3 squared	-2.557****	-0.933	1.103*	0.665
	(0.657)	(0.635)	(0.614)	(0.641)
Supervisory Power	0.212****	0.249****	0.153****	0.0989****
	(0.0237)	(0.0246)	(0.0270)	(0.0289)
H * Supervisory Power	0.157**	0.199***	0.134**	0.143**
	(0.0664)	(0.0658)	(0.0663)	(0.0691)
H^2 * Supervisory Power	-0.843****	-1.081****	-0.487****	-0.609****
	(0.137)	(0.138)	(0.146)	(0.159)
Eurozone	0.337*	0.0595	-0.189	-0.570***
	(0.190)	(0.190)	(0.185)	(0.177)
log Turnover	0.00600	0.0751****	0.0726****	0.0668****
	(0.00882)	(0.00849)	(0.00810)	(0.00768)
Constant	2.046*	3.561****	4.880	3.037***
	(1.110)	(0.925)	(33852.1)	(0.953)
Sector dummies	Yes	Yes	Yes	Yes
Institutional controls	Yes	Yes	Yes	Yes
Macro controls	Yes	Yes	Yes	Yes
Number of observations	14601	14577	14564	14558
Number of clusters	22	22	22	22
Adjusted R-squared	.0725	.085	.0611	.0582

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$, **** $p < 0.001$

The competition-fragility relationship found in Section 2.3.1 remains intact following the inclusion in the regression model of supervisory power and its interaction with the H-statistic. In

Table 2.6: Regression Results for H-statistic, robust to clustering by country (Moulton SEs), controlling for Supervisory Power

	Gearing			
Depvar: *Z2*	<11%	11-30%	30-53%	>53%
H-statistic	-4.098****	-6.786****	-6.753****	-4.596****
	(1.222)	(1.207)	(1.207)	(1.255)
H-statistic squared	9.792****	14.31****	10.11****	8.264****
	(2.006)	(2.008)	(2.089)	(2.308)
CR-3	2.761***	-0.635	-0.965	-3.518****
	(0.965)	(0.924)	(0.907)	(1.046)
CR-3 squared	-3.686****	-1.057	0.211	1.531*
	(0.814)	(0.791)	(0.768)	(0.816)
Supervisory Power	0.174****	0.220****	0.123****	0.113***
	(0.0294)	(0.0307)	(0.0338)	(0.0368)
H * Supervisory Power	0.282****	0.390****	0.385****	0.202**
	(0.0823)	(0.0820)	(0.0831)	(0.0879)
H^2 * Supervisory Power	-0.867****	-1.208****	-0.713****	-0.624***
	(0.170)	(0.172)	(0.183)	(0.202)
Eurozone	-0.209	-0.669***	-1.019****	-0.826****
	(0.235)	(0.236)	(0.232)	(0.226)
log Turnover	0.0272**	0.0959****	0.0991****	0.0991****
	(0.0109)	(0.0106)	(0.0101)	(0.00978)
Constant	4.703****	7.529****	8.172	8.619****
	(1.376)	(1.153)	(42392.7)	(1.212)
Sector dummies	Yes	Yes	Yes	Yes
Institutional controls	Yes	Yes	Yes	Yes
Macro controls	Yes	Yes	Yes	Yes
Number of observations	14601	14577	14564	14558
Number of clusters	22	22	22	22
Adjusted R-squared	.0534	.0568	.0528	.0494

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$, **** $p < 0.001$

fact, the fourth gearing cohort now also enters significantly, with a pattern similar to those in the higher cohorts.

More importantly, the interaction of H_k with OSP_k enters positively and significantly, implying that the weaker the competition-fragility relationship is, on average, weaker in countries with a more powerful supervisor.

Furthermore, the positive non-linear effect of competition is found to be smaller in countries with strong supervision, as the interaction between H_k^2 and OSP_k enters negatively and significantly.

While these results may suggest that strong supervision is a substitute for any stabilising effect of strong competition, there are several caveats to this finding. First, effective supervision may not follow from legislated supervisory power—in some cases, for example, official supervisors may elect not to enact their legislated powers and instead extend forbearance to regulated banks. This limits the extent to which supervisory power might be correlated with effective supervision.

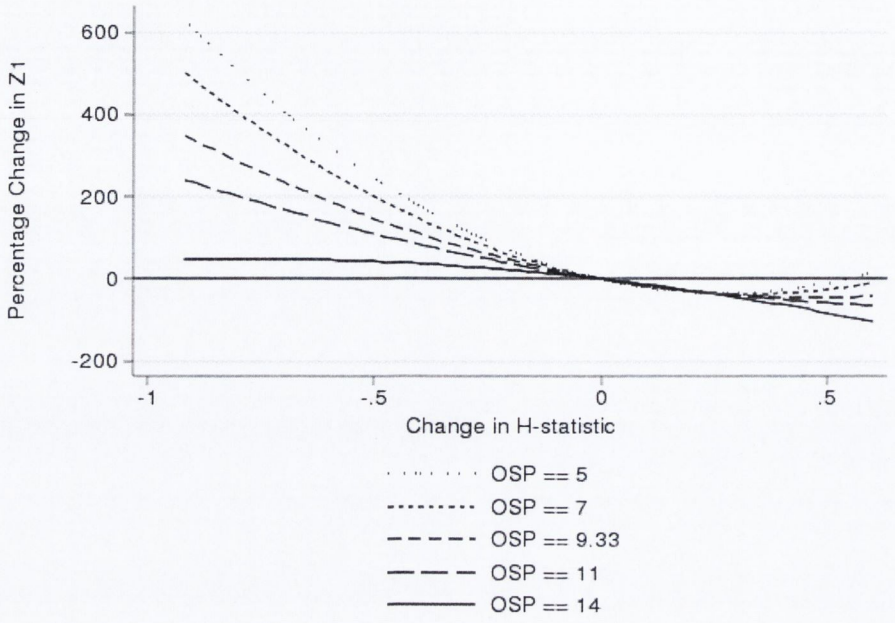
Second, while there is a significant interactive effect and variation in official supervisory power is therefore likely to explain some variation in the competition-stability relationship, this explanatory power may be driven by official supervisory power proxying for other aspects of quality and strictness of bank regulation. I therefore highlight the tentative nature of these findings and suggest that these be interpreted as being indicative of the potential for the nature of the competition-stability relationship to be endogenous to the regulatory regime or other institutional factors. Nevertheless, this result is robust to the inclusion of other controls, including an interaction between average country incomes and the H-statistic. However, it should be noted that Barth et al. (2008) point out that GDP per capita and official supervisory power are relatively weakly correlated.

Figure 2.7 graphs the predicted changes in $Z1$ for given changes in the H-statistic for different levels of official supervisory power. For brevity, only the first gearing quartile is illustrated but the patterns are the same broadly similar for all four quartiles.

2.4 Conclusions

Controlling for firm size, institutions, and sectoral and macroeconomic conditions, regression analyses of borrower Z-scores on the Panzar and Rosse (1987) H-statistic indicate that borrowers' distance to default is generally decreasing in bank competition, but that this negative relation-

Figure 2.7: Predicted Change in $Z1$ for Changes in H (Gearing Quartile 1; > 53%)



ship is dampened at higher levels of competition. Under the typical interpretation of findings of this nature, this chapter would be considered to support the traditional competition-fragility view. However, this chapter introduces a new interpretation of the policy conclusions that should be—or indeed, should not be—drawn from this finding. Specifically, the unqualified conclusion that bank competition should be dampened is incorrect for a number of reasons.

First, such an interpretation would ignore the fact that for some increases in competition the impact on borrower risk is very small, or in some cases, positive.

Second, any associated increase in risk may be offset by reductions in risk through other aspects of banks' activities—for example, by holding greater capital reserves. Additionally, even where a net increase in bank risk does arise, overall welfare may still increase through improvements in service quality and bank efficiency as a result of greater competition.

Third, correct interpretation of the Z-score requires that the importance of the effect be assessed with general conditions in the relevant market in mind. The risk-amplifying impact of bank competition should be viewed with greater concern where firms in a given country or industrial sector have volatile profits and low equity capital, such that decreases in their already-low Z-scores may translate into significant upward shifts in default probabilities.

Finally, this conclusion also assumes that the relationship between competition and stability is an exogenous given that cannot be influenced by policy: these results indicate that this may not be the case. Further controlling for official supervisory powers and their interaction with bank competition shows that as the power of supervisors increases, this relationship can be dampened to levels of marginal economic significance such that the relationship is best described as "competition-neutral." While official supervisory power may proxy for other institutional factors, this evidence suggests that the relationship between competition and stability may not simply an exogenously given, but rather may vary across regulatory regimes. Given the efficiency costs associated with restricting competition, there may be economically superior policy prescriptions.

CHAPTER 3

Bank Market Power and Financing Constraints

THIS chapter investigates the impact of bank market power on investment financing constraints experienced by small and medium sized enterprises. Using a large sample of approximately 118,000 SMEs across 20 European countries over the period 2005-2008, we provide evidence on (i) the extent to which SMEs are constrained by limited access to external finance—as measured by their reliance on internal funds for investment financing, (ii) whether the severity of those constraints is related to the level of bank market power in their domestic lending market and (iii) whether this relationship is heterogeneous across firm size categories.

The theoretical literature on the relationship between bank market power and firm financing constraints proposes two competing mechanisms through which limited competition between banks may impact positively or negatively on firm access to debt financing. The traditional industrial organisation prediction—the *market power hypothesis*—argues that increased market power results in restricted loan supply and higher lending rates, thereby intensifying financing constraints.

In contrast, the *information hypothesis* (Petersen and Rajan, 1995) argues that market power enables banks to forgo any interest rate premiums they might otherwise have to charge when lending to firms that are relatively opaque or risky—i.e. young, small and/or distressed firms—and, in return, establish a lending relationship that will allow them to extract informational rents

in subsequent periods. Conversely, banks operating in a competitive market must break even in each period and thus must hold risk-adjusted returns constant by charging higher interest rates on lending where the borrower's returns exhibit greater uncertainty. Moreover, in the presence of competition, banks cannot capitalise on this informational advantage and so the incentive to build these relationships would be negated. Market power is therefore predicted to result in greater investment in banking relationships, reduced information asymmetries and agency costs, and thus improved access to debt finance by potential borrowers.

Given that these theoretical channels produce contrasting predictions about the direction of the effect of bank market power on firms' access to finance, most recent work has focused on resolving this question empirically.

A 'first wave' of empirical research into this question generally adhered to the structure-conduct-performance (SCP) paradigm, which posits that formal measures of market structure are strong predictors of firms' competitive behaviour. Employing bank concentration as a proxy for bank market power, Petersen and Rajan (1995) find that increased concentration is associated with greater access to finance for a cross-section of US firms spread across local banking markets. Fischer (2000) also finds that higher bank concentration is associated with improved information flows and better credit access for a cross-section of German manufacturing firms. In contrast, Beck et al. (2004) find the opposite result for a survey of firms in 74 countries, but only where the level of economic development is low. This finding is corroborated by Chong et al. (2012) for a survey of Chinese SMEs.[1]

Increasingly, however, empirical research into bank market power has moved away from these "structural" concentration measures for a number of reasons. First, banking sectors are often observed to be simultaneously concentrated *and* competitive (or diluted and uncompetitive) and so concentration may be considered a poor proxy for underlying market power. Moreover, a more serious issue is that market structure and concentration may proxy for a whole range of conduct-determining bank and market characteristics, including average bank size, bank complexity in terms of product variety and activities, the ease of information flow within the market and the overall size of the market itself, for instance. As such, the aforementioned studies may fail to cleanly identify

[1]Finally, Ratti et al. (2008) finds evidence in support of the information hypothesis using observed investment data for a panel of European listed firms, although is is not clear that this finding can be generalised to the case of SMEs.

a competitive effect; indeed, this limitation may have contributed to the mixed results produced thus far.

An emerging 'second wave' of research focuses on more direct measures of the extent to which we observe the exercise of market power by banks—including the Lerner index in particular—and the results have been more consistent. Carbo et al. (2009) find that, when using regional bank Lerner indices to measure market power, greater bank market power is associated with *greater* credit constraints for a sample of Spanish SMEs, supporting the market power hypothesis. Furthermore, they find the same result when using HHI as a measure of market power, but *only* when the HHI is adjusted to control for oft-omitted confounding factors, demand elasticity in particular.[2]

Love and Peria (2012) also find that bank market power reduces access to finance for a repeated cross-section of firms across 53 primarily developing countries. However, they find this effect to be dependent on the wider economic and financial environment in which the firms operate. In particular, they find that higher levels of financial development and greater availability of credit information reduce this adverse effect, while high levels of government ownership of bank assets are associated with a stronger negative impact of bank market power.

Using a cross-country panel of European firms, we estimate the impact of bank market power on firm credit constraints in a way that remedies a number of important limitations that have not yet been overcome in the extant literature. These limitations and our solutions are as follows:

First, the identification of financial constraints by Carbo et al. (2009) depends on two measures, namely (i) firms' dependence on trade credit as a source of finance and (ii) sales growth. The former measure may be best interpreted as a proxy for the constraints faced by firms in raising short-term liquidity for operational purposes, but not necessarily in raising debt finance for capital investment. The determinants of short-term and long-term financing constraints may, in fact, be very different. The latter measure—sales growth—may not allow for clear conclusions to be drawn regarding the welfare implications of a significant bank market power effect, given that increased turnover may be offset by commensurately higher costs.

We employ a well-established identification strategy by examining the sensitivity of firm-level investment to changes in the availability of internal funds, an approach first established by Fazzari

[2]The empirical literature on concentration as a measure of competition—as reviewed by Carbo et al. (2009)—concludes that the extent to which changes in concentration are reflected in changes in the degree of competition depend especially on the extent to which the market is contestible and demand is elastic.

et al. (1988) and since employed widely in the financing constraints literature.[3] Importantly, we identify the key criticisms of our approach and provide argument supporting the robustness of our findings to these critiques.

Second, no research has, to our knowledge, examined the relationship between direct measures of banks' competitive behaviour and SME investment while controlling for the availability of investment opportunities. The presence of profitable investment opportunities to a given firm is a vital determinant of its investment behaviour and is highly likely to be correlated with many of the explanatory variables, especially as firms with profitable avenues for future expansion are likely to already enjoy profitable operations, positive cashflows and, therefore, a relative abundance of internal funds. We robustly control for investment fundamentals by estimating a 'Q' structural model of investment.

Third, our sample is the first cross-country sample to examine bank market power and SME investment (as opposed to investment by large, listed firms) in a primarily developed-country setting. This will allow us to exploit richer variation in bank market power than is likely to arise using an interregional sample as in Carbo et al. (2009), while also testing the extent to which the results from Love and Peria (2012) can be generalised beyond a largely developing country setting.

Fourth, the panel dimension allows us to build on the repeated cross-sectional work of Love and Peria (2012) by allowing us to control for potentially important firm-level heterogeneity.

Finally, in constructing our Lerner indices, we focus only on banking institutions for which corporate or commercial lending is actually observed in order to isolate actual market power within this sub-sector of the wider credit market, which improves on existing estimation.

We find that firms' investment is sensitive to the availability of internal funds and interpret this as being indicative of a wedge between the cost of internal and external financing. Furthermore, we find that bank market power is associated with lower levels of SME investment and, moreover, that this adverse impact of bank market power on investment is driven by the adverse effect of market power on financing constraints. In fact, much of the variation in cash-investment sensitivity is captured by the bank market power effect.

We separately estimate our empirical model to test for heterogeneous effects of bank market power on financing constraints across different categories of firm size. We find that the adverse

[3]See Hubbard (1998) and Chirinko (1993) for a review.

effect of bank market power on financing constraints is reduced for the smallest subset of firms—defined as "micro" enterprises—and argue that this is evidence of an information hypothesis-type effect that dampens, but is ultimately outweighed by, the direct market power effect.

Our research provides a number of important insights for SME credit policy in the context of Europe's economic recovery and in terms of financial stability. The very heterogenous impact of the financial crisis on domestic banking sectors in Europe has led, in many cases, to a retrenchment towards domestic activity (Barrell et al., 2011). This is a result of the extensive, but necessary, state intervention to provide banking sector support and restructuring (Petrovic and Tutsch, 2009). If such restructuring significantly lessens competition between financial institutions, our findings suggest that this will lead to an increase in financing constraints for SMEs. Such credit constraints, if binding in the medium term, will inevitably lead to lower investment and potential output. Policy actions which ensure financial stability but provide for additional (or even just restore) competition in the European lending market for SMEs will be a necessary condition for future SME growth and be supportive of economic development.

3.1 Empirical Approach

3.1.1 Identifying financing constraints

In order to identify financing constraints, we follow a well-established approach first proposed by Fazzari et al. (1988). They argue that financially constrained firms can be identified by the relatively high sensitivity of their investment to the availability of internal financing. The reasoning behind this is that financing constraints—i.e. obstacles to raising external financing (such as transaction costs or credit rationing)—will give rise to a differential between the costs of external and internal financing. Thus, if financing constraints are relatively severe, firms' cost of capital—and therefore their levels of investment—should depend heavily on the availability of internal funds. Conversely, if financing constraints are slight, the cost advantage of internal financing should also be small and investment levels should be less dependent on the availability of internal funding.

Therefore, our dependent variable in all specifications is *Investment* and we include *Cash Stock* as an explanatory variable. *Investment* is firm i's net accumulation of fixed assets (accounting for depreciation, amortisation and/or revaluations) in a given year, normalised by their stock of

fixed assets at the beginning of the year. *Cash Stock* is the value of firm i's balance of cash and cash equivalents, normalised by its capital stock. A positive and statistically significant coefficient on *Cash Stock* would indicate a positive sensitivity of investment to cash and therefore, based on the premise above, the presence of financing constraints. More important, if bank market power aggravates financing constraints, we should observe a greater cash-investment sensitivity among firms in country-years where banks have greater market power.

The cash-investment sensitivity approach to identifying financing constraints has been applied widely in the existing research[4] but the literature highlights a number of reasons to interpret cash-investment sensitivities with care.

First, Gross (1995) produces an intertemporal investment model and predicts that firms anticipating future financing constraints will reduce investment and increase liquid assets in the current period in order to smooth their constraint over time, giving rise to a negative (or less positive) cash-investment relationship despite the presence of financing constraints. This point relates to our research in an important way as it increases the probability of a false negative: identifying financially constrained firms as unconstrained. As such, in specifications where *Cash Stock* is not statistically significant in explaining *Investment*, this result should be interpreted with caution. Conversely, however, results indicating positive cash-investment sensitivity should thus be interpreted as particularly robust evidence of financing constraints.

Second, Kaplan and Zingales (1997) suggest that financially distressed firms may be inclined to use available liquidity to service debts rather than for capital investment. As such, cash-investment sensitivity may become less pronounced—and thus identification more difficult—where financially constrained firms are also distressed. Again, this finding suggests that insignificant results should be interpreted with caution but that positive coefficients are likely to be robust. Nevertheless, in Section 3.1.3 we outline some popular indicators of financial distress that we include in our empirical model in order to reduce any effect this may have.

Finally, a third point made by Kaplan and Zingales (1997) suggests that any preference held by managers for internal over external funding—for example, due to excessive risk aversion—may make investment more sensitive to the availability of internal funds, even if there are no external financing constraints. Otherwise said, financing constraints may be 'self-imposed' by

[4]See Guariglia (2008), Hubbard (1998) and Chirinko (1993) for useful reviews.

managers' risk preferences. If we were to assume that managers' risk preferences were exogenous and fixed over time, the estimated sensitivity of investment to cash will not be influenced by these preferences as they will be removed by the fixed effects transformation. However, if managers' preferences for internal funding change over time, this effect cannot be removed using the fixed effects transformation and, moreover, this could be problematic if the reason for managers' changing preferences is also linked with bank market power. One candidate is the financial crisis: increasing risk aversion arising from increased uncertainty in Europe may be linked with changes in bank market power arising from bank failures or policy responses to the crisis. To capture any pan-European annual effects, we include year dummies. To capture any asymmetric effects on risk aversion, for example related to countries experiencing stronger negative macroeconomic chocks, we include country GDP growth rates as a control.

3.1.2 Measuring Bank Market Power

Measuring competition in the banking sector is empirically challenging due to banks' international operations. As noted in Section 1, we focus on the non-structural measures of banking market competition and estimate the Lerner index as our main indicator. A number of studies to date have provided consistent estimates of the Lerner index across countries in Europe (Carbo et al., 2009; Fernández de Guevara et al., 2005).

We follow this existing research in our empirical estimates of the Lerner index. In this chapter, *Lerner* is the average bank Lerner index in country k in year t. The Lerner index effectively captures the extent to which banks can maintain a price level above their own marginal costs and, as such, greater values of the Lerner index should be associated with greater levels of market power.

We construct bank Lerner indices by estimating translog cost functions for our sample of 20 countries in order to generate approximations of individual banks' marginal costs and, therefore, the ratio of prices to marginal costs. We model banks as producing a single output, total assets, using three inputs; physical capital, financial capital and labour. Values of the Lerner Index in our sample range from a minimum of 0.27 up to a maximum of 0.63; the mean and median values are 0.44 and 0.41, respectively.

We include an interaction between *Lerner* and *Cash Stock* to capture the extent to which financing constraints vary with bank market power. Therefore, this interaction term is of key interest

as a positive (and statistically significant) coefficient should be indicative of an aggravating effect of bank market power on financing constraints, while a negative coefficient should be interpreted as bank market power reducing financing constraints.

3.1.3 Firm size and other controls

The information hypothesis provides an important reason as to why the impact of bank competition on financing constraints may exhibit heterogeneity across firms of different sizes. Under this hypothesis, banks use market power to effectively "subsidise" firms that are opaque or offer uncertain returns in order to generate a relationship and/or soft information that they can exploit in subsequent periods to extract economic rents. Under this premise, we would expect the impact of bank market power on financing constraints to be "more positive" for relatively small firms when compared to the impact on larger firms' financing constraints because of their relative opacity and riskiness.

$Micro^{EU}$ is a dummy which takes a value of one if the firm is classified, according to the EU definition, as a "micro" enterprise. This applies to firms that have fewer than 10 employees *and* either a turnover *or* balance sheet total of less than 2 million euro. Approximately 45 per cent of our sample comprises micro firms, while "small" and "medium" enterprises make up a further 42 per cent and 13 per cent, respectively. $Micro^{EU}$ is included in some specifications to determine whether the impact of bank market power on firm financing constraints varies across firm size categories.

As alluded to above, it is necessary to control for the availability of profitable investment opportunities, as firms operating in profitable sectors will likely invest more but also enjoy greater cash reserves. We therefore estimate *Fundamental Q*—a proxy for the marginal profit arising from additional capital, controlling for the informational content of *Cash Stock*—using a structural investment model. An outline of our structural investment model is given in Appendix B.2.

Debt Overhang is firm i's debt overhang, measured as its ratio of total debt to capital stock. Recently issued debt may boost cash reserves, while also restricting investment because (i) high levels of debt relative to the overall value of capital implies a lower availability of collateral to support additional bank finance and (ii) high leverage may be indicative of recent investment, decreasing the likelihood that the firm will invest again until their next investment cycle.

Four *Firm Age* category variables are included to account for the fact that younger firms are likely to invest a relatively large amount in their early years while also experiencing limited initial cash stocks as they establish revenue streams. Each category dummy takes a value of one if the firm is aged zero to three (six per cent of firms), four to seven (16 per cent), eight to 11 (16 per cent) or 12 to 15 years old (16 per cent), respectively, and zero otherwise. The excluded category here is firms aged 16 years or older, which represents the remaining 47 per cent of the sample.

Short-Term Debt Finance is the ratio of short-term loans to total debt. *Debt Finance* is the ratio of debt finance to total external finance, comprising debt and trade credit. We include these variables in order to capture the possibility that firms avoid becoming financially constrained as bank market power increases by substituting (i) from relatively expensive short-term to long-term finance and/or (ii) from bank debt to trade finance. The extent to which such substitution is possible may determine their investment, but may also be correlated with their creditworthiness and, therefore, the availability of cash reserves.

Fails is a dummy variable indicating whether, according to AMADEUS records, the firm fails during the sample period. As our panel is unbalanced, this control is included to account for any sample selection effect that may arise due to firms joining or leaving the sample for non-random reasons such as firm establishment or dissolution.

3.1.4 Country-level controls

HHI is the Herfindahl-Hirschman index of concentration for country k's banking sector, based on total assets. This is included to control for any additional impact the distribution of bank assets may have on firm borrowing and investment, beyond the impact of concentration on market power.

We also control for *Inflation*, *M2 Growth*, *EMU Membership*, *Private Credit Growth*, *GDP Growth*, *GDP Level*, *Government Gross Debt*, *Government Expenditure*, *Government Revenue* and *Foreign Bank Ownership*, each for their potential to simultaneously determine firm investment behaviour and firm credit constraints, independent of any impact on the degree to which banks compete. Table 3.1 provides summary statistics of our country-level variables averaged across country-years.

Table 3.1: Country data summary statistics

	Mean	St. Dev.	Median	Minimum	Maximum
Lerner	0.44	0.10	0.41	0.27	0.63
HHI (Gross Loans)	0.38	0.21	0.25	0.04	0.98
liquidity_ratio	1.19	1.54	0.94	0.00	96.58
GDP growth	1.90	1.80	2.20	-3.67	11.15
GDP (PPP)	1,489.05	656.78	1,812.11	10.57	2,929.89
Inflation (%)	2.56	1.06	2.22	0.45	13.52
Government Gross Debt (% GDP)	72.96	26.43	66.67	3.69	112.62
Credit Information Index	4.61	0.82	5.00	0.00	6.00
Government Revenue (% GDP)	45.60	4.43	45.93	32.40	56.59
Government Expenditure (% GDP)	47.59	5.11	48.45	34.21	53.57
M2 Growth (%)	13.89	7.18	12.41	1.97	60.12
Private Credit Growth (%)	105.27	29.09	95.14	25.91	272.80
Observations	304,645				

3.2 Econometric Specification

Our model takes the investment of firm i as a function of firm i's investment fundamentals, a measure of credit constraints for firm i, banking market power in country k as well as a host of controls for other characteristics of firm i, sector j, country k and year t. The basic econometric specification is as follows:

$$\begin{aligned} \text{Investment}_{ijkt} = \quad & \alpha_0 + \beta_1 \text{Q}_{ijk,t-1} + \beta_2 \text{Cash Stock}_{ijk,t-1} + \beta_3 \text{Lerner}_{kt} \\ & + \beta_4 (\text{Cash Stock}_{ijk,t-1} \times \text{Lerner}_{kt}) \\ & + \boldsymbol{\theta} \mathbf{F}_{ijkt} + \boldsymbol{\gamma} \mathbf{C}_{kt} + \boldsymbol{\delta} \bar{\mathbf{C}}_k + \boldsymbol{\tau} \mathbf{T}_t + \varepsilon_{ijkt} \end{aligned} \tag{3.1}$$

where $\mathbf{F}_{ijkt}$, $\mathbf{C}_{kt}$, $\mathbf{K}_k$, $\mathbf{T}_t$ are vectors of firm controls, country controls, country dummies and year dummies, respectively.

There are a number of factors that must be considered when selecting an appropriate econometric methodology to use when estimating the above investment equation. First, the measure we use for investment fundamentals, *Fundamental Q*, is subject to measurement error as it is a proxy for the unobservable marginal Q. To solve this measurement error problem—and thus derive consistent parameter estimates—we follow Gilchrist and Himmelberg (1995) and use a GMM approach, instrumenting for *Fundamental Q* using the third and fourth lagged values[5] of the elements of the

[5]Using the panel VAR to estimate Q means that the first and second lag variables are not valid instruments as these have been included in the differenced VAR equation. Our selection of valid instruments starts from the third level variable backwards. We therefore use the third level of the elements of the fundamental VAR to treat measurement error in Q.

Fundamental Q VAR estimated in Appendix B.2.

It is also imperative to control for any unobserved firm fixed effects that may be simultaneously correlated with both investment levels and financing constraints. As is standard in panel data models, we eliminate any time-invariant effects by transforming our data. Standard transformations include within-group orthogonal deviations, first differences or the Helmert transformation. As we require the use of lagged variables as instruments, this invalidates the use of the orthogonal deviations as these rely on a strong exogeneity assumption such as $E\left[u_{it}|c_i, x_{i1}, .., x_{i1}, ..., x_{iT}\right] = 0$. Of the remaining options, we choose to apply the Helmert transformation, which transforms the data to deviations from the forward mean, as this maximises the time dimension of our panel.

In order to control for country and year fixed effects, we include country and annual dummies. We choose to include country dummies in particular because, although less parsimonious than a transformation of the data, this will ensure that any country-level fixed effects are not inadvertently captured by our country-level variables of interest—bank market power in particular.

Our final transformation transforms all of the data to deviations from sector means in order to control for sector-level fixed effects.

To avoid endogeneity problems caused by potential reverse causality running from *Investment* to the explanatory variables *Fundamental Q*, *Cash Stock*, *Debt Overhang* and $Micro^{EU}$, the latter are lagged by one period when included in the model.

In order to ensure valid inference, our standard errors and test statistics are robust to heteroskedasticity and clustering on both country and sector. Given the small number of clusters, we apply a finite-sample adjustment, which inflates our standard errors by $\frac{M}{M-1}\frac{N-1}{N-K}$ where M is the number of country clusters, N is the total number of observations and K is the total number of regressors.

3.3 Data

We construct a dataset using the Bureau van Dijk's AMADEUS database, which comprises financial and legal information based on standardised financial statements and records for private and public companies across Europe. We combine this firm dataset with bank data from the Fitch IBCA Bankscope database as well as country-level data on macroeconomic, regulatory and institutional

characteristics from a number of standard sources, including the World Bank, IMF and Penn World Tables.

For our initial firm sample, we collect data on fixed and total assets; depreciation; debt, including short-term loans and long-term debt; turnover; cash and cash equivalents; debtors; creditors; net income; equity capital; incorporation date; legal status; and industrial category.

We use four-digit NACE industrial category codes[6] to restrict our sample to firms involved in manufacturing, corresponding to NACE codes 1000–3799 inclusive. We do not examine firms in service-oriented sectors as changes in physical capital are less likely to accurately describe their investment behaviour. Appendix B.1 describes the distribution of firms across the main industrial categories in our final sample.

As our intention is to examine SMEs, we also restrict our sample by applying two size filters. The first is based on the EU definition of SMEs: firm-years are excluded if they have (i) 250 or more employees *or* (ii) operating revenue in excess of EUR 50 million *and* total assets in excess of EUR 43 million, evaluated at purchasing power parity. This step excludes 4.5 per cent of firm-year observations.

Our second size filter is designed to address the fact that the EU definition applies a single ruler to all firms in our sample regardless of their size *relative* to their domestic market. This would ignore the fact that, for example, a firm that is considered small in Germany—and hence small relative to the German banking sector—would more accurately be considered very large were it to operate in the Maltese economy and borrow from the Maltese banking system. In order to ensure we do not include firms that are large in relative terms, we apply a definition by Gibson and van der Vaart (2008) and exclude any firm achieving a turnover in excess of 1,000 times the mean per capita GNI at purchasing power parity of the country in which it is located. This step excludes an additional 2.2 per cent of firm-year observations.

We apply a number of rules to remove non-representative firm data. We remove firms from the sample if they are considered outliers in terms of investment, debt-to-capital, sales-to-capital, sales-growth-to-capital, profits-to-capital and cash-to-capital (i.e. if they lie more than three standard deviations from the mean with respect to any of those variables).

[6]These codes are the narrowest available definition of sub-sectors provided for under the official Statistical Classification of Economic Activities in the European Community.

Table 3.2: Firm data summary statistics

	Mean	St. Dev.	Median	Minimum	Maximum
Investment	0.51	2.25	0.15	-0.99	305.65
Fundamental Q	-0.16	1.73	-0.30	-70.73	121.07
Cash Stock	0.87	2.65	0.18	0.00	136.00
Debt Overhang	0.61	2.17	0.23	0.00	249.00
Depreciation (or Revaluation) (%)	0.22	0.39	0.18	-0.07	122.30
External finance (% total finance)	0.70	0.31	0.82	0.00	1.00
Debt (% of all external finance)	0.90	0.22	1.00	0.00	1.00
Short-Term loans (% of all debt)	0.52	0.40	0.54	0.00	1.00
Sales (EUR millions)	3.07	4.23	1.32	0.00	48.06
Net income (EUR millions)	0.07	0.54	0.02	-128.22	56.12
Fixed assets (EUR millions)	0.97	2.73	0.25	0.00	232.33
Total assets (EUR millions)	2.76	4.78	1.06	0.00	235.68
Firm Age (years)	17.63	13.87	15.00	1.00	458.00
Liquidity Ratio	1.19	1.54	0.94	0.00	96.58
Observations	304,645				

We do not exclude firms with negative net investment during the period of our study. This is because firms with relatively low cash balances in a given period may choose to liquidate some or all of their fixed assets in the following period, giving rise to a statistically positive relationship between cash and investment which can be argued to represent financial constraints. Nevertheless, we separately estimate our model strictly including only firm-year observations with positive investment and find our results to be robust.

Our final sample contains approximately 118,000 firms across 20 countries over the period 2005-2008; Table 3.2 provides summary statistics.

3.4 Results

3.4.1 Main results

Table 3.3 shows the main results for firm investment estimated by two-stage GMM. In our baseline specification (1), *Cash Stock* enters positively and significantly, implying that firm-level investment is sensitive to the availability of internal funds. Specifically, an increase in the ratio of cash to fixed assets of 10 percentage points—e.g. from the median to the 58th percentile—is on average associated with a 1.82 percentage point increase in the rate of investment. At median levels of investment, this would correspond to an economically significant 12.4 per cent increase in the investment rate (from 14.63 to 16.45 per cent). We interpret this as being indicative of a 'wedge' between the cost of internal and external financing, implying that the firms in our sample are

financially constrained.

Table 3.3: Results using Lerner Index and/or HHI

	(1)	(2)	(3)	(4)	(5)
L.Fundamental Q	0.396***	0.393***	0.323***	0.377***	0.290***
	(0.076)	(0.074)	(0.094)	(0.070)	(0.082)
L. Debt Overhang	−0.117***	−0.117***	−0.116***	−0.116***	−0.115***
	(0.026)	(0.025)	(0.025)	(0.024)	(0.024)
Firm Age 0–3 years	0.148	0.149	0.178**	0.137	0.185**
	(0.100)	(0.098)	(0.072)	(0.102)	(0.077)
Firm Age 4–7 years	0.083***	0.082***	0.089***	0.080***	0.092***
	(0.018)	(0.019)	(0.014)	(0.021)	(0.016)
Firm Age 8–11 years	0.052*	0.049	0.052**	0.044	0.050*
	(0.028)	(0.031)	(0.025)	(0.027)	(0.024)
Firm Age 12–15 years	−0.014	−0.014	−0.011	−0.012	−0.011
	(0.013)	(0.013)	(0.014)	(0.017)	(0.016)
L. Cash Stock	0.182***	0.183***	0.051	0.178***	0.019
	(0.032)	(0.031)	(0.048)	(0.032)	(0.029)
Lerner		−1.648***	−1.286**		−0.457
		(0.480)	(0.573)		(0.795)
Lerner×L.Cash Stock			0.447***		0.522***
			(0.100)		(0.092)
HHI (Loans)				−5.359***	−4.726***
				(0.911)	(1.264)
HHI×L.Cash Stock				−0.062	−0.309
				(0.276)	(0.237)
Country dummies	Yes	Yes	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes	Yes	Yes
Firm-year observations	304,645	304,645	304,645	304,645	304,645
Number of countries	20	20	20	20	20
Number of sectors	306	306	306	306	306
Hansen's J (P-value)	.597	.571	.541	.476	.435
Cluster 1	country	country	country	country	country
Cluster 2	nace	nace	nace	nace	nace

Estimates efficient for, and statistics robust to, arbitrary heteroskedasticity and clustering by country and four-digit NACE sector. Q instrumented by the third and fourth lags of profits and sales, normalised by fixed assets.

In our second specification (2), *Lerner* is added and enters negatively and highly significantly, implying a negative association between bank market power and SME investment. Moreover, in our third specification (3), the coefficient on *Cash Stock* becomes insignificant while the interaction between *Lerner* and *Cash Stock* is positive and significant, suggesting that the association between market power and investment is largely explained by variation in the degree of financing constraints.

In order to make valid inferences about the direction and economic significance of the relationships implied by these point estimates, we estimate and plot, in Figure 3.1, the marginal effect of a 10 percentage point increase in cash on investment across different levels of bank market power together with 95 per cent confidence intervals. The positive slope indicates that investment

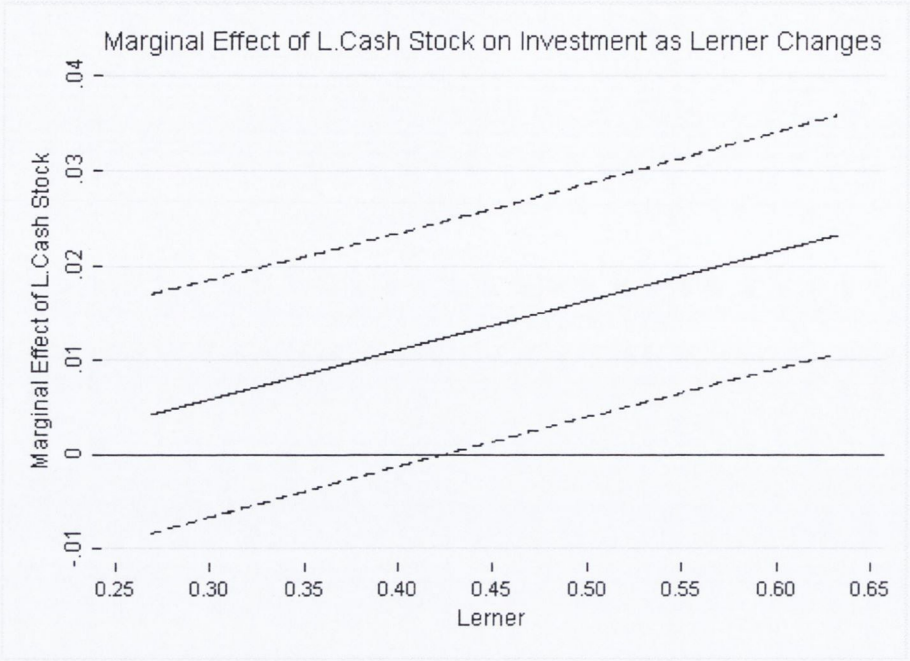


Figure 3.1: Estimated marginal effect on *Investment* of a change in *L.Cash Stock* at different levels of *Lerner*

is more cash-sensitive (and therefore firms are more financially constrained) when bank market power is high. This relationship is statistically significant at the 5 per cent level for all values of the Lerner index above approximately 0.36. This range includes almost 80 per cent of country-years in the sample, and includes both the mean and median values of the Lerner index—0.44 and 0.41, respectively.

Moreover, this relationship has considerable economic significance. Moving from the median Lerner index to the 75th percentile—an increase of 0.1—increases the sensitivity of investment to cash by 43.9 per cent. An increase from the median to the maximum causes cash-investment sensitivity to more than double. Taken together, this empirical evidence suggests our first main result: that bank market power exacerbates SME financing constraints, in line with the market power hypothesis.

3.4.2 Firm heterogeneity

Although the results thus far indicate support for the market power hypothesis, it is possible that we might observe heterogeneity across certain firm characteristics. This is particularly likely as the market power and information hypotheses are not mutually exclusive and may affect different

types of firm in different ways or magnitudes.

Based on the reasoning outlined in Section 3.1.3, we might expect the adverse effect of bank market power to be dampened or exacerbated among firms that are (i) relatively small or (ii) relatively opaque.

Table 3.4 presents results for the extension of our empirical model to allow for heterogeneous effects across categories of firm size. We include $L.Micro^{EU}$, a dummy for 'micro' firms[7]—lagged by one period to avoid reverse causality—as well as interactions between this dummy and our key regressors.

Table 3.4: Results using micro firm interaction terms

	Size Variable Definition	
	(1)	(2)
L.Fundamental Q	0.290***	0.293***
	(0.082)	(0.080)
L. Cash Stock	0.019	-0.065**
	(0.029)	(0.026)
Lerner	-0.457	0.087
	(0.795)	(1.039)
Lerner×L.Cash Stock	0.522***	0.719***
	(0.092)	(0.116)
HHI (Loans)	-4.726***	-4.550***
	(1.264)	(1.364)
HHI×L.Cash Stock	-0.309	-0.264
	(0.237)	(0.226)
$L.Micro^{EU}$	0.089**	0.113**
	(0.034)	(0.049)
Lerner×$L.Micro^{EU}$		-1.055
		(0.942)
Lerner×L.Cash Stock×$L.Micro^{EU}$		-0.307***
		(0.105)
L.Cash Stock×$L.Micro^{EU}$		0.117**
		(0.049)
Country dummies	Yes	Yes
Year dummies	Yes	Yes
Firm-year observations	304,645	304,645
Number of countries	20	20
Number of sectors	306	306
Hansen's J (P-value)	.435	.519
Cluster 1	country	country
Cluster 2	nace	nace

Estimates efficient for, and statistics robust to, arbitrary heteroskedasticity and clustering by country and four-digit NACE sector. Q instrumented by the third and fourth lags of profits and sales, normalised by fixed assets.

Importantly, the main coefficients do not change between this and the original specifica-

[7]Micro firms have an annual turnover of less than 10 times average national income and thus include the smallest—and hence most opaque—firms in our sample

tion. However, the newly-included regressors tell an interesting story. First, the coefficient on $L.Micro^{EU}$ indicates that micro firms expand their capital stock at a faster rate than their small and medium counterparts, likely reflecting their smaller initial stock. Second, the interaction term $L.Cash\ Stock \times Micro^{EU}$ enters positively and significantly, suggesting that micro firms are relatively constrained, in line with the conventional wisdom. Third, and most important, the three-way-interaction term, $Lerner \times L.Cash\ Stock \times L.Micro^{EU}$ enters negatively and significantly, suggesting that the constraint-inducing effect of market power is *smaller* for micro than small and medium firms.

This story is supported by the estimated marginal effects. In Figure 3.2 we reproduce the marginal effect graph of Figure 3.1 except this time separating micro firms from the small and medium enterprises.[8] The relative slopes of these lines indicate that, for a given increase in bank market power, the increase in cash-investment sensitivity—and thus, financing constraints—is 51 per cent greater for small and medium firms than for micro firms.

This could provide evidence that the information hypothesis does indeed play a role in the nexus between bank competition and financing constraints, but that this channel is outweighed by the direct bank market power effect.

Table 3.5 presents results for the extension of our empirical model to allow for heterogeneous effects varying with the degree of firms' opacity. We include the continuous variable *Opacity*, given by the ratio of firm i's intangible to total fixed assets and ranging from 0 to 1. We lag *Opacity* by one period to avoid reverse causality caused by investment in tangible or intangible assets.

Again, our main results are stable: bank market power exacerbates financing constraints. In this case, however, the marginal effects plotted in Figure 3.3 indicate that cash-investment sensitivity (and hence, the degree of financial constraint) increases more severely for opaque firms than their more transparent counterparts.

This suggests an opposite conclusion regarding the information hypothesis than is suggested by the evidence from micro firms. Opaque firms in this cases "suffer more" under bank market power. The most important conclusion here is that bank market power affects firms in a heterogenous fashion, but that the true relationship may be more complex than is accounted for by existing

[8]For clarity we do not show the confidence intervals; however, the vertical dotted line at Lerner=0.36 reflects the point at which the overall marginal effect is no longer statistically significant at the 5 per cent level.

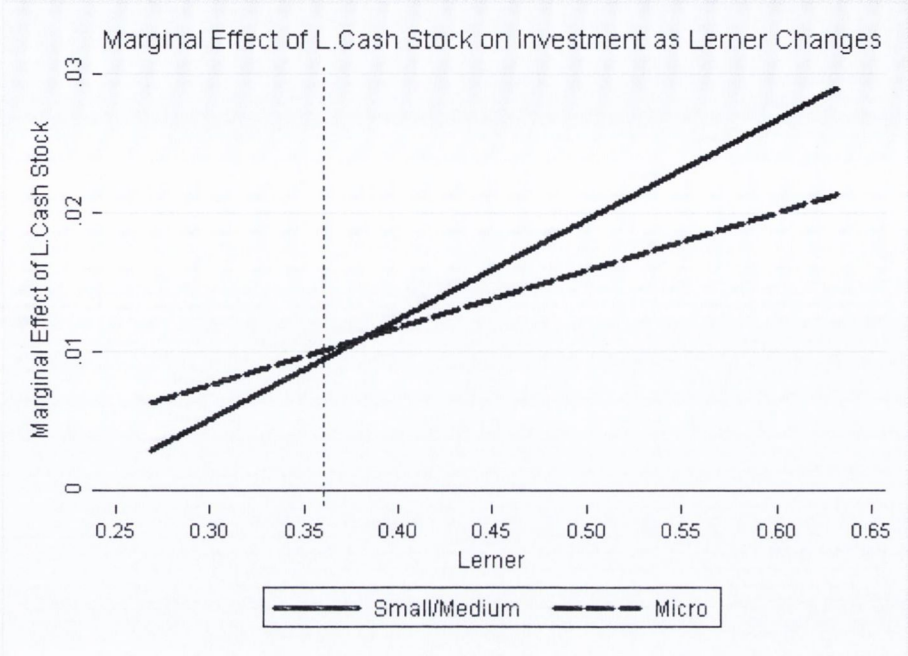


Figure 3.2: Estimated marginal effect on *Investment* of a change in *L.Cash Stock* at different levels of *Lerner* for micro versus small and medium enterprises

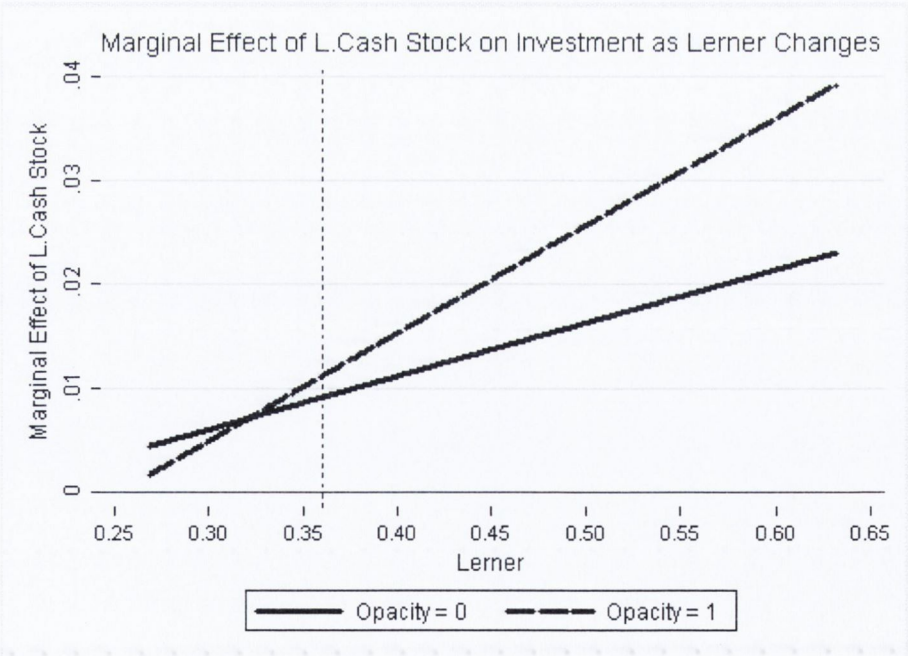


Figure 3.3: Estimated marginal effect on *Investment* of a change in *L.Cash Stock* at different levels of *Lerner* for different levels of opacity

Table 3.5: Results using *L.Opacity* interaction terms

	Size Variable Definition	
	(1)	(2)
L.Fundamental Q	0.290***	0.287***
	(0.082)	(0.083)
L. Cash Stock	0.019	0.026
	(0.029)	(0.028)
Lerner	-0.457	-0.388
	(0.795)	(0.817)
Lerner×L.Cash Stock	0.522***	0.510***
	(0.092)	(0.094)
HHI (Loans)	-4.726***	-4.592***
	(1.264)	(1.302)
HHI×L.Cash Stock	-0.309	-0.312
	(0.237)	(0.239)
L.Opacity	-0.038	0.163
	(0.166)	(0.338)
Lerner×L.Opacity		-0.676
		(0.746)
Lerner×L.Cash Stock×L.Opacity		0.524*
		(0.297)
L.Cash Stock×L.Opacity		-0.168*
		(0.080)
Country dummies	Yes	Yes
Year dummies	Yes	Yes
Firm-year observations	304,645	304,645
Number of countries	20	20
Number of sectors	306	306
Hansen's J (P-value)	.435	.482
Cluster 1	country	country
Cluster 2	nace	nace

Estimates efficient for, and statistics robust to, arbitrary heteroskedasticity and clustering by country and four-digit NACE sector. Q instrumented by the third and fourth lags of profits and sales, normalised by fixed assets.

theoretical models.

3.5 Conclusions

This chapter investigates the impact of bank market power on investment financing constraints experienced by small and medium sized enterprises (SMEs). Our sample extends the coverage of both countries and firms relative to existing research by using a large sample of approximately 118,000 SMEs across 20 European countries over the period 2005-2008. Our main contribution is to test the degree to which firms are financially constrained and investigate how such financial constraints vary by the degree of market competition between domestic banks. We also explore whether this relationship is heterogeneous across firm size categories.

We find that firms' investment is sensitive to the availability of internal funds and interpret this as being indicative of a wedge between the cost of internal and external financing. Furthermore, we find that bank market power is associated with lower levels of SME investment and, moreover, that this adverse impact of bank market power on investment is driven by the adverse effect of market power on financing constraints. In fact, much of the variation in cash-investment sensitivity is captured by the bank market power effect.

We separately estimate our empirical model to test for heterogeneous effects of bank market power on financing constraints across different categories of firm size. We find that the adverse effect of bank market power on financing constraints is reduced for the smallest subset of firms—defined as "micro" enterprises—and argue that this is evidence of an information hypothesis-type effect that dampens, but is ultimately outweighed by, the direct market power effect.

Our research provides a number of important insights for SME credit policy in the context of Europe's economic recovery and in terms of financial stability. The very heterogenous impact of the financial crisis on domestic banking sectors in Europe has led, in many cases, to a retrenchment towards domestic activity (Barrell et al., 2011). This is a result of the extensive, but necessary, state intervention to provide banking sector support and restructuring (see Petrovic and Tutsch 2009). If such restructuring significantly lessens competition between financial institutions, our findings suggest that this will lead to an increase in financing constraints for SMEs. Such credit constraints, if binding in the medium term, will inevitably lead to lower investment and potential

output. Policy actions which ensure financial stability but provide for additional (or even just restore) competition in the European lending market for SMEs will be a necessary condition for future SME growth and be supportive of economic development.

CHAPTER 4

Bank Market Power and Product Market Competition

FIRM-LEVEL Lerner indices—and their corresponding price mark-up ratios—have become popular indicators of market power in product markets with recent literature exhibiting increased effort to estimate them empirically using detailed micro-datasets. At least as important as identifying the existence and magnitude of market power, however, is identifying its sources, especially because these have strong implications for whether a policy response is necessary and/or desirable and, if so, the optimal configuration of that response. While numerous and diverse economic phenomena can give rise to imperfect competition,[1] this chapter focuses on the degree of bank market power in the upstream lending markets. Using a sample of 207,884 firms over the years 2005-2009, I find that increases in upstream bank market power are associated with greater market power in downstream product markets. The effect is strongest for increases in bank market power from a relatively competitive base level.

The following section motivates this chapter by describing the current theory and evidence relating to bank-firm competition relationships and highlighting how this research makes a contribution by testing, for the first time, the aggregate relationship between directly-measured bank market power and firm market power. In Section 4.2, I apply a two-stage empirical model to the

[1] For example, the degree of concentration; regulation; competition policy; openness to, and the extent of, international competition and trade; anti-competitive or collusive behaviour; the magnitude and efficiency of subsidies and government procurement policies (Ahn, 2002).

data by first estimating industry-level markups and then testing whether variation in those mark-ups can be explained by bank market power. The empirical results and conclusions are presented in Section 4.3.

4.1 Theoretical and Empirical Context

The main theoretical channels through which bank competition may affect firm margins relate to the way bank competition affects firms' financing constraints[2] and the implications these constraints have for barriers to entry and competition among firms.

On one hand, increased financing constraints for firms can reduce competition for two main reasons. First, exacerbating financing constraints for new entrants—opaque firms that are already likely to find raising debt finance relatively difficult—is likely act as a barrier to entry or expansion. This reduces competitive constraints on incumbent firms and is likely to give rise to wider profit margins.

Second, financing constraints increase the probability firms will fail, which makes it rational for them to favour short-term profit flows (Chevalier and Scharfstein, 1996). One way of achieving this is to increase present mark-ups: this forgoes the opportunity to expand future market share but will increase profits in the short run. This predicts that financing constraints will result in weaker competition in the short-run as weaker firms with high default probabilities sacrifice market share. In the long-run this will also result in increased concentration.

On the other hand, financing constraints may strengthen competition. First, financing constraints reduce the availability of debt, which can be used by a firm's owners to commit to an aggressive output stance and disincentivise entry (Brander and Lewis, 1986).[3]

Second, financing constraints incentivise rivals to engage in predatory margin-cutting (à la Fudenberg and Tirole (1986)) as, when rivals are financially constrained, it is more likely that cutting margins will force them to exit. However, it should be noted that this will give rise to stronger competition in the short run only. In the long-run, assuming firms' predation strategies are successful, we should see greater concentration and lessened competition.

[2]Much of this theory, and the empirical evidence thereon, is discussed in Chapter 3. The empirical evidence seems to support an overall adverse effect of bank market power on firms' financing constraints.

[3]Chevalier (1995a) and Chevalier (1995b) provide evidence to suggest that leverage does in fact lead to softer product market competition.

Apart from the channels set out above, separate theories relevant here suggest effects of bank market power on firm competition that does not operate through financing constraints. In particular, Spagnolo (2000) shows that when banks are uncompetitive, they are better positioned to coordinate the firms operating in a given market and thereby "export" collusion to their borrowers, where those borrowers could not otherwise coordinate their strategies.

General evidence relating to effects on industry structure—but not on firm conduct directly—produces conflicting evidence. Cetorelli and Strahan (2006) find that for a sample of US industries, deregulation and decreases in local bank concentration (measured by the HHI)—and thus, by assumption, reduced market power—are associated with a greater number of firms and smaller average firm size, consistent with lower barriers to entry. Cetorelli (2004) find supporting evidence for a panel of industries across the OECD: lower bank concentration (also measured by the HHI) is associated with expansion in new firms and more rapid exit by older incumbents. However, the exception is Bonaccorsi di Patti and Dell'Ariccia (2004), who find evidence for a non-linear relationship between bank concentration and firm birth rates across province-level industries in Italy. They conclude that improved information flows associated with bank market power are found to *aid* firm entry up to a point but that this effect is outweighed by the increased cost of lending as bank market power moves towards the maximum observed levels. That this bell-shaped relationship is driven by the information hypothesis is supported by the fact that the relationship is found to be more pronounced for opaque firms: those for which a relatively large proportion of their assets is classified as intangible.

The present chapter represents the first research to examine directly the impact of bank market power on firm market power, rather than firm market structure, entry or average size.[4]

This chapter may also be considered a contribution to the theoretical and empirical work of Chevalier and Scharfstein (1996). The latter work highlights how capital market imperfections may affect firm liquidity constraints and, therefore, firm margins. This chapter adds to the empirical evidence on the matter by testing a specific form of capital market imperfection, namely imperfect competition in lending.

[4]Market structure should not be conflated with market power, as outlined in Section 2.2 in particular. Examining firm entry will only capture some of the channels mentioned in this section.

4.2 Empirical Methodology

4.2.1 Estimating Mark-ups

This first stage of the empirical model estimates firm mark-ups following Roeger (1995), which in turn is based on well-known initial work by Hall (1988).[5] Hall shows that under constant returns to scale, growth in the output-capital ratio can be decomposed into growth from technical advance, the labour-to-capital ratio, the intermediate-goods-to-capital ratio and a mark-up:[6]

$$\begin{aligned} &\Delta Q_t - \alpha_{Nt}\Delta N_t - \alpha_{Mt}\Delta M_t - (1 - \alpha_{Nt} - \alpha_{Mt})\Delta K_t \\ &\quad = (1 - \tfrac{1}{\mu_t})(\Delta Q_t - \Delta K_t) + (\tfrac{1}{\mu_t})\theta_t, \end{aligned} \tag{4.1}$$

where ΔN_t, ΔM_t and ΔK_t are the growth rates in period t of labour input, intermediate goods inputs and capital input, respectively; ΔQ_t is the growth rate of output; α_H is the revenue share of input H; θ_t is the Solow technological residual; and μ_t is the mark-up ratio of prices to costs.

Roeger (1995) shows that if we derive the Solow technological residual in another way—namely, as the price-based residual in the firm's cost-minimisation problem rather than the volume-based residual in the firm's profit-maximisation problem—the resulting equation can be combined with equation 4.1, which eliminates θ_t and leaves an expression for the firm's mark-up ratio solely consisting of nominal, observable variables. Roeger's price-based equation is:[7]

$$\begin{aligned} &\Delta p_t^Q - \alpha_{Nt}\Delta w_t - \alpha_{Mt}\Delta m_t - (1 - \alpha_{Nt} - \alpha_{Mt})\Delta r_t \\ &\quad = (1 - \tfrac{1}{\mu_t})(\Delta p_t^Q - \Delta r_t) - (\tfrac{1}{\mu_t})\theta_t, \end{aligned} \tag{4.2}$$

where w_t is the wage rate, p_t^M is the price of intermediate goods, r_t is the user cost of capital, and

[5] Existing work using this approach to estimate mark-ups includes Oliveira Martins et al. (1996), Høj et al. (2007), Christopoulou and Vermeulen (2008) and Bottini and Molnár (2010).

[6] See Appendix C.1 for the derivation of equation 4.1.

[7] See Appendix C.2 for the derivation of equation 4.2.

p_t^Q is the price of output. Thus, combining equations 4.1 and 4.2 gives:

$$\begin{aligned}(\Delta p_t + \Delta Q_t) - \alpha_{Nt}(\Delta w_t + \Delta N_t) - \alpha_{Mt}(\Delta p_t^M + \Delta M_t) \\ -(1 - \alpha_{Nt} - \alpha_{Mt})(\Delta r_t + \Delta K_t) \\ = (1 - \tfrac{1}{\mu_t}) \left[(\Delta p_t^Q + \Delta Q_t) - (\Delta r_t + \Delta K_t)\right]. \end{aligned} \tag{4.3}$$

Equation 4.3 effectively states that after accounting for technical advance and growth in inputs, revenue growth can be attributed to either increases in the output-to-capital ratio or increases in the price mark-up ratio. That is, any divergence between observed output net of increased inputs and the output-capital ratio must be explained by changing mark-ups. By removing the need to find instruments for productivity growth, this formulation allows for relatively straightforward estimation.

Equation 4.3 can be restated as:

$$y_t = B_t z_t, \tag{4.4}$$

where

$$\begin{aligned} B_t &\equiv (1 - \tfrac{1}{\mu_t}), \\ y_t &\equiv (\Delta p_t + \Delta Q_t) - \alpha_N(\Delta w_t + \Delta N_t) - \alpha_M(\Delta p_t^M + \Delta M_t) \\ &\quad -(1 - \alpha_N - \alpha_M)(\Delta r_t + \Delta K_t), \text{ and} \\ z_t &\equiv (\Delta p_t^Q + \Delta Q_t) - (\Delta r_t + \Delta K_t). \end{aligned}$$

Under the assumption that output and inputs adjust instantaneously and the variables are measured without error, there should be no need to include an error term in equation 4.4 and the Lerner index, B_t, could be computed rather than estimated. However, a number of authors argue that measurement error is likely to arise for a number of reasons including: excess capacity and labour hoarding (Hall, 1988); errors in labour survey methodologies, statistical measurement errors in estimating value added, and errors arising from the approximation of the cost of capital caused by using (i) ex-post rather than expected real interest rates and (ii) simplifying assumptions about depreciation (Roeger, 1995); the prevalence of sunk costs and the presence of indirect taxation

(Oliveira Martins et al., 1996); the assumption of constant returns to scale (Dobrinsky et al., 2004); and the quasi-fixity of capital (Boulhol, 2008). The presence of these errors means that equation 4.4 must in practice be estimated including a measurement error term, ε_t.

To the extent that ε_t is correlated with z_t, the estimated coefficient $\hat{B}_t$—and the corresponding mark-up estimate $\hat{\mu}_t$—will be biased.[8] This implies that in the second-stage regressions, $\hat{B}_t$ will enter as a dependent variable that is observed with measurement error equal to the first-stage bias. This measurement error adds noise—meaningless variation—to the dependent variable, which does not hinder consistent estimation of the effect of bank market power in explaining firm mark-ups, but potentially biases against finding a significant result. This potentially implies that my results, where significant, are more robust than is suggested by the test statistics.

For estimation purposes, the unit of observation is the "country-sector" average, while Lerner indices and mark-ups are estimated on the higher "country-industry" level.[9] For the purposes of this chapter, country-sectors are indexed by j and country-industries by k. The annual sectoral averages $\bar{y}_{jt}$ and $\bar{z}_{jt}$ are formed by collapsing firm data in the relevant sectors.[10] In order to allow for variation in mark-ups over time, separate regressions are estimated for individual periods using data from the start and beginning of each year—that is, in t and $t-1$. The preferred estimation equation is thus:

$$\bar{y}_{jkt} = \Sigma_j \Sigma_k B_{kt}(D_k \times \bar{z}_{jkt}) + \gamma D_t + \varepsilon_{jkt}, \tag{4.5}$$

where D_k is a dummy variable that equals one if sector j is in country-industry k and zero otherwise, and each regression includes observations from the years t and $t-1$. The dummy variable D_t is a year fixed effect for the second year in the regression sample (i.e., year t). This equation is estimated using a fixed effects model and the coefficient estimates $\hat{B}_{kt}$ are saved for use in the second stage.

Two adjustments are made to the estimated mark-ups to correct for potential sources of mis-measurement. First, the nominal output data used to measure output in equation 4.5 include

[8] Christopoulou and Vermeulen (2008) derive a term for the case of measurement error arising from approximation of the cost of capital and conclude that the bias caused by this measurement error is positive.

[9] A "country-industry" is a broadly defined activity carried out within a given country—such as the manufacture of food products in France—while a "country-sector" is more narrowly defined in terms of its activity—such as the manufacture of bread products and pastries in France. Aggregated industry or country-industry mark-ups are also estimated in, among others, Haskel et al. (1995) and Oliveira Martins et al. (1996).

[10] For a description of the data, see Section 4.2.3.

indirect taxes that do not accrue to the firms in question. In order to identify the true economic mark-up as experienced by the firms in question I reduce the estimated mark-up by $\frac{1}{1+\tau}$, where τ is the average rate of indirect taxation on national nominal output, retrieved from the European Commission's AMECO database.

This is a simplification of the correction applied by Oliveira Martins et al. (1996), who reduce their estimated mark-ups based on sector-specific indirect tax rates. Due to data limitations, this cannot be applied in this case, and this suggests that the estimated mark-ups for sectors with relatively low indirect taxation will be slightly underestimated and those with high indirect taxation will be overestimated. However, value-added taxes are typically applied quite evenly across most sectors and where this is not the case, it should not affect the interpretation of the empirical results to the extent that this error is not related to the effect of bank competition on mark-ups.

Second, Oliveira Martins et al. (1996) show that in the case of non-constant returns to scale, the $\hat{B}$ index estimated using equation 4.3 is biased. To correct for this issue, I follow Dobrinsky et al. (2004) and adjust the estimated mark-up ratio using the returns to scale index, λ, estimated in Appendix C.3.

The Lerner index adjusted for these corrections, $\tilde{B}$, is thus given by:

$$\tilde{B} = 1 - \frac{\lambda(1+\tau)}{\hat{\mu}}, \tag{4.6}$$

where $\hat{\mu} = \frac{1}{1-\hat{B}}$.

4.2.2 Bank Market Power and Mark-ups

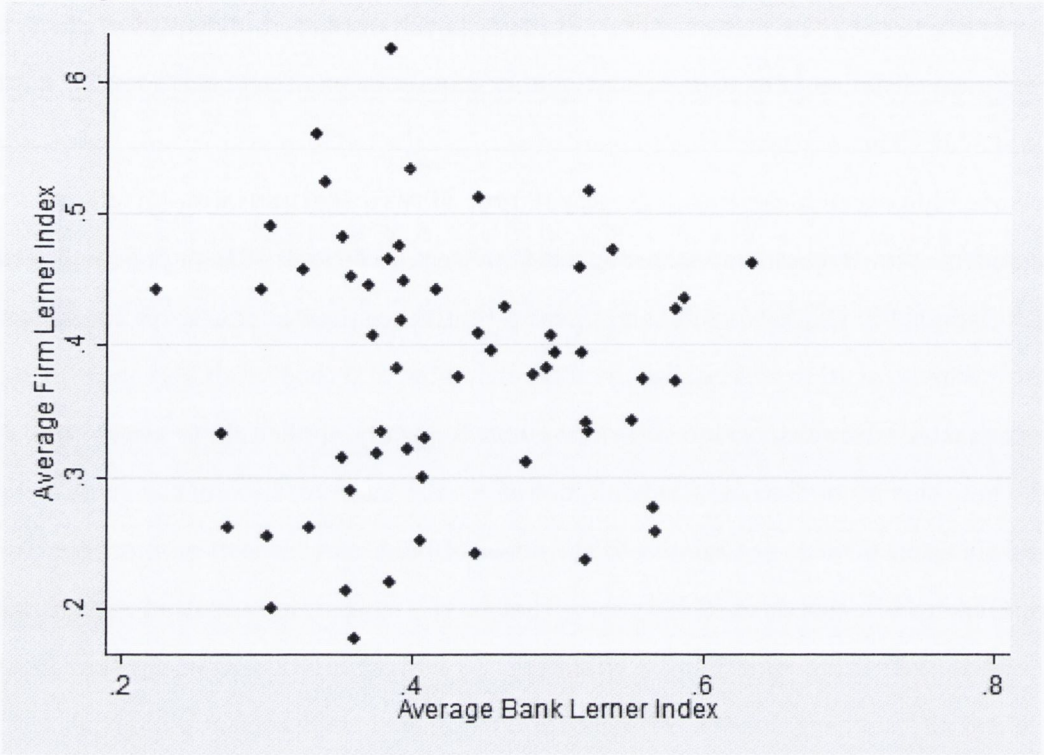
In this second stage, I test for a relationship between bank and firm Lerner indices by estimating the following second-stage regression equation:

$$\tilde{B}_{kt} = \beta_0 + \beta_1 \Pi_{lt} + \boldsymbol{\gamma} C_{lt} + \boldsymbol{\eta} G_{kt} + \upsilon_{jt}, \tag{4.7}$$

where Π_{lt} is the average Lerner index of the banking system in country l and C_{lt} and G_{kt} are vectors of country and country-industry controls. [11] The vectors C_{lt} and G_{kt} incorporate controls

[11] A similar regression equation could be estimated to explain sector-level Lerner indices $\tilde{B}_{jt}$; however, this is computationally very demanding and is left as a possibility for future research.

Figure 4.1: Scatter plot of firm and bank Lerner indices with fitted line



for a number of potentially important confounding factors. Firm leverage is included, as Chevalier (1995a) and Chevalier (1995b) provide theoretical arguments and empirical evidence that leverage increases the incentives for firms to increase prices. I control for GDP growth as evidence from Nekarda and Ramey (2013) suggests that mark-ups may be either counter- or procyclical. I also control for bank concentration (HHI of Gross Loans); total country GDP at purchasing power parity; the percentage of bank assets foreign-owned; industry-level leverage and the industy-level liquidity ratio. Year dummies are included to capture annual fixed effects. Figure 4.1 shows a scatter plot of country-year average firm and bank Lerner indices.

The ambiguity of the theoretical predictions on possible links between bank market power and product market competition suggests that there is a reasonable possibility that the relationship is non-linear. It is not clear from casual inspection of Figure 4.1 whether or not a linear relationship is the best way to capture the relationship in the data. I expand the estimation to allow for a non-linear relationship, first by including a Bank-Lerner-squared term, and secondly by including interaction terms to allow the effect of the Bank Lerner variable to differ for country-years above or below the median value of Bank Lerner.

4.2.3 Data

I collect data for 207,884 manufacturing firms over the years 2005-2009 from the Bureau van Dijk's AMADEUS database. These firms can be categorised into 2,867 four-digit NACE "country-sectors", which are in turn nested within 409 two-digit NACE "country-industries". The variables collected principally consist of those data necessary to estimate, using the Roeger method, mark-ups for the sample of industries—i.e. to populate equation 4.3.

Output is measured based on sales or operating revenue. There are three key input costs: labour, which is captured using employee costs; materials, which is captured using material costs for most countries but cost of goods sold for Denmark, Iceland, Ireland, Lithuania, Moldova, Norway, Russia and the UK; and capital, whose total cost is calculated as $r_{it}K_{it}$, where K_{it} is firm i's capital stock, measured as their stock of tangible assets (or total fixed assets where tangible assets are not recorded explicitly), and r_{it} is the user cost of capital.

The user cost of capital, r_{it}, is based on Hall and Jorgenson (1967), and is constructed as:

$$r_{it} = \rho_{lt}^{K} \left[\left(r_{\text{debt}} \frac{D_{it}}{D_{it} + E_{it}} + r_{\text{equity}} \frac{E_{it}}{D_{it} + E_{it}} \right) + \delta_{it} \right], \tag{4.8}$$

where ρ_{lt}^{K} is country l's investment price deflator (from the European Commission's AMECO database). The first two terms inside the brackets make up the required rate of return, given by the weighted average of r_{debt}, the average apparent interest rate on debt, and r_{equity}, the required return on equity. For most firms, the apparent interest rate on debt is incurred financial expenses divided by total debt (derived from AMADEUS data). For firms with missing financial expenses data, sectoral or industrial average rates are used. The equity rate is given by the long-term real interest rate (also from the AMECO database) plus a 5.3 per cent equity risk premium.[12] The depreciation rate, δ_{it}, is a firm-specific rate calculated from AMADEUS balance sheet data.

The inputs' revenue shares, α_H, are estimated using the Levinsohn and Petrin (2003) method—see Appendix C.3 for details.

The firm data are merged with measures of bank market power and market structure, derived

[12]This is the average market risk premium used by professors to calculate the "required return to equity" based on a survey by Fernandez and del Campo (2011) of 332 professors in 17 European countries.

from The Fitch IBCA Bankscope database, and other country-level data on macroeconomic, regulatory and institutional characteristics provided by various sources including the World Bank, IMF and Penn World Tables. Average Bank Lerner indices are calculated as per Appendix B.3.

Table 4.1 presents descriptive statistics. Appendix C.4 provides additional summary statistics describing cross-country average firm Lerner indices by sector.

Table 4.1: Summary statistics

Variable	Obs	Mean	Std. Dev.	P10	P90
Firm Lerner (corrected)	1427	.339	.311	-.037	.734
Bank Lerner	1427	.416	.108	.284	.549
Bank HHI (Gross Loans)	1427	.367	.267	.12	.88
Leverage ratio (0.01%)	1427	6.317	46.696	.026	3.95
Liquidity ratio (%)	1427	1.794	.879	1.091	2.683
GDP (PPP)	1427	.714	.821	.086	2.069
GDP per capita (PPP)	1427	28288.65	9614.802	16618.43	37942.93
GDP Growth (%)	1427	.998	4.588	-5.073	6.752
Foreign Bank Assets (% total)	1427	40.666	35.824	2	92

4.3 Results and Conclusion

I estimate equation 4.7 using a fixed effects model robust to heteroskedasticity and clustering by country. Table 4.2 reports the results for a number of specifications, each testing the hypothesis that firms' mark-ups are correlated with market power in their domestic banking systems during the period 2005-2009. In each regression, estimated firm Lerner indices are regressed on average bank Lerner indices for a country as well as a range of industry and firm controls. The explanatory variables are all lagged by one period in order to avoid problems of reverse causation.

The results generally support the hypothesis that firms tend to have relatively low mark-ups in country-years when banks enjoy a relatively high degree of market power. Column 1 shows the basic linear specification testing the impact of average Bank Lerner indices on industry-level Lerner indices, $\tilde{B}_{kt}$. The coefficient of interest, that of Bank Lerner, is negative and suggests that an increase of one standard deviation—around 10 percentage points—in the average Bank Lerner would result in an decrease of around 5 percentage points in the average firm Lerner index, implying an economically significant effect. This result is statistically significant at the 1 per cent level. Columns 2 and 3 show that, while controlling for non-linear aspects of the relationship

Table 4.2: Impact of Bank Market Power on Firm Lerner Indices

	(1)	(2)	(3)
Bank Lerner	−0.485***	−0.835**	−0.532***
	(0.133)	(0.327)	(0.138)
Bank Lerner squared		0.406	
		(0.281)	
High Bank Lerner			0.016
			(0.020)
Bank HHI (Gross Loans)	−0.266**	−0.268**	−0.279*
	(0.122)	(0.117)	(0.135)
Leverage ratio (0.01%)	−0.000**	−0.000**	−0.000**
	(0.000)	(0.000)	(0.000)
Liquidity ratio (%)	−0.038**	−0.039**	−0.038**
	(0.016)	(0.016)	(0.016)
GDP (PPP)	−0.227*	−0.232**	−0.215*
	(0.112)	(0.109)	(0.116)
GDP per capita (PPP)	0.000	0.000	0.000
	(0.000)	(0.000)	(0.000)
GDP Growth (%)	0.003	0.004	0.003
	(0.002)	(0.002)	(0.002)
Foreign Bank Assets (% total)	0.001	0.001	0.002
	(0.001)	(0.001)	(0.001)
Constant	0.280	0.401	0.266
	(0.407)	(0.385)	(0.408)
Year dummies	Yes	Yes	Yes
Industry-year observations	1,397	1,397	1,397
Number of countries	18	18	18

Estimates efficient for, and statistics robust to, arbitrary heteroskedasticity and clustering by country.

increases the magnitude of the linear effect, the non-linear effect is not significant.

Robustness checks

Measurement Error

In order to examine the importance of measurement error, I check whether the results hold without correcting for indirect taxation or non-constant returns to scale. Table 4.3 displays the results for regressions equivalent to those in Table 4.2 except that the dependent variable is the uncorrected B_{kt} instead of $\tilde{B}_{kt}$. The results are robust to this test.

Endogeneity

This is, to my knowledge, the first paper to identify the extent of correlation between firm and bank mark-ups, controlling for a wide range of factors. In particular, a number of steps have been taken to reduce the potential for endogeneity, for example by controlling for both year-specific effects and

Table 4.3: Impact of Bank Market Power on Firm Lerner Indices

	(1)	(2)	(3)
Bank Lerner	−0.242***	−0.763**	−0.457***
	(0.0793)	(0.3124)	(0.1563)
Bank Lerner squared		0.594	
		(0.3069)	
High Bank Lerner			−0.094
			(0.0742)
Bank HHI (Gross Loans)	−0.114	−0.117	−0.143
	(0.0866)	(0.0808)	(0.0918)
Liquidity ratio (%)	−0.027*	−0.027**	−0.027*
	(0.0129)	(0.0127)	(0.0128)
GDP (PPP)	−0.105	−0.111	−0.082
	(0.1058)	(0.0998)	(0.1053)
GDP Growth (%)	0.003	0.004	0.004
	(0.0031)	(0.0032)	(0.0031)
Foreign Bank Assets (% total)	−0.000	−0.001	−0.001
	(0.0011)	(0.0011)	(0.0012)
Bank Lerner ×High Log Bank Lerner			0.277
			(0.1915)
Constant	0.647***	0.805***	0.729***
	(0.0832)	(0.0878)	(0.0740)
Year dummies	Yes	Yes	Yes
Industry-year observations	1,397	1,397	1,397
Number of countries	18	18	18

Estimates efficient for, and statistics robust to, arbitrary heteroskedasticity and clustering by country.

unobserved country heterogeneity, and exploiting the panel dimension to reduce the potential for reverse causation. Nevertheless, the estimated relationship could be driven by common omitted country-specific effects that vary over time. For example, asymmetric changes in country-level economic institutions during the sample period may simultaneously affect bank and firm margins, giving rise to non-causal correlation. However, it is worth noting that it is not obvious what single institution is likely to simultaneously cause increased margins in the banking sector and narrower margins in the non-bank sector.

Nevertheless, I carry out an additional test to examine whether unidentified endogeneity can be ruled out. The logic of the identification test is similar to that employed in Rajan and Zingales (1998). Bank market power may exacerbate financing constraints, which in turn may increase downstream competition in the short run by encouraging predatory margin-cutting or by preventing firms from discouraging entry through the use of debt as a mechanism to credibly commit to higher output levels. If this is true, we should observe a stronger relationship between bank market power and firm margins in industries where firms are inherently dependent on bank debt, as financing

constraints are more likely to be binding. If this can be shown to be the case, the channel-based evidence may make it less likely that this relationship may be driven by some other confounding factor.

The test is implemented as follows. I first define an industry, within a given country-year, as highly leveraged if that industry's leverage is higher than the average across industries in that country-year. I then define an industry as inherently bank-dependent if, across countries and years, it falls into the above 'highly leveraged' definition more often than not.[13] Based on how often these industries are highly-leveraged, it could be concluded that they are dependent on bank debt based on their exogenous nature. I then test to see whether the relationship is stronger for these 'inherently bank-dependent' firms.

The results indicate that the null hypothesis that the relationship between bank and firm margins is the same for weakly and strongly bank dependent firms cannot be rejected. As such, it is not possible, using this test, to conclusively rule out endogeneity arising from time-varying omitted variables.

Conclusion

These results sit in opposition to the main findings from the existing evidence. A negative relationship between bank and firm Lerner indices contradicts the empirical evidence of Cetorelli and Strahan (2006) and Cetorelli (2004), who find that bank concentration (and by corollary, bank market power) is associated with greater barriers to entry.

While these results suggest a negative aggregate effect of bank market power on firm mark-ups, they do not identify the channel through which it operates. Identification of the predominant channel or channels and the heterogeneity of those channels across sectoral characteristics and regulatory regimes would be of pivotal importance from a policymaking perspective and thus is a highly valuable option for future research. Nevertheless, this first evidence on bank and firm mark-ups represents an important contribution to the existing evidence.

Moreover, the negative relationship identified in this Chapter arises when exploiting short-term variation in bank and firm mark-ups. If this is driven by an incentive to engage in predation, the long-run effect may actually be a decrease in competition between firms as financially constrained

[13]The result are the same when the latter conditions is stricter, for example, 'in more than two thirds of cases'.

Table 4.4: Impact of Bank Market Power on Firm Lerner Indices

	(1)	(2)
Bank Lerner	−0.714*	−0.529***
	(0.384)	(0.136)
Bank Lerner squared	0.252	
	(0.325)	
High Bank Lerner		0.031
		(0.029)
Bank Lerner ×High External Dependence	−0.278	
	(0.429)	
Bank Lerner squared ×High External Dependence	0.352	
	(0.456)	
Bank HHI (Gross Loans)	−0.272**	−0.265*
	(0.119)	(0.147)
Leverage ratio (0.01%)	−0.000**	−0.000*
	(0.000)	(0.000)
Liquidity ratio (%)	−0.039**	−0.038**
	(0.016)	(0.016)
GDP (PPP)	−0.232**	−0.212*
	(0.109)	(0.117)
GDP per capita (PPP)	0.000	0.000
	(0.000)	(0.000)
GDP Growth (%)	0.004	0.003
	(0.002)	(0.002)
Foreign Bank Assets (% total)	0.001	0.002
	(0.001)	(0.001)
High Bank Lerner ×High External Dependence		−0.033
		(0.041)
Constant	0.405	0.270
	(0.387)	(0.404)
Year dummies	Yes	Yes
Industry-year observations	1,397	1,397
Number of countries	18	18
Estimates efficient for, and statistics robust to, arbitrary heteroskedasticity and clustering by country.		

firms are induced to exit. The policy implications of this evidence should therefore be interpreted carefully. However, to the extent that bank market power may affect competition in downstream lending markets, competition in lending markets is a potentially important input into national price levels and, therefore, international competitiveness.

A particularly interesting avenue for future research may be the heterogeneity of this effect. In particular, sources of heterogeneity may reflect the main channels through which this aggregate effect operates or, indeed, does not operate. Moreoever, in countries where bank market power is high, an understanding of the regulatory changes that could weaken this relationship may be useful for combating inflation and maintaining competitiveness.

CHAPTER 5

Conclusions

This thesis contributes to the empirical evidence on the impact of bank competition on three distinct but interrelated economic outcomes. Using data on European firms and banks, it examines the relationships between bank market power and: risk-taking by firms; access to finance for SMEs; and downstream product market competition. The following outlines the main findings and policy implications. While each of the preceding analytical chapters highlights directions for future research, I also recount those avenues with the greatest potential value.

In Chapter 2, I show that greater competition in banking systems is associated with greater credit risk among borrowers, but that this effect becomes modest when the supervisory regime is relatively powerful. This is the first research to find evidence supporting the importance of supervision in this relationship and thus it highlights one avenue for policymakers to dampen the negative effects of competition without implementing anti-competitive policies. This finding is especially important in view of the establishment of a European System of Financial Supervisors and the European Systemic Risk Board; indeed, this may alter the cost-benefit calculation in favour of greater competition between banks. Further examination of cross-policy and cross-sectoral heterogeneity in this effect would be useful because it may further widen the array of tools available to policymakers to dampen any competition-fragility effect and thereby improve the social outcomes

for other pro-competitive bank regulation.

In Chapter 3, I, together with co-authors Conor O'Toole and Fergal McCann, provide new evidence that small and medium enterprises suffer more restrictive credit constraints when banks' market power is greater, providing support for the traditional industrial organisation prediction of reduced supply and higher prices. However, this negative effect is also found to be weaker among the smallest subset of firms, lending support to the competing hypothesis that bank market power encourages relationship lending and is, therefore, "less bad" for relatively small and opaque firms. The policy implications of this are context-dependent. In a setting where the SME sector makes up a particularly large share of employment and/or output—the German *Mittelstand*, for example—and credit access is proving to constrain that sector's investment, this evidence is more likely to tip the scales toward a pro-competitive stance in the banking sector. Conversely, in countries where access to credit is currently not considered to be an obstacle, the return on increased competition is smaller, particularly if it results in increased fragility. Again, the greatest potential to advance this research would be to examine whether this effect varies across financial systems and regulatory systems, to examine whether the financial constraints imposed by bank market power might be relaxed through policy or structural changes outside the competition arena.

In Chapter 4, I provide first evidence that market power among banks tends to be associated with greater competition in downstream product markets. The direct deadweight losses caused by bank market power through its effect on prices and quantities may therefore be ameliorated by reducing deadweight losses in the real economy.

The findings and conclusions in each of these chapters are mutually consistent. The weight of evidence in Chapters 2 and 3 is in favour of the idea that bank market power is associated with lower levels of borrower risk but greater financing constraints for small and medium enterprises. Together, these are consistent with the finding in Chapter 4 that bank market power is associated with greater competition between firms. For example, one simple explanation is that bank market power induces financing constraints, which act as an incentive to engage in short-term predatory margin-cutting, which may cause firms to exit but in the long run may result in the stability of surviving firms. This is, of course, just one potential explanation for what is undoubtedly a complex chain of interlinked causation. In fact, the final and potentially most interesting avenue for future research would be to understand, both theoretically and empirically, exactly how these

relationships interact with each other.

Ultimately, the question "is bank competition good or bad?" is difficult—if not impossible—to answer definitively. However, the new evidence presented in this thesis does contribute to a *less imperfect* understanding of the circumstances under which increases in bank competition are more (or less) likely to lead to an improvement in social welfare. Perhaps most importantly, where the goal of policy is to achieve specific goals relating to stability, credit supply, competitiveness or efficiency, this thesis provides evidence that allows policies to be tailored to the specific context to which they will be applied and thereby indeed improve overall social welfare.

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APPENDIX A

Appendices to Chapter 2

A.1 Sectoral Distribution

Table A.1: Sample firms by NACE category

	N	%
Wholesale and Retail Trade; Repair of Motor Vehicles and Motorcycles	13,969	23.8
Manufacturing	12,081	20.5
Professional, Scientific and Technical Activities	6,907	11.7
Agriculture, Forestries and Fisheries	6,287	10.7
Transportation and Storage	3,995	6.8
Accommodation and Food Service Activities	3,802	6.5
Administrative and Support Service Activities	3,563	6.1
Information and Communication	2,007	3.4
Human Health and Social Work Activities	1,858	3.2
Arts, Entertainment and Recreation	1,118	1.9
Other Service Activities	1,058	1.8
Education	683	1.2
Water Supply, Sewerage, Waste Management and Remediation Activities	656	1.1
Electricity, Gas, Steam and Air Conditioning Supply	414	0.7
Mining and Quarrying	329	0.6
Public Administration and Defence; Compulsory Social Security	46	0.1
Activities of Extra-Territorial Organisations and Bodies	27	0.0
Activities of Households as Employers; Undifferentiated Goods and Services	8	0.0
Total	58,808	100.0

A.2 Country Distribution

Table A.2: Sample firms by country

	N	%
Belgium	2,544	4.3
Croatia	2,004	3.4
Czech Republic	1,661	2.8
Denmark	2	0.0
Estonia	1,316	2.2
Finland	1,647	2.8
Germany	355	0.6
Greece	108	0.2
Hungary	8	0.0
Iceland	31	0.1
Ireland	126	0.2
Italy	8,392	14.3
Latvia	792	1.3
Lithuania	235	0.4
Luxembourg	7	0.0
Malta	5	0.0
Moldova	2	0.0
Norway	2,315	3.9
Poland	602	1.0
Portugal	1,805	3.1
Romania	5	0.0
Russia	5,542	9.4
Slovak Republic	499	0.8
Slovenia	76	0.1
Spain	22,384	38.1
Sweden	2,832	4.8
Ukraine	2,850	4.8
United Kingdom	663	1.1
Total	58,808	100.0

A.3 Main regressions excluding Spain

Table A.3: Regression Results for H-statistic, robust to clustering by country (Moulton SEs), excluding Spain

	Gearing			
Depvar: *Z1*	<11%	11-30%	30-53%	>53%
H-statistic	0.537**	-0.452	-0.920****	-0.873****
	(0.263)	(0.278)	(0.224)	(0.218)
H-statistic squared	0.0775	1.013***	1.984****	1.088****
	(0.306)	(0.327)	(0.266)	(0.267)
CR-3	1.652**	-0.710	-1.764***	-1.754**
	(0.783)	(0.780)	(0.633)	(0.706)
CR-3 squared	-1.426**	0.407	1.495***	0.944*
	(0.663)	(0.664)	(0.531)	(0.567)
GDP growth	-0.110****	-0.0301	-0.0486*	-0.0439*
	(0.0294)	(0.0327)	(0.0250)	(0.0250)
GDP per capita (PPP)	-0.0172**	-0.00369	-0.00379	-0.00583
	(0.00817)	(0.00911)	(0.00832)	(0.00835)
σ(GDP growth)	0.263****	0.118	-0.0158	-0.0624
	(0.0743)	(0.0816)	(0.0762)	(0.0724)
Inflation	-0.0273	-0.0674***	-0.0362*	-0.0310
	(0.0190)	(0.0253)	(0.0213)	(0.0249)
Eurozone	0.506****	0.177	-0.111	-0.306****
	(0.125)	(0.121)	(0.0932)	(0.0927)
log Turnover	0.0108	0.0754****	0.0686****	0.0523****
	(0.0113)	(0.0110)	(0.0104)	(0.0102)
Constant	2.595**	4.053**	4.940****	2.756**
	(1.288)	(1.796)	(0.952)	(1.232)
Sector dummies	Yes	Yes	Yes	Yes
Institutional controls	Yes	Yes	Yes	Yes
Number of observations	9797	9621	9063	7530
Number of clusters	21	21	21	21
Adjusted R-squared	.0771	.0892	.0535	.0527

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$, **** $p < 0.001$

Table A.4: Regression Results for H-statistic, robust to clustering by country (Moulton SEs), excluding Spain

	Gearing			
Depvar: *Z2*	<11%	11-30%	30-53%	>53%
H-statistic	0.346	-0.769***	-0.636**	-1.063****
	(0.290)	(0.298)	(0.278)	(0.274)
H-statistic squared	0.244	1.087***	1.287****	1.195****
	(0.335)	(0.338)	(0.330)	(0.335)
CR-3	3.845****	1.062	1.430*	-2.089**
	(0.840)	(0.808)	(0.785)	(0.888)
CR-3 squared	-3.083****	-0.799	-0.592	1.526**
	(0.722)	(0.691)	(0.658)	(0.713)
GDP growth	-0.0591*	0.0316	-0.0628**	-0.0126
	(0.0306)	(0.0328)	(0.0309)	(0.0315)
GDP per capita (PPP)	-0.0272***	-0.00868	-0.0179*	-0.0146
	(0.00856)	(0.00961)	(0.0103)	(0.0105)
σ(GDP growth)	0.00685	-0.0789	-0.133	-0.323****
	(0.0774)	(0.0885)	(0.0944)	(0.0911)
Inflation	-0.00885	-0.0597**	0.00371	-0.0245
	(0.0198)	(0.0254)	(0.0264)	(0.0314)
Eurozone	0.414***	0.0699	-0.0666	-0.305***
	(0.130)	(0.121)	(0.116)	(0.117)
log Turnover	0.0276**	0.0907****	0.0917****	0.0710****
	(0.0137)	(0.0130)	(0.0129)	(0.0129)
Constant	3.947***	6.608****	6.075****	4.617***
	(1.341)	(1.799)	(1.179)	(1.550)
Sector dummies	Yes	Yes	Yes	Yes
Institutional controls	Yes	Yes	Yes	Yes
Number of observations	9797	9621	9063	7530
Number of clusters	21	21	21	21
Adjusted R-squared	.0553	.0496	.0404	.0342

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$, **** $p < 0.001$

APPENDIX B

Appendices to Chapter 3

B.1 Sectoral Distribution

Table B.1: Firm-year observations by NACE two-digit industrial category

NACE Rev. 2 primary code	No.	%
Fabricated metal products except machinery and equipment	57,857	18.99
Food products	38,503	12.64
Machinery and equipment	25,064	8.23
Printing or reproduction of recorded media	18,643	6.12
Other non-metallic mineral products	16,927	5.56
Repair and installation of machinery and equipment	16,618	5.45
Rubber and plastic products	15,036	4.94
Wood; products of wood and cork; articles of straw and plaiting materials	14,784	4.85
Furniture	14,339	4.71
Other manufacturing	11,860	3.89
Textiles	10,462	3.43
Wearing apparel	10,260	3.37
Chemicals and chemical products	8,264	2.71
Eletrical equipment	8,029	2.64
Computer, electronic and optical products	7,304	2.40
Leather and related products	6,133	2.01
Beverages	5,095	1.67
Paper and paper products	4,272	1.40
Motor vehicles, trailers and semi-trailers	3,995	1.31
Basic metals	3,853	1.26
Electricity, gas, steam and air conditioning supply	3,606	1.18
Other transport equipment	2,275	0.75
Basic pharmaceutical products and pharmaceutical preparations	1,035	0.34
Coke and refined petroleum products	396	0.13
Tobacco products	35	0.01
Total	304,645	100.00

B.2 Q Model of Investment

A theoretical outline of the Q model of finance in the context of a standard dynamic investment model is presented in Erickson and Whited (2000) and readers are directed there for a full treatment of the model. In summary, however, the Q statistic is an estimate of the marginal benefit of an additional unit of capital to the firm, consisting of any "marginal additions to profit and reductions in installation costs" (Erickson and Whited, 2002, p. 1032). From a theoretical perspective, Q is the Lagrangian shadow price and is unobservable to the econometrician. However, obtaining a reliable proxy for unobservable Q is important as it allows us to control for the availability of profitable investment opportunities in our own investment model.

The majority of studies attempting to approximate Q use financial market data, taking the ratio of the market value of the firm to the accounting book value. However, most SMEs are privately owned and financial market data is not available.

This has a number of consequences and relies on some very strict assumptions. One important corollary is that significant measurement error arises in taking a proxy for the unobservable Q: a detailed outline of the problems relating to this is provided in Erickson and Whited (2000).

As we have noted above, these are the very firms that are potentially most constrained in terms of accessing external financing and of particular interest in this research. Gilchrist and Himmelberg (1995) outline an approach to proxy Q from firm level fundamentals where market information is unavailable or expected to be particularly noisy. They specify a first order vector autoregressive approach which uses variables of firms' performance. The vector includes firm level fundamentals which relate to the profitability of the organisation. The panel VAR is outlined as follows:

$$\mathbf{x_{it}} = \mathbf{A}\mathbf{x_{i,t-1}} + \zeta_\mathbf{i} + \phi_\mathbf{t} + \epsilon_\mathbf{it} \tag{B.1}$$

$$q_{it} = \left(\mathbf{d}'[\mathbf{I} - \tau\mathbf{B}]\right)\mathbf{x_{it}} \tag{B.2}$$

The system of equations that is governed by the panel VAR relates measures of firm level profitability to the Q model through the coefficient matrix B.[1] $\mathbf{x_{it}}$ is the vector of fundamentals.

[1] A detailed outline of the mechanisms behind this relationship are outside the scope of this paper and can be found in Gilchrist and Himmelberg (1995).

An important consideration in using this model is the selection of the appropriate variables for this vector. In line with other studies such as Benjamin and Phimister (2002) and Bierlen and Featherstone (1998) we include the marginal value product of capital (mvpk) and the sales to capital ratio. The mvpk is defined as in Gilchrist and Himmelberg (1995) as the profit to capital ratio and captures the increments to profitability of an additional unit of capital. τ is the combined discount and depreciation rate and is set by the econometrician. For this paper, we have set τ at a value of 0.8 in line with Gilchrist and Himmelberg (1995).[2] The matrix d is an identifier that highlights the coefficients on the marginal product value of capital in the project of $\mathbf{x_{it}}$ onto q_{it}.

As well as the normal error component, $\epsilon_{\mathbf{it}}$, the VAR equation has a composite error structure which includes a time specific effect, $\phi_{\mathbf{t}}$, to capture the impact of the general macroeconomic climate and business environment on firm performance, and a firm specific effect $\zeta_{\mathbf{i}}$ to capture unobserved heterogeneity. The panel VAR is estimating using the GMM methodology outlined by Holtz-Eakin et al. (1988) and used by Gilchrist and Himmelberg (1995). The resulting estimate for Q, known as fundamental Q, can be included in the standard empirical investment equation.

[2] τ is set in line with Gilchrist and Himmelberg (1995). It assumes a depreciation rate, δ, of 0.15% and a discount rate, r, of 6%. λ is calculated as $\frac{1-\delta}{1+r}$.

B.3 Lerner Estimation

The Lerner Index used to measure market power in the banking sector is defined as:

$$Lerner = \frac{P_{\text{TA}} - MC_{TA}}{P_{\text{TA}}} \tag{B.3}$$

where the price, P_{TA}, is proxied for using interest income over total assets. Our banking data are taken from Fitch IBCA for the period 2005-2009. We explicitly limit the estimates of market power to only those banks with evidence of non-zero commercial lending on their balance sheet. This is to ensure that we capture only those financial institutions that actually finance commercial firms.

We estimate marginal cost, MC_{TA}, using a translog cost function with three cost inputs: cost of capital ($P_1 = \frac{\text{interest expenses}}{\text{total deposits}}$), cost of labour inputs ($P_2 = \frac{\text{personnel expenses}}{\text{total assets}}$) and cost of physical capital ($P_3 = \frac{\text{other operating expenses}}{\text{fixed assets}}$). The translog cost function for the total cost C of producing output Y is given by:

$$\ln C = \alpha + \Sigma_i \beta_i \ln P_i + 0.5 \Sigma_i \Sigma_j \theta_{ij} \ln P_i \ln P_j + \beta_y \ln Y + 0.5 \beta_{yy} \ln Y^2 + \Sigma \theta_{iy} \ln P_i \ln Y, \tag{B.4}$$

where C is the sum of interest expenses, personnel expenses and other operating expenses, i and j index costs 1, 2 and 3 and Y is output, proxied for using total assets.

The above equation is estimated with the following constraints:

$$S_i = \beta_i + \Sigma_j \theta_{ij} \ln P_j + \theta_{ij} \ln Y; \tag{B.5}$$

$$\theta_{ij} = \theta ji; \tag{B.6}$$

$$\Sigma_i \beta_i = 1; \tag{B.7}$$

$$\Sigma_i \theta_{ij} = 0, \text{ and} \tag{B.8}$$

$$\Sigma_i \theta_{iy} = 0, \tag{B.9}$$

where S_i is the share of cost i in total costs. Equation B.5 ensures that the estimated coefficient produce the same cost shares as is observed in the data. Equations B.6, B.7, B.8 and B.9 impose symmetry and linear homogeneity. This system of equations is estimated on a panel fixed effects basis for all of the countries in our sample.

Marginal costs are then derived using the following expression:

$$MC = \frac{TC}{Y}\left(\beta_y + \beta_{yy} \ln Y + \Sigma_i \theta_{iy} \ln P_i\right). \tag{B.10}$$

APPENDIX C

Appendices to Chapter 4

C.1 Derivation of Equation 4.1

In deriving equation 4.1, Hall (1988) suggests that marginal cost, x, can be measured as:

$$x = \frac{w\Delta N + p_m \Delta M + r\Delta K}{\Delta Q - \theta Q}, \tag{C.1}$$

where ΔN, ΔM and ΔK are the changes in labour input, intermediate goods inputs and capital input, respectively; ΔQ is the change in output; w is the wage rate, p_m is the price of intermediate goods and r is the actual service cost of new capital. Thus, the numerator in equation C.1 is the value of increases in inputs[1] and the denominator is the value of the resulting increase in outputs (i.e. excluding any increase that might arise from technical advance). Hall restates this equation as a relation between the rates of growth of output and inputs, as follows:

$$\frac{\Delta Q}{Q} = \frac{wN}{xQ}\frac{\Delta N}{N} + \frac{p_m M}{xQ}\frac{\Delta M}{M} + \frac{rK}{xQ}\frac{\Delta K}{K} + \theta. \tag{C.2}$$

Imposing constant returns to scale $\left(\text{i.e. } \frac{rK}{xQ} = 1 - \frac{wN}{xQ} - \frac{p^M M}{xQ}\right)$ on equation C.2 and rearranging yields:

$$\theta = \frac{\Delta Q}{Q} - \frac{\Delta K}{K} - \frac{wN}{xQ}\left(\frac{\Delta N}{N} - \frac{\Delta K}{K}\right) - \frac{p^M M}{xQ}\left(\frac{\Delta M}{M} - \frac{\Delta K}{K}\right) \tag{C.3}$$

Finally, if mark-up μ is price over marginal cost, p^Q/x, and α_j is the revenue share of input j, this becomes:

$$\theta = \frac{\Delta Q}{Q} - \frac{\Delta K}{K} - \mu\frac{wN}{p^Q Q}\left(\frac{\Delta N}{N} - \frac{\Delta K}{K}\right) - \mu\frac{p^M M}{p^Q Q}\left(\frac{\Delta M}{M} - \frac{\Delta K}{K}\right) \tag{C.4}$$

$$\theta = \frac{\Delta Q}{Q} - \frac{\Delta K}{K} - \mu\alpha_N\left(\frac{\Delta N}{N} - \frac{\Delta K}{K}\right) - \mu\alpha_M\left(\frac{\Delta M}{M} - \frac{\Delta K}{K}\right) \tag{C.5}$$

For small changes in the main variables, they can be approximated by log-differences and, as such, applying the notation of Section 4.2.1 gives:

$$\theta_{it} = (q_{it} - k_{it}) - \mu\alpha_N(n_{it} - k_{it}) - \mu\alpha_M(m_{it} - k_{it}). \tag{C.6}$$

[1] In formulating this expression for marginal cost, Hall abstracts from changes in wages, intermediate goods prices and costs of capital by assuming that $w\Delta N$, $p_m\Delta M$ and $r\Delta K$ are good approximations of changes in the total costs of labour, intermediate goods and capital, $\Delta(wN)$, $\Delta(p_m M)$ and $\Delta(rK)$, respectively.

C.2 Derivation of Equation 4.2

Estimating equation C.6 empirically poses a number of econometric challenges. In particular, shocks to productivity, θ_{it}, are correlated with firms' input decisions—to the extent that they are observed by the firm—but are typically not observed by the econometrician. Hall (1988) corrects for this bias using an instrumental variables approach, but Roeger (1995) offers an alternative that is now popular in the empirical literature. In short, Roeger expresses the productivity in two different ways—once as the residual in the volume-based Solow model and again as the price-based residual—and eliminates the term by subtracting the two expressions from each other.

In Roeger's set-up, firms have a general cost function:

$$C(w_t, r_t, p_t^M, Q_t, \Theta_t) = \frac{G(w, r, p^M)Q_t}{\Theta^R}. \tag{C.7}$$

Marginal costs are therefore given by:

$$x_t = \frac{\partial C_t}{\partial Q_t} = \frac{G(w, r, p^M)}{\Theta_t}. \tag{C.8}$$

Taking logs and calculating the total derivative with respect to time gives:

$$\Delta x_t = \frac{\frac{\partial G}{\partial w_t} w_t \Delta w_t}{G_t} + \frac{\frac{\partial G}{\partial r_t} r_t \Delta r_t}{G_t} + \frac{\frac{\partial G}{\partial p_t^M} p_t^M \Delta p_t^M}{G_t} - \Delta\Theta_t \tag{C.9}$$

By Shepard's lemma this becomes:

$$\Delta x_t = \frac{w_t N_t \Theta_t \Delta w_t}{Q_t G_t} + \frac{p_t^M M_t \Theta_t \Delta p_t^M}{Q_t G_t} + \frac{r_t K_t \Theta_t \Delta r_t}{Q_t G_t} - \Delta\Theta_t \tag{C.10}$$

Plugging in Equation C.7 and applying constant returns to scale as in Appendix C.1, we have:

$$\Delta x_t = \frac{w_t N_t \Delta w_t}{C_t} + \left(1 - \frac{w_t N_t}{C_t} - \frac{p_t^M M_t}{C_t}\right) \Delta r_t + \frac{p_t^M M_t \Delta p_t^M}{C_t} - \Delta\Theta_t \tag{C.11}$$

The firm's objective profit function is:

$$\max_Q \left[p_t^Q Q_t - C(w_t, r_t, m_t, Q_t, \Theta_t)\right] \tag{C.12}$$

The first-order condition gives:

$$\frac{1}{\mu_t} p_t^Q = \frac{\partial C}{\partial Q_t} \tag{C.13}$$

and, where μ_t is fixed,

$$\Delta p_t^Q = \Delta x_t. \tag{C.14}$$

Cost minimisation and constant returns to scale imply that

$$\mu_t C_t = p_t^Q Q_t. \tag{C.15}$$

Thus, by Equations C.11, C.14 and C.15, we obtain Equation 4.2:

$$\begin{aligned} &\Delta p_t^Q - \alpha_{Nt}\Delta w_t - \alpha_{Mt}\Delta m_t - (1 - \alpha_{Nt} - \alpha_{Mt})\Delta r_t \\ &= (1 - \tfrac{1}{\mu_t})(\Delta p_t^Q - \Delta r_t) - (\tfrac{1}{\mu_t})\theta_t. \end{aligned}$$

C.3 Modeling of Firm Production Functions

In populating equation 4.3, it is necessary to identify the revenue shares of labour and capital, α_N and α_M. Firms' revenue functions are modeled as Cobb-Douglas:

$$p_{it}^{Q} Q_{it} = \Theta_{it} (w_{it} N_{it})^{\alpha_N} (p_{it}^{M} M_{it})^{\alpha_M} (r_{it} K_{it})^{\alpha_K} \tag{C.16}$$

where, for firm i in year t, Y_{it} is output and Θ_{it} is total factor productivity. There are three inputs: N_{it} is labour, M_{it} is intermediate inputs and K_{it} is capital. The inclusion of output prices p_{it}^{Q}, wages w_{it}, intermediate goods prices p_{it}^{M} and the user cost of capital r_{it} reflects that both input and output are expressed in nominal terms.[2] The function is homogeneous of degree $\lambda = \alpha_N + \alpha_M + \alpha_K$, where α_j is the revenue share of input j. This equation can be restated as:

$$\theta_{it} = q_{it}^{n} - \alpha_N n_{it}^{n} - \alpha_M m_{it}^{n} - \alpha_K k_{it}^{n}, \tag{C.17}$$

where the lower-case variables θ_{it}, q_{it}, n_{it}, m_{it} and k_{it} are the log-differenced equivalents of their upper-case counterparts and the superscript n indicates that the variable is expressed in nominal terms.

The (revenue) shares of each input are assumed to be constant, in line with evidence in Gollin (2002). Estimation proceeds using the Levinsohn and Petrin (2003) method. For an accessible guide on how to implement their proxy approach, see Petrin et al. (2004).

[2]Nominal data are common in the literature on estimating production functions and factor shares—Zuleta (2008) and the references cited therein, for example.

C.4 Summary Statistics

Table C.1: Average Firm Lerners by Sector

Sector	Mean Average Firm Lerner
Food products	0.53
Beverages	0.40
Tobacco products	0.67
Textiles	0.22
Wearing apparel	0.31
Leather and related products	0.20
Wood and cork products	0.39
Paper products	0.34
Printing and reproduction	0.21
Coke and petroleum products	0.61
Chemical products	0.44
Pharmaceutical products	0.31
Rubber and plastic products	0.35
Non-metallic mineral products	0.32
Basic metals	0.36
Fabricated metal products	0.30
Computer, electronic and optical products	0.23
Electrical equipment	0.36
Machinery and equipment	0.33
Motor vehicles	0.32
Other transport equipment	0.25
Furniture	0.40
Other manufacturing	0.36
Repair and installation	0.14
Electricity, gas, steam, etc.	0.54
Water supply	0.05
Total	0.34