Of Firms and (Wo)men

Explorative Essays on the Economics of Firm, Gender and Welfare

Inaugural-Dissertation
zur Erlangung des Grades
Doctor oeconomiae publicae (Dr. oec. publ.)
an der Ludwig-Maximilians-Universität München

2011

vorgelegt von

Ines Pelger

Referentin:	Prof. Dr. Monika Schnitzer
Koreferent:	Prof. Alexander Danzer, Ph.D.
Promotionsabschlussberatung:	16. Mai 2012

Datum der mündlichen Prüfung: 30. April 2012

Namen der Berichterstatter: Monika Schnitzer, Alexander Danzer, Joachim Winter

Danksagung

An dieser Stelle möchte ich mich ganz herzlich bei allen bedanken, die zum Gelingen dieser Arbeit beigetragen haben.

Mein größter Dank gilt meiner Betreuerin Prof. Dr. Monika Schnitzer für ihre Unterstützung und Ermutigung in den letzten fünf Jahren. Prof. Alexander Danzer hat die Zweitbetreuung meiner Dissertation übernommen, seine Ratschläge waren ebenfalls besonders hilfreich und wertvoll. Prof. Dr. Joachim Winter danke ich für seine Bereitschaft, sich als Beisitzer für die mündliche Prüfung zur Verfügung zu stellen.

Von Prof. Dr. Claudia Buch, Prof. Dr. Jörg Baten und Prof. Dr. Harald Strotmann habe ich während meines Studiums an der Universität Tübingen und teilweise auch darüber hinaus sehr viel Unterstützung erfahren.

Das historische Staatsarchiv in Rio de Janeiro, der Deutsche Industrie- und Handelskammertag (DIHK) und die KfW Bankengruppe haben freundlicherweise Daten für diese Arbeit zur Verfügung gestellt. Ich bedanke mich bei allen Mitarbeiterinnen und Mitarbeitern der Volkswirtschaftlichen Abteilung der KfW Bankengruppe für die nette Gastfreundschaft. Insbesondere Dr. Margarita Tchouvakhina danke ich sehr für unsere gute Zusammenarbeit und für viele inspirierende Gespräche. Auch Dr. Frank Reize bin ich zu besonderem Dank verpflichtet. Während meiner Forschungsaufenthalte stand er mir bei der Datenanalyse stets mit viel Geduld und sachkundigem Rat zur Seite.

Dr. Silke Englmaier vom Department für Volkswirtschaftslehre verdanke ich sehr viele Freiräume und großzügigen Rückhalt in jeglicher Hinsicht.

Die Affiliated Professors der Volkswirtschaftlichen Fakultät Michèle Tertilt, Matthias Doepke, Monika Piazzesi, Martin Schneider, Theo Eicher sowie Dirk Jenter haben mit sehr hilfreichen Kommentaren zu den letzten beiden Kapiteln der Arbeit beigetragen. Till von Wachter danke ich darüber hinaus auch für die Einladung zu einem Gastaufenthalt an die Columbia University.

Schließlich danke ich allen meinen Kolleginnen und Kollegen für ihre Unterstützung und die gemeinsam verbrachte Zeit.

Contents

Preface

This dissertation is comprised of four self-contained chapters that contribute to research in Latin American anthropometric history, international economics and gender economics. Each chapter can be read independently of the other chapters. Still, the contributions can be embraced under the theme 'Of firms and (wo)men', since German firms, female firm owners and Latin American men are in the focus of the analysis.

One of the main contributions of this dissertation is the acquisition and exploration of three new micro data sets, that have not or not extensively been scientifically examined before. For the empirical analysis of the first chapter, I gained access to historical records of convicts from a prison in Rio de Janeiro. The second chapter is based on a cross-section firm survey of the German Chambers of Industry and Commerce (DIHK) that is not publicly accessible. In Chapter 3 and 4 I work with German firm-level panel data of the KfW Bankengruppe. This data set serves as an empirical basis for in-house policy reports and publication series of the KfW Bankengruppe that are addressed to the public. Access to the data is very restricted and is approved only for research on specific topics that are of interest to the institution.

The first chapter of this dissertation examines the anthropometric history of three Latin American countries during the 19th and early 20th century. More precisely, the study investigates the development of average body heights in Argentina, Brazil and Peru and relates them to GDP estimates for the respective time period. The analysis for Argentina is based on military data, whereas for Brazil and Peru we use prisoner's data from Rio de Janeiro and Lima, respectively.

In modern economic history, anthropometric studies are conducted to quantitatively explore the long-term evolution of the biological standard of living. It is not only in historical contexts that biological measures of the standard of living are considered an important alternative or complement to more conventional measures like GDP per capita. GDP as the traditional indicator of welfare and economic progress has its limits in describing a populations economic well-being. The biological components of physique are useful indicators for socio-economic welfare as they correlate with health

and life expectancy. Furthermore, there is evidence that a taller physical stature is related to higher social status, income and education. The average stature of a population mirrors the average quality of nutrition, the availability of medical care, the epidemiological environment and also to some extent a nation's income distribution (Steckel 1995). While individual physical stature is of course determined by genetic as well as environmental factors, genetic factors are negligible when studying averages at a population level. We are the first to provide comparative evidence on the welfare development of three Latin American countries that experienced dramatic economic and political changes in the 18th and 19th century. Furthermore, we assess regional and social differences for every country under study. We contribute the first anthropometric evidence for Peru in the 19th century. We add to the results of Frank (2006) on Brazil by performing a more elaborate analysis with a larger and more detailed data set. Regarding Argentina, we broaden the existing knowledge on Southern Argentinean provinces whose anthropometric history has not been examined before.

We relate our findings on biological welfare trends to the development of historical GDP estimates from Maddison (2001). Argentinean GDP grew substantially during the period 1870-1913 and by the beginning of the 20th century Argentina was one of the richest countries in the world. Argentinean men were tall to begin with, but heights stagnated until 1910 and welfare as measured by average height did not grow proportionally to GDP. The only exception were farmers and landowners, who benefited from the Argentinean export boom. Brazil and Peru experienced only modest GDP growth during the observed time period compared to Argentinean standards. GDP growth rates were somewhat higher in Peru than in Brazil while both countries started at relatively low height levels. In Brazil, biological progress in height trends did not significantly increase until the 1860s. Then, Brazil made substantial progress during the 'coffee boom' from the 1860s to the 1880s. In contrast, Peru did not catch up. According to GDP estimates we would have expected greater height development in Peru. Our results highlight the importance of biological indicators as complementary welfare measures to GDP, particularly for historical contexts where GDP estimates are imprecise.

The object of investigation in Chapter 2 are German small and medium sized enterprises (SMEs) and their international activities. The importance of SMEs as growth and job-creation engines has often been highlighted (EU Commission 2009). Yet, there is still little empirical knowledge on increasing international activity of SMEs, the related employment changes and the differences in motivation as compared to large firms. The second chapter fills this gap by contributing to a better understanding of how SMEs differ from large firms regarding their motivation for foreign direct investment

(FDI) and the related employment changes. Furthermore, it examines for all firms whether jobs at home and abroad are complements or substitutes.

The empirical analysis is based on a firm-level survey from the German chambers of industry and commerce (DIHK) that was conducted in 2005 and includes only firms that are internationally active. First descriptive evidence shows that exporting is the most important international activity for large firms as well as for SMEs. FDI in contrast is still an activity where large firms are on average more active than SMEs. Regarding the motivation for FDI, the data suggests that there are only small differences between SMEs and large firms. For all firms horizontal motivations are more important than vertical motivations. The proximity to customers matters more for large firms while SMEs give on average more weight to less bureaucracy, personal reasons and better availability of employees.

The core of the analysis is the estimation of a bivariate ordered probit model of employment changes in the home country and in the host country after FDI for all firms. A bivariate approach accounts for the interdependence between employment changes at home and abroad, as the two processes are correlated either directly or through unobserved effects. The two estimated variants, a simultaneous and a seemingly unrelated model, yield nearly identical parameter estimates and standard errors. The changes in employment after FDI at home and abroad are mainly explained by size, host region and motivation for the investment. The results reveal that the relationship between employment changes at home and abroad is positive, suggesting that these are complements rather than substitutes. SMEs show a higher probability of increasing employment in the home country after engaging in FDI compared to large firms. Firms with higher sales volumes have more positive job changes at home while firms with more than 200 employees are more likely to shed jobs.

Our findings suggest that horizontal motivation results in job gains while vertical motivation has no significant impact on job changes. Relocation of production however leads to a higher probability of decreasing work force in the home country compared to firms that do not relocate their production. Additional evidence on the host region of FDI reveals that FDI to a distant region like USA/Canada with similar factor endowment leads to job gains at home while FDI to close and similar regions like Western Europe does not have a significant effect. Investments in Eastern Europe, a close region with lower labor costs, significantly lower the probability of positive employment changes in the home country.

Chapter 3 and 4 provide the first evidence on gender differences in investment behavior, investment financing, credit application and credit denial rates in Germany.

The two contributions add to a better understanding of gender differences in entrepreneurship and firm size by analyzing how and why female firm owners make systematically different investment and financing decisions. The empirical analysis is carried out on a sample of firms drawn from the KfW Mittelstandspanel, a representative survey of German SMEs for the period from 2003 to 2009.

Previous research on gender differences in entrepreneurship has mainly concentrated on firms at the start-up stage. There is little evidence on gender differences between firm owners of established firms. Yet, there are significant differences in the characteristics of female and male-owned firms. Female-owned firms are on average smaller and have lower growth rates. They are over-proportionally represented in the service sector and underrepresented in construction and manufacturing (Allen et al. 2007). The smaller size of firms owned by women is still a puzzle that cannot entirely be explained by differences in other firm and owner characteristics. However, gender differences in firm size might depend to a large extent on differences in firm investment and other entrepreneurial decisions.

The results indicate that gender differences in investment and financing are not based on gender discrimination but rather on differences in preferences, which in turn may be based on cultural norms. In Germany, the incidence of female part-time employment and the gender wage gap are higher than the OECD average. The tax-system benefits single-earner families more than dual-earner couples and incentivizes the lowest income-earner, often the women, not to work or not to work more than part time (OECD 2011). Furthermore, particularly in West Germany, childcare facilities are scarce and often do not allow for full-time employment of both parents. It is well known that these circumstances have a considerable impact on women's labor market participation. They may also affect gender specific entrepreneurship behavior and female owner's lower growth aspirations.

Chapter 3 focuses on gender differences in investment activity. An analysis of the extensive margin of investment, i.e. the investment decision, reveals that female-owned firms are less likely to invest. For the intensive margin there is evidence that if female-owned firms invest, their average investment rate is lower than for male-owned firms. Furthermore, female investment is less sensitive to cash flow, which indicates that it is unlikely that lower investment by women is driven by difficulties in acquiring external finance. Previous studies have found that women are on average more risk-averse, less overconfident and have different entrepreneurial objectives. These differences may be reflected in investment behavior, too. An analysis of stated investment goals reveals that women indicate to a lesser extent aspiring and growth-orientated investment goals like sales increases, innovation/R&D or implementation of new products.

The central theme of Chapter 4 is the analysis of gender differences in investment financing, credit application and credit denial rates. Access to finance is a main concern for entrepreneurs. Although the findings in Chapter 3 suggest that the investment gap is driven by preferences rather than financial constraints, women may face higher barriers to accessing finance due to firm or personal characteristics. It is therefore relevant to examine whether there are gender differences regarding financing patterns and access to credit. The data suggests that female-owned firms differ as the share of internal capital in investment financing is higher and the share of external funds is lower than for male-owned firms. An analysis of the credit application process of investing firms shows that differences in investment financing cannot be explained by discrimination on the credit market. Women are not more likely to be denied credit. Yet, the probability that they apply for credit is on average lower. Discrimination on the credit market could therefore be underestimated as the female-owned firms that apply for credit are very likely to be a positive selection of all applying firms. A further analysis shows that the gender difference in the probability of credit application is only evident when considering firms with negative or neutral sales expectations. There is no significant gender difference in credit application rates of firms with positive sales expectations. Previous research suggests that there are not only gender differences in risk aversion and overconfidence but also women report more intense nervousness and fear than men in anticipation of negative outcomes (Croson and Gneezy 2009). Possibly, women act in a more risk-averse way only when negative outcomes are expected. This could explain why the application rates differ only in the case of non-positive sales expectations. Nevertheless, whether women's more cautious or men's more risky investment and application behavior generates better business outcomes remains a question to be answered by future research.

In all chapters I use econometric methods to capture aspects of economic phenomena in anthropometrics, international economics and gender economics. The approaches are not based on fully-specified theoretical models as these are not available for the questions under study. Hence, I employ an exploratory and inductive, rather than a structural approach, without claiming identification of causal impacts. The search for an adequate econometric specification without strong theoretical foundations has its drawbacks. The main problem may be that by working in a way which is not theory-driven the data assume a certain double-duty, as they are used to formulate hypotheses for which they provide also empirical evidence (Spanos 2000). Yet, a data-driven approach is able to discover economic puzzles that ask for a theoretical explanation. Besides, the application of a strict theory-first approach can be criticized as well. Juselius (2011, p. 426) states that 'statistics is often (ab)used as a tool to

procure certain theoretically meaningful estimates irrespective of their statistical meaning. By following strict theoretical rules and principles, one is less open to signals in the data and runs the risk of producing empirically irrelevant and misleading results'. Both approaches are complementary and have their justifications and relative merits. However, it is often the observation of economic reality in a data-driven approach that discovers economic puzzles and inspires the development of economic theories. Following such a data driven approach, the results presented in this dissertation might contribute to the development of new economic theories that offer explanations for the observed phenomena.

References

Allen, E., Langowitz, N. and M. Minniti (2007). Global entrepreneurship monitor, 2006 report on women and entrepreneurship, The Center for Women's Entrepreneurship at Babson College and London Business School.

Croson, R. and U. Gneezy (2009). Gender differences in preferences, *Journal of Economic Literature* 47(2), 448-474.

European Commission (2009). European SMEs under pressure, annual report on EU small and medium-sized enterprises. EIM Business & Policy Research, Netherlands.

Frank, Z. (2006). Stature in nineteenth-century Rio de Janeiro: Preliminary evidence from prison records. *Revista de Historia Económica: Journal of Iberian and Latin American History* 24(3), 465-490.

Juselius, K. (2011). Time to reject the privileging of economic theory over empirical evidence? A reply to Lawson, *Cambridge Journal of Economics* 35(2), 423-436.

Maddison, A. (2001). *The World Economy: A Millennial Perspective*. OECD, Paris.

Spanos, A. (2000). Revisiting data mining: 'hunting' with or without a license. *Journal of Economic Methodology* 7(2), 231-264.

Steckel, R. (1995). Stature and the standard of living, *Journal of Economic Literature* 33(4), 1903-1940.

OECD (2011). Report on the Gender Initiative: Gender Equality in Education, Employment and Entrepreneurship. Meeting of the OECD Council at Ministerial Level, 25-26 May. Paris.

Chapter 1

The anthropometric history of Argentina, Brazil and Peru during the 19th and early 20th century*

1.1 Introduction

Anthropometric evidence can shed light on historical trends in living standards. The analysis of average heights offers insights on welfare and development, as differences in stature have often been found to correlate with differences in health, physical robustness and life expectancy (Komlos 1985, Steckel 1995, Fogel 1993). While 60-80% of individual height variation is attributable to genetics, differences in average height between populations are determined by environmental factors (Steckel 1995). The quality of nutrition during pregnancy and in the first three years of living as well as health care are related to stature. The crucial components of nutrition are proteins, contained mainly in dairy products and meat. There is also evidence that an increase in physique correlates with increases in cognitive abilities, educational attainment and higher wages (Cinnirella et al. 2011, Persico et al. 2004, Case and Paxson 2008). Finally, as Arora (2001) argued, height trends correlate positively with GDP growth and negatively with the degree of income inequality. An increasing monetary living standard of a population improves the biological living standard as it facilitates the access to high-quality food. As a result the average height of a population increases.

The purpose of our study is to estimate height trends for Argentina, Brazil and Peru and to compare them with GDP estimates, a conventional measure of welfare. Furthermore, we assess regional and social differences in height for each country. Of

*This chapter is joint work with Jörg Baten and Linda Twrdek from University of Tübingen and has been published in 2009 in *Economics and Human Biology*, 7(3).

Table 1.1: GDP per capita in selected Latin American economies

year	1820	1850	1870	1890	1900	1910	1913	2001
Argentina			1,311	2,152	2,756	3,822	3,797	8,137
Brazil	646	686	713	794	678	769	811	5,570
Peru					817	975	1,037	3,630
Total Latin America	692		681		1,109		1,481	5,811

Notes: GDP per capita in 1990 Int. $ (Geary-Khamis Dollar). Source: Maddison (2001)

course, height and GDP per capita do not measure the same components of welfare. Also, there are conceptual differences between height and GDP measurement of living standards. GDP is much more sensitive to urbanization and industrialization, whereas height reflects the quality of nutrition and medical care (Steckel and Floud 1997, Komlos and Baten 1998). We gain new insights by studying the extent to which our estimates of height trends correspond to historical GDP levels and to long-term welfare growth.

Maddison (2001) estimates historical GDP trends for Latin American countries (Table 1.1).[1] Yet, the economies and populations of the three countries under study present distinctly different GDP trends. Argentina's GDP grew substantially during the period 1870 to 1913. GDP rose from $1300 to $3800 (in 1990 Geary-Khamis-$), and real wages reached European levels (Williamson 1995).[2] By the end of the 19th century Argentina was one of the richest countries in the world. For Brazil, Maddison (2001) assumes that the growth rate of GDP per capita from 1820 to 1850 was similar to the period from 1850 to 1913, for which the first data-based estimates were published by Goldsmith (1986). Brazil's economy grew little between the 1820s and 1910s, certainly modestly by European or by Argentinean standards (Maddison 2001).[3] For Peru, Maddison (2001) assumes that during the decade before 1913, Peru's development matched the average growth rate of Brazil and Chile. An additional estimate by Seminario and Beltrán (1998) suggests a modest upward trend from 1896-1913, but does not cover the period which came before it.

[1] We should mention though that there are general doubts about the strategy with which to estimate GDP based on backward interpolation, see Fukao et al. (2007).

[2] There are other GDP estimates for Argentina by Cortés Conde and Harriague (1994) and della Paolera and Taylor (2003).

[3] see also Goldsmith (1986) for the post-1850 period.

Our hypothesis to be tested is that anthropometric trends are similar to GDP trends. The GDP estimates in Table 1.1 imply that:

1. Argentina experienced rapid economic growth during the export boom of 1870 to 1913, which should have resulted in some height increase.
2. Brazil experienced very modest improvements in living standards during the 19th century.
3. Peru had a modestly higher standard of living than Brazil.

We use new anthropometric evidence for all three countries. By contributing data on the 1820s to 1880s for Peru, we fill an important gap in Latin American anthropometric history.[4] Table 1.2 provides descriptive evidence for the data under study.

Table 1.2: Average heights in cm by country and birth decade

	Argentina			Brazil			Lima (Peru)		
year	N= 6,953	av. height	st. dev.	N= 6,771	av. height	st. dev.	N= 1,139	av. height	st. dev.
1810				75	164.3	(6.58)			
1820				323	164.3	(7.38)	65	162.8	(7.15)
1830				705	164.8	(7.3)	205	165	(8.47)
1840				1265	164.6	(7.04)	317	162.2	(8.08)
1850				1604	164.5	(6.85)	146	164.5	(7.13)
1860				1740	165	(6.71)	78	164.3	(6.16)
1870	668	167.6	(6.49)	887	166.5	(6.77)	158	163.5	(6.68)
1880	1475	167.6	(6.39)	172	166.1	(6.53)	170	164	(6.85)
1890	1842	167.8	(6.28)						
1900	2066	167.9	(6.58)						
1910	902	167.8	(6.6)						

Our results confirm previous findings that heights in Argentina did not increase during the 1870-1913 period (Salvatore 2004a, 2004b, 2007). We therefore reject the first hypothesis, as the only significant benefit was to Argentinean farmers. In Brazil, biological progress as measured by height trends stagnated between the 1810s and the 1860s. However, we can confirm and extend the second hypothesis, as Brazilian heights in our urban sample increased substantially between the 1860s and 1880s. We find that heights in Lima, Peru, remained at a modest level. Brazilian anthropometric

[4]Previous studies consider only Mexico, Argentina, Brazil, and Colombia (Lopez-Alonso and Condey 2003, Carson 2005, Meisel and Vega 2007, Frank 2006, Salvatore 1998, 2004a, 2004b, 2007, Salvatore and Baten 1998, Bogin and Keep 1999).

indicators show higher values than those of the inhabitants of Lima. We therefore reject the third hypothesis, that the quality of life in Peru was higher than that of Brazil. Hence, only for Brazil the GDP estimates correspond to our results on the biological improvements in living standard.

We focus separately on each of the three countries, beginning with Argentina, followed by Brazil and Peru. We describe each country's social and economic history, its main export goods, and food supply and discuss the new anthropometric evidence.

1.2 Argentina

1.2.1 Social and economic history of Argentina

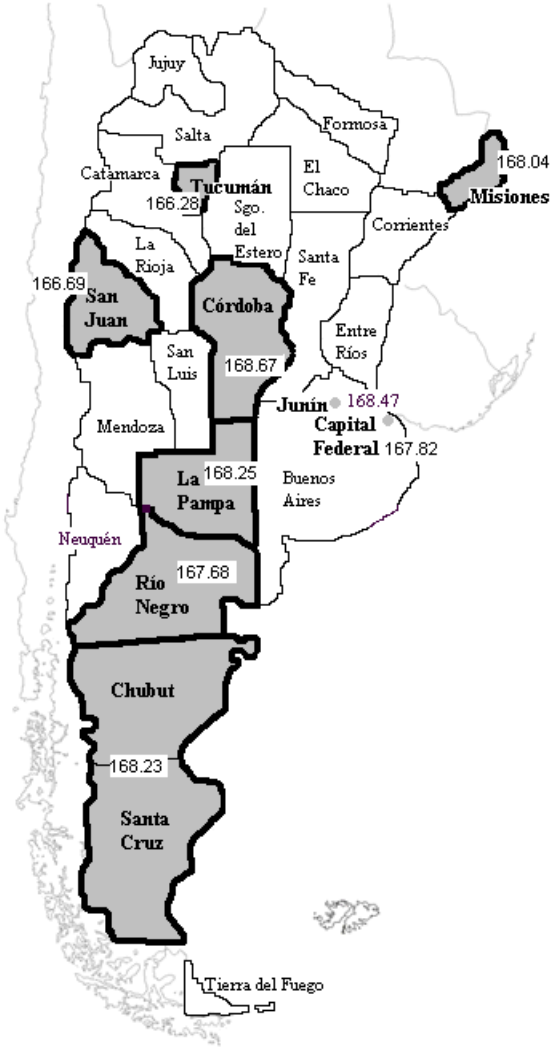
Between 1870 and 1913, Argentina became a major player in the world economy. Its 56 million hectares of pampa plains, ideally suited for temperate-zone agriculture and for raising livestock production, but sparsely populated in the mid-19th century, became a magnet for European immigrants and capital (Ferrer 1967). Argentina's society changed considerably during the 19th century as its population became increasingly dominated by recent European arrivals. They arrived in great numbers in the second half of the century, driven by a desire to escape poor living conditions in Europe and attracted by this vast territory. By 1914, the Argentinean census reported that one-third of the population was composed of people that were not born in the country (República Argentina 1916).

Many economists have supported Douglass North's theory that exports increase a nation's productivity, especially in the New World, if world markets demand at least one of its export staples (North 1966). The availability of export staples in turn could have a positive impact on other sectors of the economy, raising the population's standard of living. Argentina had become well-integrated into the world market by 1913 and gained large export revenues. It became well-known for producing export surpluses, mainly in beef and wheat. During the first decade of the 20th century, Argentina's growing export economy (Diaz Alejandro 1970) provided its citizens with one of the highest per-capita incomes in the world. This period is considered the 'Golden Age' in Argentinean economic history. However, as Salvatore (2007) argued, export-led growth raises the general standard of living only if export revenues also benefit lower-income groups. Whether this actually took place is an empirical question, which Salvatore (2007) answered negatively.

1.2.2 New anthropometric evidence on Argentina

To learn more about the military potential of its male population, Argentinean authorities measured all men in 1927, recording their heights and other physical data. The study registered both native-born and naturalized men born between 1820 and 1915. For our study, we consider a random sample between ages 17 and 52 (birth cohorts of 1875 to 1910). Our sample of 6,953 observations was drawn from a randomly chosen series of registration books preserved in a general register in the military-history archives in Buenos Aires.[5]

Figure 1.1: Spatial distribution of heights in Argentina



Notes: Only the grey-shaded provinces plus the cities of Buenos Aires and Junín are included in the sample. Their mean heights in cm are reported in the white boxes.

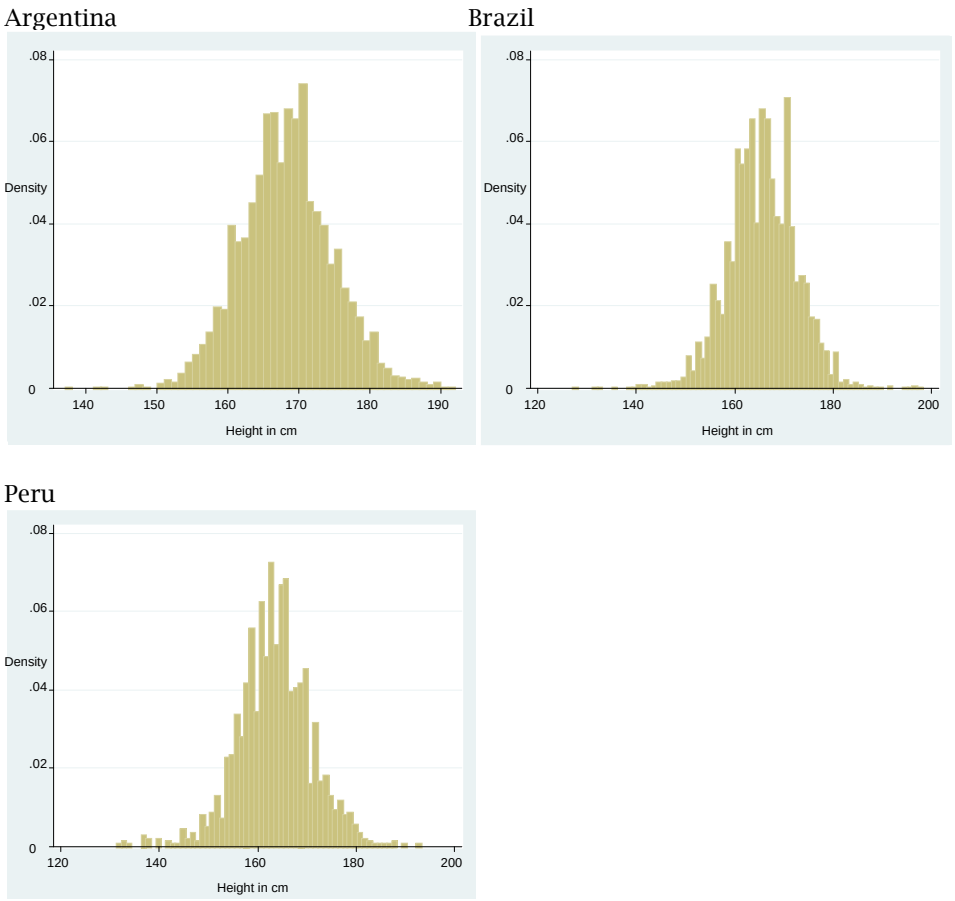
[5]Servicio Histórico del Ejército, Archivo General del Ejército, Calle Defensa (entre C. Mexico y Chile), Capital Federal, Argentina.

We take a convenience sample from the following provinces and cities: Misiones, Tucumán, San Juan, Córdoba, La Pampa, Buenos Aires city, Junín city, Río Negro, and Chubut/Santa Cruz. Figure 1.1 indicates global height averages by province. Average height values in the Argentinean provinces were quite similar, except for the Northwest, especially in Tucumán and to a lesser extent in San Juan, where the male population was shorter. Moreover, those in Río Negro and the city district of Buenos Aires were slightly shorter than those in the other six provinces. We include Southern provinces in the sample that have not been studied before.

1.2.3 How representative is our Argentinean data?

Military data often suffer from truncation problems, as armed forces usually require a minimum body height for admission. Our data for Argentina benefit from the fact that the entire male population was recorded in the data source. Figure 1.2 shows that our data is virtually normally distributed for every country under study.

Figure 1.2: Distribution of heights in our samples for Argentina, Brazil, and Lima



Because the Argentinean military census did not record the country of birth, our study includes immigrants as well as native born Argentineans. Previous studies exclude immigrants since the focus is mainly on estimating the determinants of heights within Argentina (Salvatore 1998, 2004a, 2004b, 2007). But, as we compare our results to GDP estimates, we are interested in long-term trends in heights for the entire Argentinean population, as is done in GDP estimation where the contributions of migrants that permanently reside in a country are included.

1.2.4 Armstrong's classification of occupational groups

We used the Armstrong (1972) scheme of occupations to get a clearer understanding of the social structure of Argentinean society. It was developed for 19th century censuses, and was designed to capture the skill level and social status level of different occupations during that period. Clearly, some occupations can span several social strata. However, this classification scheme has proved useful for a large number of applications. In anthropometric history, it has been employed in a number of studies (e.g., Johnson and Nicholas 1995).

Accordingly, we classify our observations into six categories that capture occupational status. The first group consists of unskilled workers, including domestic servants and similar low status occupations. The second group includes semiskilled occupations, such as house painters, which do not feature the lengthy craftsmen-type extended sort of apprenticeship required for skilled crafts. The third group consists mainly of skilled craftsmen and other workers with higher craft levels and responsibilities, e.g. shop assistants. The fourth category consists of semiprofessionals, such as clerks and telegraphers, whose occupations clearly require a somewhat greater skill level, but not as much as the fifth category, that of the professionals. The typical member of the latter group has usually attended high school and in some cases also university (e.g., lawyers and physicians), or has attained success as an entrepreneur, thus acquiring considerable social status. We code the farmers as a separate group since they might have benefited from direct access to land ownership and food production (Komlos 1987). Most of our Argentinean sample consists of farmers, unskilled and semiskilled workers (around 74%). As one might expect, a higher share of skilled persons are found in Buenos Aires than in the rest of the country.

1.2.5 Regression results

We estimate two regressions for Argentina (Table 1.3). In regression (1) we include the whole sample, in regression (2) only farmers. The results in regression (1) show that average heights remained nearly constant during the 19th century. The insignificant time coefficients indicate that the increase compared to the 1870s constant was close to zero.

Table 1.3: Determinants of heights in Argentina

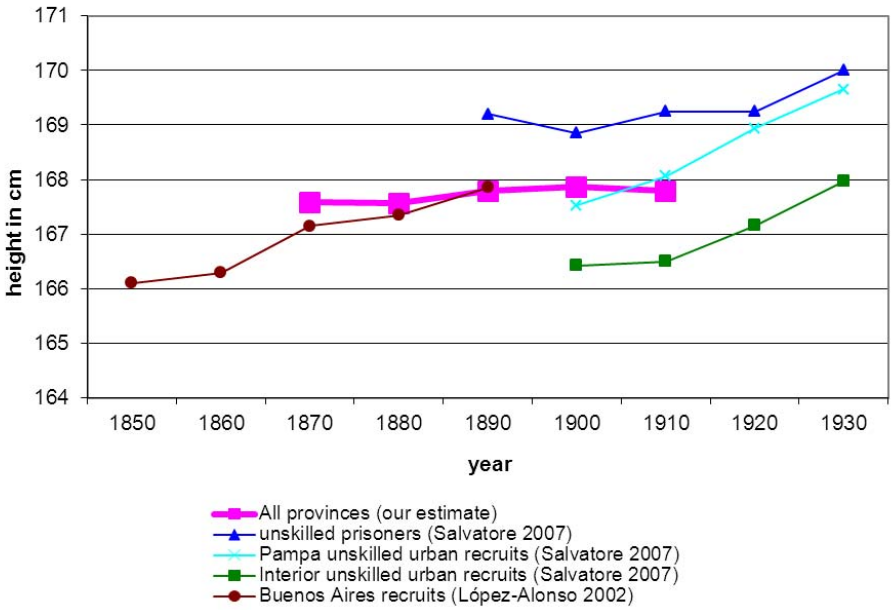
	(1) Argentina full sample	(2) Argentina farmers only
1870	ref. cat.	ref. cat.
1880	-0.00	0.94
1890	0.25	1.13*
1900	0.40	1.04
1910	0.30	
Unskilled	ref.cat.	
Semiskilled	1.64***	
Skilled	0.59**	
Semiprofessional	1.58***	
Professional	2.88***	
Farmer	2.04***	
Constant	166.42***	168.02***
Observations	6951	1356
R-squared	0.03	0.00

Notes: We estimate an OLS regression with robust standard errors. Dependent variable: body height in cm. *,**,*** refer to significance levels of 10,5, and 1%. The constant in model (1) refers to an unskilled male, born in the 1870s; model (2) refers to farmers only, and excludes the 1910s.

The absent growth of average heights confirms in the main Salvatore's findings (Salvatore 2007). In Figure 1.3, we compare our own height trends with the trends of Salvatore (2007) and López-Alonso (2002). Earlier historians, states Salvatore, who described this period as the 'Golden Age' of Argentina, did not take into account the fact that the standard of living of lower-income groups did not improve during the country's so-called Golden Age, and that heights in fact stagnated.

Our results also confirm height gaps between occupational groups. The difference between unskilled and semiskilled persons was relatively large in Argentina. Farmers

Figure 1.3: Comparison of various height estimates for Argentina



were 2.04 cm taller than the unskilled group in the 1870s (regression (1)), and professionals were even by 2.88 cm taller. We find that farmers' heights did not only start at a higher level, they also benefited from the export boom more than unskilled workers. From the initial height gap during the 1870s between farmers and unskilled people, the height difference between these two groups increased by almost one centimeter in height until the 1890s, which is statistically significant (regression (2). At the same time the heights of unskilled workers stagnated.

Argentina, and especially its Pampas region, was successfully integrated into the world market thanks to the international trade in beef and grain, and to the influx of immigrants (Salvatore 2007). At the same time its population suffered from marked social inequality. Salvatore (2004a, 2004b) argues that the arrival of large numbers of immigrants during this period contributed to nutritional stress. Native workers competed in the labor markets with European immigrants, who were often more highly skilled. Hence, Salvatore (2004a, 2004b) concludes that labor supply increased so rapidly that native Argentinean workers had difficulties maintaining their living standard as rising food and rent prices diminished real wages. He also notes that the share of protein provided to infants and toddlers may have been relatively low during this period. In general, wages rose from 60% to 80% (of the British level in 1905) during the 1880s and 1890s, and from 90% to 100% during the 1900s (Williamson 1995). Real wage increases may have been lower, since higher costs of rent and non-tradable products often bias purchasing-power estimates, especially during periods of rapid urban growth. We can

safely conclude that GDP per capita increased much more than real wages did and that disparities in income increased as well. Unregulated child labor, crowded housing conditions in the cities as well as spread of infection and disease mitigated an increase in living standards.[6]

Obviously, the notable growth of wealth in Argentina from 1870 until the 1920s did not benefit all sectors of the population equally. While landowners and farmers made some gains, workers did not enjoy a proportionate growth in their income (Cortés Conde 1986). As the big height gap in Argentina was between unskilled workers and more skilled occupational groups, we find that a strong middle class represented by the latter groups had already emerged by the late 19th century. These results for Argentina are somewhat similar to those of Cranfield and Inwood (2007) on physical well-being in Canada. They found that during the 19th century the physical stature of Canadian-born men stagnated or declined slightly in spite of a substantial increase in income. Similar findings were recorded in the U.S. during the 1860s to the 1890s, when the agricultural-exports boom began (Komlos 1998). This divergence between height and GDP seems to be the pattern for food-exporting New World countries which initially had small populations.

1.3 Brazil

1.3.1 Social and economic history of Brazil

Throughout the 18th century, Brazil's economy was agrarian and monocultural. In 1815, Brazil became a monarchy with equal rights for its citizens and it remained a monarchy after gaining independence from Portugal in 1822. Furthermore, Brazil made a fairly peaceful transition to independence despite repeated efforts by secessionists (Bernecker et al. 2000). Though political conditions were stable, the Brazilian economy is often assumed to have grown too slowly or even to have stagnated on account of low agricultural productivity and a lack of capital, infrastructure, and financial institutions. A slow transition to industrialization did not begin until the end of the 19th century. Latin American economic history has traditionally held the view that

[6]During the period studied in this paper, life expectancy at birth in Argentina rose from around 33 years in 1883 to 40 years in 1905 (Somoza 1973) and mortality rates declined from 24 per 1000 inhabitants between 1881 and 1890 to 18 per 1000 inhabitants during 1901-1910 (Elizaga 1973). This can however also be viewed as a convergence to the more favorable levels of other countries with similar incomes at the time. For instance, life expectancy in Paris was already 47 years in 1880 and mortality rates in Paris and London were 6 to 8 per 1000 inhabitants accordingly (López-Alonso 2002).

newly independent Brazil fell under the economic control of Great Britain. In fact, Brazilian trade with Great Britain was based on special treaties. Haber and Klein (1994) argue that 'Brazilian policy makers were not British puppets' and that it is not clear whether these treaties resulted from Brazil's independence or from its prior close relationship with Great Britain.

Slavery still played a vital role. Although the importation of slaves had been prohibited since 1850, Brazil did not abolish slavery until 1888. It was the last country in the world to do so, and then only because of British pressure. As a consequence, prosperous coffee plantations in the South soon found themselves short of workers. A vast southward migration of former slaves from stagnating sugar plantations in the Northeast began. Meanwhile, European immigrants arrived in large numbers. Coffee planters pressed Brazil's central government and the province of São Paulo to pay the transportation costs of immigrants from southern Europe (Leff 1994), who might otherwise have sought higher wages in the United States or Argentina. Coffee planters were more willing to finance immigration from Europe than migration within Brazil, as they preferred 'hardworking white people' to black Brazilian workers (Vainer and Brito 2001). This preference was in line with the prevailing intention of 'whitening' the Brazilian population, a policy that the government acknowledged in the second half of the 19th century (Skidmore 1990).

Brazil was an agricultural economy both before and after independence. Sugar exports led the world market until 1815, but then stagnated on account of growing competition from other Latin American countries and later from European sugar-beet producers. As a result, coffee soon overtook sugar as Brazil's most important export staple. Northeastern sugar and cotton exports declined, and per-capita income fell below that of the boom region in the southeast (Leff 1994).

Johnson and Frank (2006) point out that focusing on aggregate economic performance tends to obscure the level of wealth and economic dynamism in southeast Brazil. Moreover, Frank (2006) discovers that mean wealth in Rio de Janeiro in the first half of the 19th century was surprisingly large and growing steadily, although the period was marked by a high level of economic inequality.[7]

What can be said about the nutrition of Brazilians? As the concentration on cattle raising might suggest, the amount of animal protein per capita was potentially higher in inland Brazil (Bauer 1986). Meat and especially milk have a positive effect on human height (Baten 2009). However, meat was consumed both in fresh and in dried forms,

[7]Frank (2006) calculates a Gini coefficient of 0.87 for the 1820s and 1850s in Rio de Janeiro and estimates a top decile share of 77 to 78%.

which had different health implications. The process of salting and drying destroys the thiamine (vitamin B1) and mostly also the fat in the meat (Kiple 1989). In the Northeast in the 19th century the basic diet was nothing but dried meat and manioc flour. The diet in Rio de Janeiro and São Paulo consisted of fresh meat and beans for the rich, and dried meat and cornmeal or manioc flour for the poor. In Minas Gerais both rich and poor consumed a great deal of pork, cornmeal, and beans, while in Rio Grande do Sul the diet featured fresh meat, cereals, and vegetables. Kiple (1989) pointed out that the diet of dried meat and manioc was seriously deficient in thiamine, and that beriberi, the disease caused by this deficiency, was a serious health problem in Brazil during the latter half of the 19th century. High consumption of beans helped overcome some of the health problems, and bean soup with offal, feijoada, became an indispensable national dish (Fish 1978). High in protein, feijoada improved the diet of many Brazilians.

1.3.2 The data set

Our Brazilian sample consists of 6,771 male prisoners from the Rio de Janeiro city jail, measured between 1861 and 1903.[8] The sample was drawn from a randomly chosen series of registration books. The data include height, origin, occupation, birthplace, age, and skin color. Until 1879, height was measured in Portuguese feet, and from then on in meters. One Portuguese inch equals 2.75 centimeters. Frank (2006) has studied a smaller data set stemming from the same prison with 1,142 observations of the 1850s to 1860s. He finds that on account of measurement error in the Rio prison, it is more accurate to calculate 2.73 cm to the inch. Prison records document the heights of some individuals in both centimeters and feet, and an analysis of the double measurements leads to this correction. We follow Frank's reasoning and adopt this approach.

The prisoners came from many regions of Brazil as well as from other countries. We pool the information on skin color into three categories - white, black, and mixed. The description of skin color varies for mixed-race individuals, but the manifold terms used at the time to denote skin color (e.g., crioulo, moreno, acaboclado, fula, cabra) cannot be unambiguously classified. The individuals in the sample pertain to birth cohorts of the 1810s to the 1880s. Standard deviations of the height distributions are relatively high, as we would expect for a country with pronounced social inequality (Table 1.2).

[8] Rio de Janeiro/Brazil: Arquivo Público do Estado do Rio de Janeiro - APERJ - Depositum Casa de Detenção do Rio de Janeiro.

How representative is our data? In prison samples, there might be occupational bias. The proportion of prisoners from the lower class is often greater in prison than in the overall population. We agree with Frank (2006) that the sample is somewhat biased towards the poorest portion of the population. In Table 1.4 we compare our sample means for the share of occupational groups, slaves and skin color with the Brazilian census of 1872.

Table 1.4: Occupational and social structure in Brazil in 1872

	Brazil census share 1872	Brazil sample share 1870s
Occupational group		
No occupation	n.a.	3.1
Unskilled	33.9	35.9
Farmers	n.a.	1.7
Semiskilled	26.5	34.5
Skilled	20.6	21.1
Semiprofessionals	13.5	3
Professionals	5.5	0.7
Slaves		
free	84.3	82.9
slave	15.7	17.1
Skin color		
White	38.5	41.6
Mixed	41.5	30.4
Black	20	28

Notes: Without considering farmers.
Source census share: Recenseamento (1872)

We use the Armstrong scheme of occupations for Brazil, too. Comparing our sample's measurement cohort of the 1870s with the census, we find that the share of unskilled workers is quite similar, but the prison sample contains about 10% more semiskilled workers (Recenseamento 1872). By a similar percentage, there are fewer semiprofessionals in the sample. With less than 1%, professionals are nearly absent in the sample, compared with 5.5% in the census population. The share of slaves in our data and the share in the census are almost equal. Compared with the census, our sample describes more persons as 'black' (28 vs. 20%) and similarly fewer 'mixed' (30.4 vs. 41.5%). This may be a true difference, or it may reflect different definitions of skin color used by the prison and the census. We analyze descriptively the distribution of heights for each birth decade separately, but we observe no systematic changes over time (see Appendix Figure 1.6 and Table 1.8).

Table 1.5: Determinants of heights in Brazil

	(1) full sample	(2) only native Brazilians	(3) native Brazilians without slaves
1810 & 1820	ref. cat.	ref. cat.	ref. cat.
1830	0.55	-0.02	0.44
1840	0.35	-0.34	0.11
1850	0.37	-0.34	0.11
1860	1.07**	0.30	0.75
1870	2.49***	1.74***	2.16***
1880	2.83***	2.17***	2.59***
Age 19	-1.86***	-1.93***	-1.89***
Age 20	-1.02***	-0.93**	-1.00**
Age 21	-0.65	-0.53	-0.47
Age 22	-0.49	-0.33	-0.32
Age 51-60	-0.18	-0.26	-0.17
Rio de Janeiro	ref. cat.	ref. cat.	ref. cat.
Southeast w/o Rio	1.88***	1.91***	1.89***
South	0.75	0.75	0.83
Northeast	0.18	0.19	0.05
North/Middle West	0.77	0.79	0.27
Africa	0.04		
France	0.69		
Germany	3.66***		
UK	3.17***		
North America	3.57***		
Spain	0.33		
Portugal	-0.05		
Italy	0.49		
Other Immigrant	1.84***		
Unskilled	ref. cat.	ref. cat.	ref. cat.
Semiskilled	0.55***	0.45**	0.65***
Skilled	0.85***	0.90***	0.86***
Semiprofessional	0.75*	1.20***	1.26***
Professional	2.77***	3.65***	3.68***
Farmer	-1.20*	-0.66	-0.76
Round Age	-0.67***	-0.78***	-0.71***
White	ref. cat.	ref. cat.	ref. cat.
Black	0.53*	0.60**	0.61**
Mixed	0.12	0.14	0.16
Slave	-0.98**	-0.65	
Constant	163.7***	164.3***	163.8***
Observations	6,760	5,613	5,257
R-squared	0.035	0.028	0.028

Notes: We estimate an OLS regression with robust standard errors. Dependent variable: body height in cm. *,**,*** refer to significance levels of 10,5, and 1%. The constant refers to a criminal unskilled free white man aged 23-50 born in the Federal State of Rio de Janeiro in the 1810s or 1820s. We pool the decades 1810 and 1820 due to small number of observations, and include only adult males aged 19-60. `Northeast´ refers to the Federal States Pernambuco, Bahia, Sergipe, Alagoas, Paraíba, Rio Grande do Norte, Ceará, Piauí, and Maranhão. `South´ refers to Rio Grande do Sul, Paraná and Santa Catarina. `Southeast w/o Rio´ refers to São Paulo, Minas Gerais and Espírito Santo. North/Middle West refers to today's Goias, Mato Grosso, Mato Grosso do Sul, Amazonia, Pará, Acre, Roraíma, Tocantins and Amapá.

1.3.3 Brazilian height trends

In Table 1.5 we report three height regressions for Brazil: regression (2) excludes immigrants, regression (3) excludes immigrants and slaves, whereas regression (1) includes both and controls for slave status and the origins of the immigrants with dummy variables.[9] Interpreting the birth decade dummies, we find that Brazilian heights stagnated at first, but time coefficients after 1860 imply a distinct upward trend which is robust in all regressions and confirm the descriptive impression from the raw data (Table 1.2).

Brazilians born in the 1880s were 2.83 cm taller than those born in the 1810s or 1820s if we consider all Brazilians and 2.59 cm taller if we include only native Brazilians and exclude slaves. We also control for age composition by including dummy variables for the ages 19, 20, 21, 22 and 51 to 60 in the regression. The reason for selecting these age groups is that those in the younger group have not yet achieved their adult height, whereas some of those in the older group may have actually shrunk. The results are as expected, with the exception of those aged 51 to 60, who were not significantly shorter. Among the young men, height continued to increase until the age of 21.

1.3.4 Regional height differences and migration

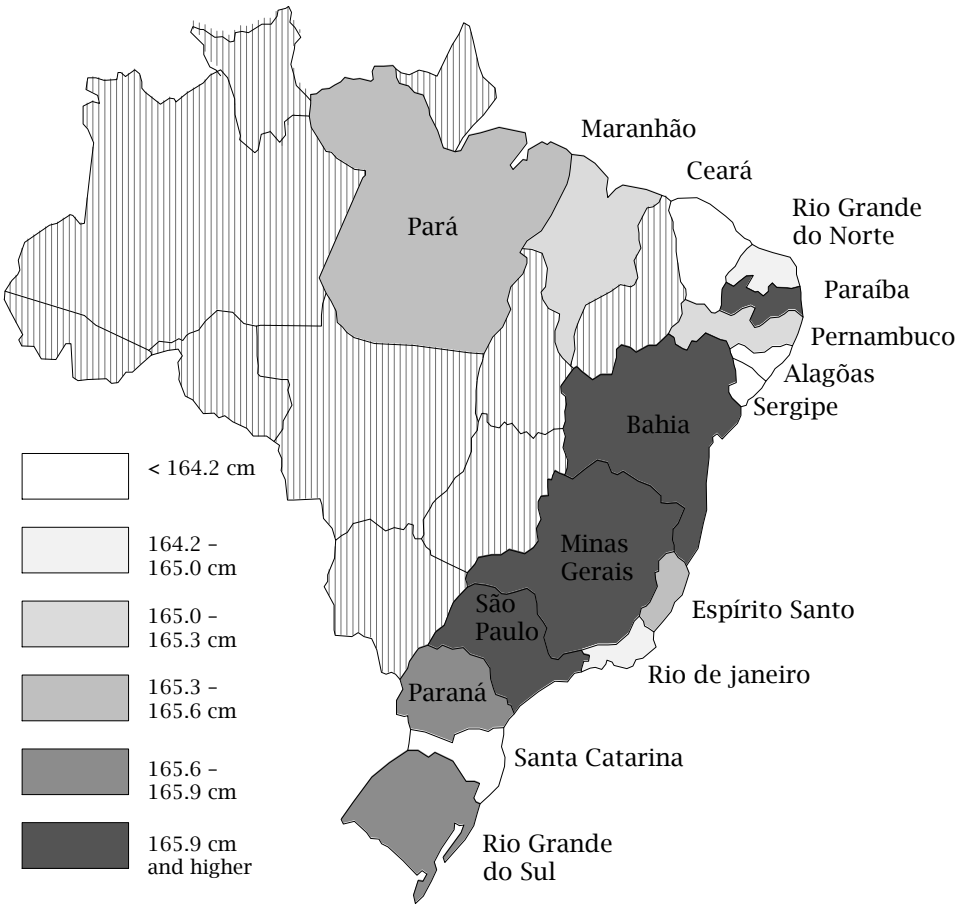
We collected our data from a Rio de Janeiro prison, but the places of birth of the prisoners vary widely. Of the adult males, 58% were born in the South or Southeast (including Rio), 39% were born in the Northeast and a mere 3% in the West or in the North.

Figure 1.4 provides a rough descriptive picture of regional height differences. The tallest Brazilians were living between São Paulo and Bahia and in Paraíba. With the exception of residents of the latter two states, Northeasterners were relatively short, as were those in the coastal regions of Rio de Janeiro, Santa Catarina, and Espírito Santo. Looking at Bauer's map of agricultural specialization, we note that the highest average body heights were found in grain- and cattle-producing regions (Bauer 1986). This holds true for the booming São Paulo and Minas Gerais coffee plantation belt.[10]

[9] The R^2 are generally low, which is quite common in individual height regressions. We know that we cannot capture individual genetic height variation, which accounts for a large share of the unexplained part. As soon as heights are averaged, for instance by regions, and the genetic component averages out, R^2 increase strongly, see Baten (1999).

[10] Baten (1999) finds very strong height advantages of proximity to the production of perishable proteins. E.g., milk or offal could not be transported and traded over longer distances before the mid-20th century (see Baten 1999, Komlos 1996). The proximity had the effect of relatively positive health and height levels, even among populations of modest purchasing power. We should note though that the South attracted many tall Europeans. Moreover, in Minas Gerais there was a remarkably high number of freed slaves. Characterized by smaller plantations, the number of slaves

Figure 1.4: Heights in Brazil by states



Line pattern indicates fewer than 30 observations.

In contrast, the plantations in the Northeast (cotton, sugar, and tobacco) and those of Espírito Santo (cocoa), on the southern coast, had shorter-than-average people, perhaps because the diet there was based on local, low-protein foods, or because they could not afford adequate housing. The taller population of Paraíba can be explained by the favorable economy of its cattle farming and coffee plantations, which stretched to the coast. The unexpectedly moderate heights recorded in the Rio de Janeiro region may be partly due to the rapid expansion of the city itself. Frank (2006) hypothesized that Rio, in becoming one of the two largest cities in Latin America along with Mexico City, imposed an 'urban penalty' on its population.

In order to control for potential bias in the anthropometric trend, we include four dummy variables for Brazilian regions with the Federal State of Rio de Janeiro as

per slaveholder was relatively small in Minas Gerais, a situation that may have fostered social interaction between slaves and their owners (Klein 1986).

reference category in the regressions. We find that only prisoners born in the booming Southern coffee-plantation region had significantly larger heights than prisoners from Rio de Janeiro. For other regions there is no significant difference. However, we cannot exclude the possibility that the significant result could have been caused by selective migration as well.

Another possible trend distortion could derive from European immigration. In the second half of the century Brazil was the destination of increasing numbers of immigrants, mostly from Portugal. The influx of taller individuals into a region could have brought an upward trend in height, but regression (2) shows that this was not the case. There is also a substantial upward trend among native Brazilian prisoners only. Moreover, those who emigrated from Portugal, Italy, Spain, and France, were not statistically different from those born in Brazil. In contrast, German, British, and North American immigrants were more than 3 cm taller.[11]

1.3.5 Heights by occupation and numerical skill

Modest but significant differences in height can be observed between unskilled and skilled groups, with the exception of professionals, who were as much as 2.77 cm taller than unskilled workers, and even as much as 3.65 cm if we consider only native Brazilians. Thus, the greatest difference in height was between the elite and the rest of the population, and not between the unskilled workers and skilled craftsmen. Farmers in the sample were shorter than all other groups, but in regression (2) the difference is not significant. The significance in regression (1) is probably driven by migrants who had left their country in search of work, having failed at farming.

Another strategy for assessing educational levels in historical samples is to examine 'age heaping', an indicator for numeracy. Persons who cannot state their exact age often round it off to a multiple of five, and such persons are typically less educated than average (Baten et al. 2009, Crayen and Baten 2010). Age-heaping indices correlate negatively with other human-capital indicators, such as literacy and school enrollment, and even more so with modern measures of mathematical skills (A'Hearn et al. 2009). The Whipple Index of age heaping is calculated by dividing the number of persons reporting an age ending in 0 or 5 by the total number in the study, multiplied by 500. The Whipple Index runs from 0 to 500, with typical values located between 100 (no age heaping, good numeracy) and 500 (extreme age heaping, bad numeracy).[12] Values substantially higher than 100 indicate problematic numeracy; the higher the

[11] We include only immigrant groups with more than 50 observations.
[12] A value of 0 would mean complete avoidance of all multiples of five.

number, the greater the problem. Manzel and Baten (2009) estimate a value of 205 for Brazilians born in the 1850s, while our data produce a slightly more positive index of 178. How large is this difference? Throughout the 19th century, values in the Middle East and South Asia were near 500, whereas in European industrial countries they were closer to 100, with those of Latin America ranging from 100 (Argentina, 1890s) to 290 (Ecuador, 1880s). The difference of 27 in the two data sets for Brazil is small but not negligible. Our regression estimates show that those prisoners who rounded off their age were significantly shorter. However, according to the comparison of census shares with our sample shares in Table 1.4 we conclude that the prison sample does not have a strong negative educational bias, we attribute this to a more urban sample.

1.3.6 Height differences by skin color and slave status

Even after controlling for occupation, slave status, birth decade and all other characteristics, black people were significantly taller than native Brazilian white people on average. However, this differences refers to black free men, as slaves were significantly shorter than white people. The fact that black Brazilians were relatively tall in spite of their low status probably cannot be explained genetically, as black people born in Africa were in fact shorter than those born in regions of Brazil where feijoada was an important component of the diet. On average, black people of African birth were 161.7 cm (N=151) tall, while those born in Brazil were significantly taller, at 164.9 cm (N=921).[13]

Slaves in the United States were considerably taller than their Brazilian counterparts. According to Margo and Steckel (1983), the mean height of U.S. slaves (ages 25 to 39 in the 1790s to 1840s) was 4 cm greater than that of Brazilian slaves. The white population in the U.S. was also considerably taller than that of Brazil: around 173 cm from the 1800s to the 1830s, and then falling to 169.1 cm in the 1890s. In the U.S. South, whites were about 2.5 centimeters taller than slaves (Komlos and Coclanis 1997). Fogel and Engerman (1974, 1995), Steckel (1986) and more recently Rees et al. (2003) have argued that U.S. slaveholders provided those of their slaves who reached adulthood with reasonably nutritious food. As importing slaves became more difficult

[13]Our results are in line with the arguments that Eltis (1982) has provided against strong height selectivity in slave-trade. For example, he argues that if traders put a significant premium on taller slaves, prices and volumes of slaves traded in those areas with taller populations would have been higher, which does not appear to have happened in the 19th century. Second, by the 19th century, physically strong (and tall) Africans were also demanded by Africa's plantations and farms. Finally, Eltis (1982) observed that the height distributions from all regions were quite normal. If there had been something like a minimum height requirement of slaves or a height interval which was much less demanded, slaves from the regions with shorter stature should have displayed some shortfall.

and expensive, some slaveholders began to provide their slaves with offal and other cheap sources of protein. It is questionable whether this may have been true for Brazil as well.

1.4 Peru (Lima)

1.4.1 Social and economic history of Peru

The pronounced stratification of Peruvian society can be traced back to the conquistadors, who took possession of most of the fertile land and introduced slavery. Peru gained independence from Spain in 1821, but the social and economic inequalities introduced during the colonial era did not diminish significantly (Gootenberg 1990). The legacy of the Spanish Empire was a two-class system defined by rigid social rules and tax laws where white elite held the privileged positions (Contreras 2004). The elite appropriated the riches of the country and was able to protect its social status and profit over time. White men often had children by their Indio servants, creating a mixed racial group, mestizos. The abolition of slave trade, in the 1850s, had serious consequences for farmers, who had relied on slave labor.

Peru was a an important exporter of silver throughout the colonial era, but in the early 19th century investments and profits declined during and after the independence conflicts (Contreras 2004). In the same period, Peru launched a new export good, guano, a fertilizer and commodity for gun powder made from excrements of seabirds. Guano replenished the public treasury and enabled an enormous amount of profits to be captured until the 1860s. Due to the demand of many middlemen and retailers for other goods, income increased also for other inhabitants of the capital (Gootenberg 1990). Nevertheless, Peru's finances remained unstable. Violent political upheavals, including frequent coups d'état, made governing the country next to impossible and contributed to a rise in government debt. The government borrowed on future revenues from guano and then squandered the money within a few years. After three decades of frenetic prosperity, Peru sank into a recession in the mid-1870s. The country's undiversified export structure depended on the markets of Great Britain and France, and orders diminished as international trade in general slowed (Gootenberg 1989).

Cotton plantations dominated the coastal region around Lima while sheep, llamas, and alpacas were raised in the interior of the country (Bauer 1986). In Peru's northern mountains, cattle production was more pronounced, and the meat consumption of

Lima's upper class may have therefore been fairly high.[14] However, the cost of transporting meat from the North was probably prohibitive for the urban poor. Due to the distance, milk was not consumed in large amounts in Lima, neither by rich nor by poor persons.

1.4.2 New anthropometric evidence for Lima

For Peru, as we did for Brazil, we rely on a prison sample comprising 1,139 cases, mostly convicts from Lima and a modest number of immigrants.[15] They were measured in the years 1866 to 1909, allowing us to study the birth decades of the 1820s to 1880s. Since sample size for each birth decade would be too small, we aggregate Peruvian birth cohorts into 20-year birth groups.

We compare the social and occupational structure in the mostly urban prison sample with the 1876 census of population born in the Lima district (Table 1.6). The 1876 census provides information about the social structure of Peruvian society, including such variables as skin color, religion, and nationality (Díaz Alejandro 1974). We refer to the census report from Pinto and Goicochea (1977) and classify all occupations in the sample according to the Armstrong scheme. We limit the sample to those convicts measured during the 1870s. This sample actually overrepresents skilled people in comparison to that for the Lima district, which includes the city's rural surroundings. However, in combining semiskilled and skilled groups, the prison sample is quite representative for the Lima district, with the exception of farmers, who are of course underrepresented in our urban sample. In contrast, professionals and semiprofessionals are well represented, among the prisoners some were slightly better off than most average male person. This may help to explain why the standard deviations of the height distribution are relatively large (Table 1.2). The prison population includes merchants and traders, convicted of business-related crimes . All skin-color groups except Asians (which usually meant Chinese) are well represented in our sample. Immigrants compose 22% of our prison sample, in contrast with 3% in the census for the Lima district.

[14] Peru had by far the smallest number of cattle per capita, with only 1 million in 1917 relative to a population somewhere between less than 3 million in 1876 and 7 million in 1940 (Mitchell 1993). Brazil had 31 million cattle in 1912 and 17 million population in 1900, and Argentina's per capita values declined from more than 7 per capita in the late 1860s/early 1870s to 4 per capita in 1910. Hence in Peru 5-6 inhabitants 'shared' one cow, whereas Brazil had initially around 2 cattle per capita and Argentina between 8 and 4 cattle per capita. The decline of cattle per capita in Argentina could have contributed to the disappointing stagnation of heights, but of course, Argentina had a much higher export of first salted, later refrigerated cattle meat, hence production did not equal consumption.

[15] Lima/Peru - Archivo General de la Nación. Archival source 'penitenciaria central', the main prison in Lima, and Guadalupe prison. Libros de Entrada y Salida de Reos, Nr. 3.20.3.3.1.1.4 to 26.

Table 1.6: Occupational and social structure in Lima in 1876

	Lima census share 1876	Lima sample share 1870s
Occupational group		
No occupation	0.1	0.6
Unskilled	16.3	16.5
Farmers	47.8	18.4
Semiskilled	21.7	14.6
Skilled	9.4	34.8
Semiprofessionals	4.2	12
Professionals	0.5	3.2
Skin color		
White	22.7	20.7
Indio	44.1	43
Mestizo	15.7	21.8
Black	6.8	10.5
Asian	10.7	3.2
Immigrants	3	22

Source census share: Pinto, H. and A. Goicochea (1977)

Furthermore, we assess representativeness by comparing the Whipple Index of the prison sample to the overall population. The Whipple Index of age heaping of the whole prison sample is 127 (ages 33 to 62, 1820s to 1880s). Manzel and Baten (2009) estimate a Whipple Index for Lima's population at 139 for the birth cohort of the 1880s, a much better value than in Brazil. In other words, from an age-heaping perspective, our prison sample and the overall population are quite similar.

1.4.3 Height, ethnicity and occupation in Lima

We estimate one regression for native Peruvians only, and one including immigrants (Table 1.7). Unfortunately we cannot assess growth patterns or differences between immigrant groups. Heights of the birth decades before 1859 were lower than those after 1860. A yellow-fever epidemic during the 1840s must have made life in Lima exceedingly difficult (Sánchez-Albornoz 1986).

There were no significant differences in height by occupation. The reason why the occupation coefficients are insignificant could be that most Indios in the sample were categorized as 'unskilled' or 'unknown', and as a consequence there could be multicollinearity between occupation and skin-color/ethnicity. However, there was large variation in height by ethnicity. Indios were shorter than whites by 5 to 6 cm, mestizos

Table 1.7: Determinants of heights in Lima

	(1) without immigrants	(2) full sample
1880	ref.cat.	ref.cat.
1820/30	-2.22*	-2.34**
1840/50	-2.27***	-2.31***
1860/70	0.11	0.07
Unskilled	ref.cat.	ref.cat.
Semiskilled	0.75	0.39
Skilled	0.32	0.21
Semiprofessional	0.58	0.24
Professional	-1.62	0.47
Farmer	-0.34	-0.4
White	ref.cat.	ref.cat.
Indio/Cholo	-5.02***	-6.03***
Mestizo	-2.91***	-3.37***
Zambo	0.73	-0.45
Black	2.25*	1.01
Asia		-3.58***
Constant	165.78***	166.88***
Observations	884	1139
R-squared	0.14	0.13

Notes: We estimate an OLS regression with robust standard errors. Dependent variable: body height in cm. *,**,*** refer to significance levels of 10,5, and 1%. The constant refers to a criminal unskilled male of white skin color and age 23-50, born in the 1880s.

by around 3 cm, and Asians (mostly Chinese) by 4 cm. Blacks were not significantly shorter than whites, and those born in Peru were even significantly taller.[16]

White people born in the 1880s were 5 to 6 centimeters taller than Indios of the same age. How different were the heights in Lima from those in other regions of Peru? The first representative data set on heights with a sufficient number of cases refers to birth cohorts of 1950 to 1967, when Lima recorded average female heights of 151 cm (Baten and Fraunholz 2004). The average height of women in the Northeast, East (Madre de Dios) and South was about 152 cm, while women in the central highlands and the Northwest measured 150 cm or less. This pattern persisted for birth cohorts of 1968 to 1979, although the region around Lima gained somewhat in height. Assuming

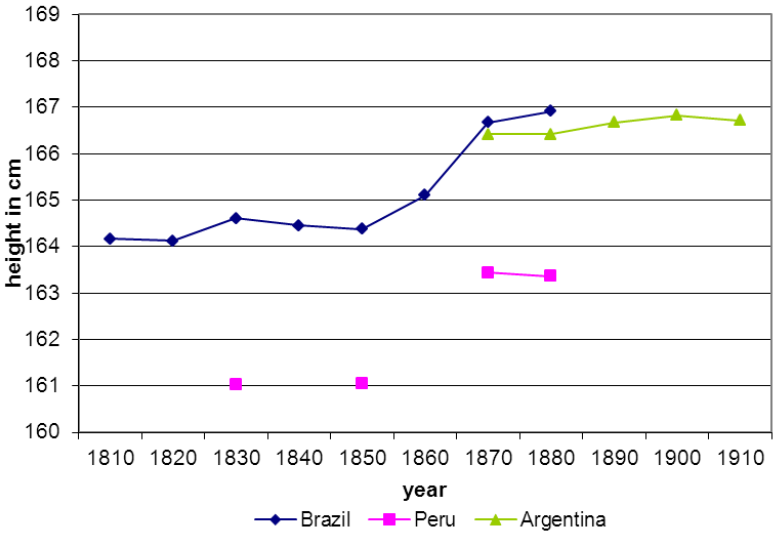
[16] In a separate regression model, we also checked whether occupational groups became more significant if we considered only individuals born after the 1840s, but the difference to the original regression was quite modest.

that the 19th century and the post-1950 periods were not dramatically different, one can reasonably conclude that heights not only in Lima but in the rest of Peru as well were not dramatically different. But this conclusion is tentative, and requires further study. A number of anthropological studies of height using data derived exclusively from tribes in the Andes estimates the height of rural male Indios in Peru and Northern Bolivia born mostly between the 1880s and 1900s at somewhat under 159 cm (Steggerda 1943, Bogin and Keep 1999). The urban Indios of our sample who were born in the 1870s and 1880s were slightly taller (about 160 cm). Although our Lima sample is small, it seems safe to conclude that the height level of its population was substantially shorter than that of Brazil. The height gap between white and Indio prisoners steadily widened.

1.5 Comparative conclusion

Figure 1.5 shows a comparative picture of the height trends in Argentina, Brazil and Peru. Argentinean height levels were quite impressive during the period under study compared with other Latin American or with European populations. However, they did not increase during the GDP boom, as we would have expected from the GDP estimates in Table 1.1. This finding confirms earlier studies that indicate a stagnation of average stature during the period when exports were growing the fastest (Salvatore 1998, 2004a, 2004b, 2007). Heights in Brazil started from a comparatively low level and stagnated during the first half of the 19th century before an upward trend began in the 1860s. Lima experienced an upward trend, as well, in the 1870s and 1880s but was still far away from Argentinean or Brazilian height levels. This result is suprising as GDP estimates for Peru are slightly higher than those for Brazil. We conclude that lower average heights in Lima are attributable to a higher level of income disparity and urbanization.

Figure 1.5: Height trends in Argentina, Brazil, and Lima by birth decade (Brazil, Argentina), and 20- or 10-year birth cohort (Lima)



Note: The Lima value for 1830 refers to those born 1820-39, the one for 1850 to 1840-59, the one for 1870 to 1860-1879, the one for 1880 to 1880-89. The years denote the beginning of a birth decade for Brazil and Argentina (1810 for 1810-19 etc.). We adjusted for occupational group and for skin color by using the coefficients of the main regression tables, and census weights so as to obtain unbiased population averages for each birth cohort and country (the census weights were derived from the Peruvian census of 1876, values for the Lima region, and the Brazilian census of 1872)

The analysis of occupational classes and skin color reveals that among the birth cohorts of the 1810s to the 1880s, the most significant height differences in Brazil were between the elite and the rest of the population. In contrast, by the 1870s Argentina's middle class was considerably taller than the lower class. In Peru, where the height gap between Indios and whites was particularly wide, skin color may have compounded the social and economic differences between the races, complicating any attempt at an analysis of heights according to occupational classifications.

1.6 Appendix

Figure 1.6: Distribution of heights in Brazil per birth decade

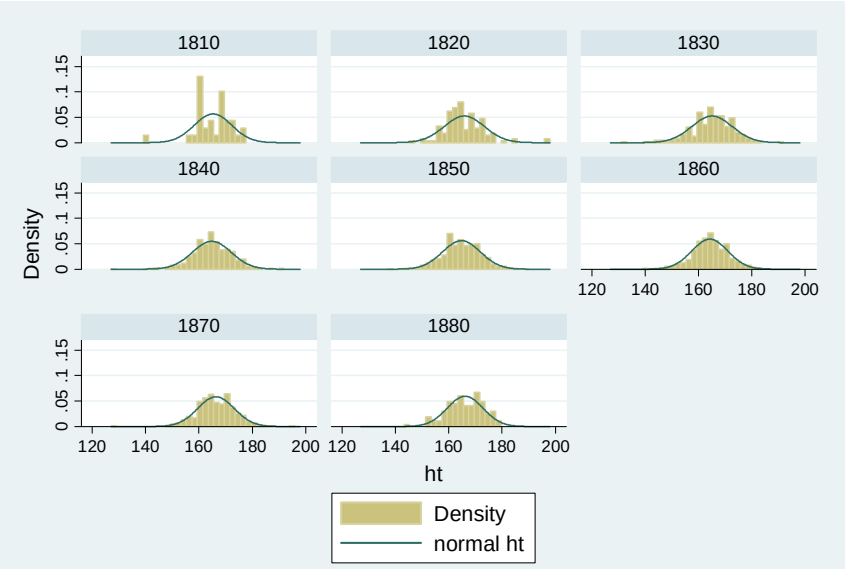


Table 1.8: Descriptive statistics of heights in Brazil per birth decade

Birth decade	N	mean	median	p10	p25	p75	p90	skewness
1810	75	164.3219	165.165	156.975	161.07	167.895	171.99	-0.88041
1820	323	164.3165	163.8	155.61	159.705	168	171.99	0.86928
1830	705	164.8438	165	155.61	161	169.26	173.355	-0.30131
1840	1265	164.5723	165	156	160	169.26	173.355	-0.14697
1850	1604	164.4832	164	156	160	169.26	173	-0.05359
1860	1740	165.0249	165	157	161	170	173	-0.11104
1870	887	166.5445	166	159	162	171	175	-0.05963
1880	172	166.1453	166	158	162	171	174	-0.39845
Total	6771	164.9791	165	156.975	160	170	174	-0.0838

1.7 References

A'Hearn, B., Baten, J. and D. Crayen (2009). Quantifying quantitative literacy: Age heaping and the history of human capital, *Journal of Economic History* 69(3), 783-808.

Armstrong, W. A. (1972). The use of information concerning occupations. In: Wrigley, E. A. (ed.), *Nineteenth Century Society: Essays on the Use of Quantitative Methods for the Study of Social Data*, 191-310. Cambridge University Press.

Arora, S. (2001). Health, human productivity, and long-term economic growth, *Journal of Economic History* 61(3), 699-749.

Baten, J. (1999). *Ernährung und wirtschaftliche Entwicklung in Bayern, 1730-1880.* Franz Steiner Verlag, Stuttgart. [Nutrition and Economic Development in Bavaria, 1730-1880, English translation in progress.]

Baten, J. (2009). Protein supply and nutritional status in nineteenth century Bavaria, Prussia and France, *Economics and Human Biology* 7(2), 165-180.

Baten, J., Crayen, D. and K. Manzel (2009). Zahlenfähigkeit und Zahlendisziplin in Nord- und Westdeutschland, 16.-18. Jahrhundert. In: *Jahrbuch fuer Wirtschaftsgeschichte*, 217-229. [Numeracy and Number Discipline in Northern and Western Germany, 16th-18th Centuries]

Baten, J. and U. Fraunholz (2004). Did partial globalization increase inequality? The case of the Latin American periphery, 1950-2000. *CESifo Economic Studies* 50(1), 45-84.

Bauer, A. (1986), Rural Spanish America, 1870-1930. In: Bethell, L. (ed.), *The Cambridge History of Latin America* 4, 153-185. Cambridge University Press.

Bernecker, W., Pietschmann, H. and R. Zoller (2000). *Eine kleine Geschichte Brasiliens*, Suhrkamp, Frankfurt am Main.

Bogin, B. and R. Keep (1999). Eight thousand years of human growth in Latin America: Economic and political history revealed by anthropometry. In Komlos, J., Baten, J., (eds.). *The Biological Standard of Living in Comparative Perspective.* Franz Steiner Verlag, Stuttgart.

Carson, S. A. (2005). The biological standard of living in 19th century Mexico and in the American West, *Economics and Human Biology* 3(3), 405-419.

Case, A. and C. Paxson (2008). Stature and status: Height, ability, and labor market outcomes, *Journal of Political Economy* 116(3), 499-532.

Cinnirella, F., Piopiunik, M. and J. Winter (2011). Why does height matter for educational attainment? Evidence from German Children, *Economics and Human Biology*, 9(4), 407-418.

Contreras, C. (2004). El aprendizaje del capitalismo. Estudios de historia económica y social del Perú republicano. IEP Ediciones, Lima.

Cortés Conde, R. (1986). The growth of the Argentine economy, 1870-1914. In: Bethell, L. (ed.), *The Cambridge History of Latin America* Vol. 5, 327-357. Cambridge University Press.

Cortés Conde, R. and M. M. Harriague (1994). Estimaciones del producto bruto interno de Argentina 1875-1935. Documento de Trabajo, Departamento de Economía, Universidad de San Andrés, Buenos Aires (unpublished).

Cranfield, J. and K. Inwood (2007). A great transformation: A long-run perspective on physical well-being in Canada, *Economics and Human Biology* 5(2), 204-228.

Crayen, D. and J. Baten (2010). Global trends in numeracy 1820-1949 and its implications for long-run growth, *Explorations in Economic History* 47(1), 82-99.

Díaz Alejandro, C. F. (1970). *Essays on the economic history of the Argentine Republic*, Yale University Press, New Haven and London.

Díaz Alejandro, C. F. (1974). *El Censo General de 1876 en el Perú*, Seminario de Historia Rural Andina.

Elizaga, J. C. (1973). La evolución de la población de la Argentina en los últimos cien años. *Desarrollo Económico* 12(48), 795-805.

Eltis, D. (1982). Nutritional trends in Africa and the Americas: heights of African, 1819-1839, *Journal of Interdisciplinary History* 12, 453-475.

Ferrer, A. (1967). *The Argentine economy*, University of California Press, Berkeley and Los Angeles.

Fish, W. (1978). Changing food use patterns in Brazil, *Luso-Brazilian Review* 15(1), 69-89.

Fogel, R. W. and S. L. Engerman (1974/1995). *Time on the cross: The economics of American negro slavery.* Reissued edition. W.W. Norton and Company, New York.

Fogel, R. (1993). Economic growth, population theory, and physiology: The bearing of long-term processes on the making of economic policy, *American Economic Review* 84, 369-95.

Frank, Z. (2006). Stature in nineteenth-century Rio de Janeiro: Preliminary evidence from prison records. *Revista de Historia Económica: Journal of Iberian and Latin American History* 24(3), 465-490.

Fukao, F., Ma, D. and T. Yuan (2007). Real GDP in pre-war Asia: A 1934-36 benchmark purchasing power parity comparison with the U.S., *Review of Income and Wealth* 53(3), 503-523.

Goldsmith, R.W. (1986). *Desenvolvimento financeiro sob um fecolo de inflação.* Harper and Row, São Paulo.

Gootenberg, P. (1989). *Between silver and guano. Commercial policy and the state in post-independence Peru.* Princeton University Press, New Jersey.

Gootenberg, P. (1990). Carneros y chuño: Price levels in nineteenth-century Peru, *Hispanic American Historical Review*, 70(1), 1-56.

Haber, S. and H. S. Klein (1994). The economic consequences of Brazilian independence. In: Haber, S. (ed.). *How Latin America fell behind.* Stanford University Press.

Johnson, P. and S. Nicholas (1995). Male and female living standards in England and Wales, 1812-1857: Evidence from criminal height records, *Economic History Review, New Series* 48(3), 470-481.

Johnson, L. and Z. Frank (2006). Cities and wealth in the South Atlantic: Buenos Aires and Rio de Janeiro before 1860. *Comparative Study of Society and History* 48(3), 634-668.

Kiple, K. (1989). The nutritional link with slave infant and child mortality in Brazil, *The Hispanic American Historical Review* 69(4), 677-690.

Klein, H. S. (1986). *African slavery in Latin America and the Caribbean.* Oxford University Press.

Komlos, J. (1985). Stature and nutrition in the Habsburg monarchy: The standard of living and economic development in the eighteenth century, *American Historical Review* 90(5), 1149-61.

Komlos, J. (1987). The height and weight of West point cadets: Dietary change in Antebellum America, *Journal of Economic History* 47, 897-927.

Komlos, J. (1996). Anomalies in economic history: Reflections on the Antebellum puzzle, *Journal of Economic History* 56(1), 202-214.

Komlos, J. (1998). Shrinking in a growing economy? The mystery of physical stature during the Industrial Revolution, *Journal of Economic History* 58(3), 779-802.

Komlos, J. and J. Baten *eds.* (1998). *The biological standard of living in comparative perspective.* Stuttgart.

Komlos, J. and P. Coclanis (1997). On the puzzling cycle in the biological standard of living: The case of antebellum Georgia, *Explorations in Economic History* 34, 433-459.

Leff, N. (1994). Economic development in Brazil, 1822-1913. In: Haber, S. (ed.), How Latin America fell behind, Stanford University Press.

López-Alonso, M. (2002). Growth without growth: Heights, health, nutrition and income in Mexico, 1870-1950. Conference Paper, XIIIth Congress of the International Economic Association, Buenos Aires.

López-Alonso, M. and R. P. Condey (2003). The ups and downs of Mexican economic growth: The biological standard of living and inequality 1870-1950, *Economics and Human Biology* 1(2), 169-186.

Maddison, A. (2001). *The World Economy: A Millennial Perspective.* OECD, Paris.

Manzel, K. and J. Baten (2009). Gender inequality in numeracy: the case of Latin America and the Caribbean, 1880-1949, *Revista de Historia Económica* 27(1), 37-74.

Margo, R. and R. H. Steckel (1983). Heights of native born Northern whites during the Antebellum period, *Journal of Economic History* 43, 167-174.

Meisel, A. and M. Vega (2007). The biological standard of living (and its convergence) in Colombia, 1870-2003: A tropical success story, *Economics and Human Biology* 5(1), 100-122.

Mitchell, R. (1993). *International historical statistics. The Americas 1750-1988.* Stockton, New York.

North, D. (1966). *The economic history of the United States, 1790-1860.* W.W. Norton, Englewood Cliff.

della Paolera, G. and A. M. Taylor (2003). *Tensando el ancla: La caja de conversión Argentina y la búsqueda de estabilidad macroeconómica 1880-1935*, FCE, Buenos Aires.

Persico, N., Postlewaite, A. and D. Silverman (2004). The effect of adolescent experience on labor market outcomes: The case of height, *Journal of Political Economy* 112, 1019-1053.

Pinto, H. and A. Goicochea (1977). *Ocupaciones en el Perú: 1876.* Universidad Nacional Mayor de San Marcos, Seminario de Historia Rural Andina, Lima.

Recenseamento geral do Brasil 1872 - Império do Brasil (1872). Accessed on June 6th, 2008: http://biblioteca.ibge.gov.br/visualizacao/monografias/visualiza_colecao_digital.php?titulo= Recenseamento Geral do Brasil 1872 - Império do Brazil&link=Imperio do Brazil

Rees, R., Komlos, J., Long, N. V. and U. Woitek (2003). Optimal food allocation in a slave economy, *Journal of Population Economics* 16(1), 21-36.

República Argentina (1916). Tercer Censo Nacional de la República Argentina 1914. Buenos Aires.

Salvatore, R. (1998). Heights and welfare in late-colonial and post-independence Argentina. In: Komlos, J., Baten, J. (eds.). *The Biological Standard of Living in Comparative Perspective*, Franz Steiner Verlag, Stuttgart.

Salvatore, R. (2004a). Stature decline and recovery in a food-rich export economy: Argentina 1900-1934, *Explorations in Economic History* 41(3), 233-255.

Salvatore, R. (2004b). Stature, nutrition, and regional convergence: The Argentine Northwest in the twentieth century, *Social Science History* 28(2), 231-248.

Salvatore, R. (2007). Heights, nutrition and well-being in Argentina, ca. 1850-1950. Preliminary results, *Journal of Iberian and Latin American Economic History* 25(1), 53-86.

Salvatore, R. and J. Baten (1998). A most difficult case of estimation: Argentinean heights, 1770-1840. In: Komlos, J., Baten, J. (eds.). *The biological standard of living in comparative perspective*, Franz Steiner Verlag, Stuttgart.

Sánchez-Albornoz, N. (1986). The population of Latin America, 1850-1930. In: Bethell, L. (ed.), *The Cambridge History of Latin America*, Vol. 4, Cambridge University Press.

Seminario, B. and A. Beltrán (1998). *Crecimiento económico en el Perú 1896-1995: Nuevas evidencias estadísticas*. Universidad del Pacífico, Lima, Serie Documento de Trabajo 32.

Skidmore, T. (1990). Racial ideas and social policy in Brazil, 1870-1940. In: Graham, R., (ed.) *The idea of race in Latin America, 1870-1940*. Edition 3. Texas University Press.

Somoza, J. L. (1973). La mortalidad en la Argentina entre 1869 y 1960, *Desarrollo Económico* 12(48), 807-826.

Steckel, R. (1986). A peculiar population: The nutrition, health, and mortality of American slaves from childhood to maturity, *Journal of Economic History* 46, 721-741.

Steckel, R. (1995). Stature and the standard of living, *Journal of Economic Literature* 33(4), 1903-1940.

Steckel, R. H. and R. Floud (1997). *Health and welfare during industrialization*, The University of Chicago Press.

Steggerda, M. (1943). Stature of South American Indians, *American Journal of Physical Anthropology*, 1(1), 5-20.

Vainer, C. B. and F. Brito (2001). Migration and Migrants Shaping Contemporary Brazil. Presentation at the XXIVth General Population Conference, International Union for the Scientific Study of Population, Salvador, Bahia, Brazil, August 18-24, 2001. Available: http://www.abep.nepo.unicamp.br/iussp2001/cd/Sessao_Especial_Vainer_Brito_Text.pdf

Williamson, J. G. (1995). The evolution of global labor markets since 1830: Background evidence and hypotheses, *Explorations in Economic History* 32, 141-196.

Chapter 2

Motivation and employment effects of FDI: Evidence from German SMEs

2.1 Introduction

Politicians and the media often emphasize the major contribution of small and medium sized enterprises (SMEs) to job creation in the German economy. SMEs provide 60.5% of jobs in Germany, they contribute 52.8% to the total value-added and they play a key role in innovation and R&D (European Commission 2009). However, international activities in general and foreign direct investment (FDI) in particular are attributed to large firms rather than to SMEs. Large firms are said to be more productive, they have better access to finance, are better organized and have better internal expertise to fully explore a major FDI decision. Nevertheless, particularly in Germany, we have observed increasing international activities for SMEs in the last decade. International economic integration provides an important stimulus not only to trade, but also to FDI (European Commission 2003). German SMEs do not only play a major role in the export business, they also invest abroad and have foreign affiliates or joint ventures. This process has been considerably enhanced by the political and economic integration of Central and Eastern Europe and by a continuous decrease in communication and transportation costs.

FDI is often associated with relocation of production since several large firms have in part moved their production from Germany to Eastern Europe, China or India. This process has created a lot of uproar in the media. News about planned production relocations always meet with disapproval or with skepticism from the public. Moreover, not only employees of big firms are afraid of losing their jobs because of relocation of production but also employees of SMEs that pursue international activities. Yet, these concerns are only partly substantiated by empirical work. Empirical studies have

found both positive and negative effects of outward FDI on home employment. However, research has not yet addressed international activities of SMEs and the resulting implications for employment in the home country. There is very little evidence on SMEs and the related employment effects after FDI. Existing research mainly focuses on large firms or does not explicitly differentiate between large firms and SMEs.

To the best of our knowledge, this is the first paper to analyze the employment changes at home and abroad for internationally active SMEs using German firm-level data. We examine a cross-section survey of the German Chambers of Industry and Commerce (DIHK) from the year 2005 that contains a large share of SMEs. We define SMEs as firms that have less than 200 employees and a sales volume of less than 50 million Euro. Most data sets do not provide explicit information on the reasons why firms invest abroad. The DIHK survey asks for detailed self-assessed information on the motivation for the international activity. This allows us to draw a conclusion on the effects of motivation for FDI on home employment changes. Beyond descriptively assessing the international activities and motivations of large firms and SMEs, we contribute to the literature in three ways. First, we provide evidence on how SMEs differ from large firms in their employment behavior after having engaged in FDI. Second, we analyze for all firms if there is a direct relationship between employment at home and abroad. Third, we provide further evidence on how the motivation to invest and the host region of investment affect employment changes in the home country.

A firm's decisions about employment changes at home and abroad are not taken separately. They depend on each other as well as on the same firm-specific characteristics. To assess this question we estimate an ordered probit model in a bivariate framework in which the change in employment at home is estimated simultaneously with the change in employment abroad. The results show that there is a positive correlation between employment change at home and jobs abroad. Thus, employment changes at home and abroad are complements rather than substitutes. We control for size in terms of sales and number of employees. We find that firms with more than 200 employees have a significantly lower probability of positive employment change at home. But, with increasing sales volume the probability of positive employment change increases significantly. As an alternative to size measures in terms of sales and number of employees we include a dummy variable for SME status. We find that compared to large firms, SMEs are more likely to increase their employment at home after FDI. Horizontal motivations have a positive impact on job changes at home after FDI, we find no significant effect of vertical motivations. Relocations of production and investments to Eastern Europe lead to job losses, investments to USA/Canada result in job gains and FDI to Western Europe or Asia has no significant impact.

2.2 Literature review

2.2.1 SMEs and FDI

Reduced barriers to international trade and investment as well as advancements in information and communication technology have created new opportunities for smaller firms to expand internationally (Prasad 1999). Nevertheless, there is little evidence on the characteristics of the increased international activities of SMEs. Even less is known about differences in motivations, investment patterns and related employment changes between large firms and SMEs. Research on SMEs and FDI is instead concentrated on business and management studies that examine the rationale for SMEs investing abroad - their opportunities, threats and benefits. Among the few economic studies, Fujita (1995) uses survey data from the UNCTAD Programme on Transnational Corporations to provide descriptive statistical evidence on trends and patterns of FDI by SMEs. He finds that until 1992 large firms were responsible for the bulk of total FDI in value terms whereas the absolute size of SME's FDI was small in value but large in terms of the number of affiliates with an ongoing upward trend that begun in the 1980s. FDI by SMEs before 1992 was mainly concentrated in developed countries, particularly in manufacturing and in industries that produce capital goods.

General approaches and findings on FDI can possibly not directly be assigned to SMEs as the size of a firm has an important impact on offshoring activities and their determinants. Most important of all, for smaller firms the costs of production disintegration might be higher than the benefits that can be achieved through exploitation of factor price differences (Barba Navaretti and Venables 2004). Buckley (1989) gives an overview of the theoretical background of FDI with special focus on SMEs. He discusses several approaches to the analysis of SMEs' FDI, among others the economics of firm growth and trade theories. He defines two critical issues that may disadvantage smaller firms in particular: shortages in capital and in management expertise. Financial constraints for SMEs are on average more severe than for large firms whereas the fixed monetary costs of FDI and the fixed costs of learning about a foreign environment are high. Moreover, smaller firms face higher risks when they go international. First, the proportion of resources that are put into FDI may be greater for small firms. Second, owner-managers bear higher risks than employed decision makers and third, one single mistaken investment may have substantial implications for the survival of the firm. Consequently, risks and costs of an FDI are a greater barrier for small firms investing abroad than for large firms. Furthermore, recent theoretical and empirical findings suggest that only more productive firms can undertake a foreign direct invest-

ment (Melitz 2003, Helpman et al. 2004). Since there is a consensus that SMEs are on average less productive (Leung et al. 2008, Taymaz 2005) the share of SMEs that can afford to invest abroad is smaller than for large firms.

2.2.2 Motivations for FDI

Research on multinational firms has explored two main reasons for the internationalization of production: Reduction of production costs and market access (see e.g. Barba Navaretti and Venables (2004) for an overview). Horizontally integrated firms gain access to foreign markets through FDI when distance and other barriers to trade make exports less profitable. In horizontally integrated firms, parents and affiliates perform the same stage of production (Markusen 1984). Vertically integrated firms in contrast aim at reducing production costs through internationalization. They benefit from existing factor price differentials between countries by splitting up the production process and relocating labor intensive stages of production into countries where labor is cheaper (Helpman 1984). Vertical investments are assumed to go prevailingly to low-wage or less-developed countries whereas horizontal investments are destined to high-wage or developed countries.

Empirically, the firms' motivations for FDI are difficult to assess, in most data sets the motivation for FDI is not explicitly provided. Furthermore, only very few firms have one clearly defined reason for FDI, most firms pursue both horizontal and vertical motives in their host country (Feinberg and Keane 2006). Yet, horizontal motives seem to prevail. Buch and Kleinert (2006) find that a large part of German FDI into Eastern Europe is driven by the market-access motive, but for some manufacturing sectors the production cost motive is indeed important. Sethupathy (2010) reveals that the vertical share of activity in low-income countries is higher than in high-income countries while vertical and horizontal activities occur in both types of countries.

It is worth asking why SMEs go abroad and whether they differ in their motivations from large firms. Kuo and Li (2003) apply a hazard rate approach to explore the internal and external factors that were significant motivations for Taiwanese SMEs to invest abroad during the period from 1989 to 1996. They find that the motivation for FDI is similar to that for large firms, namely cost reduction and market access. The decisive firm-specific factors motivating SMEs in Taiwan to undertake FDI are size, experience in exporting and low capital intensity. Larger firms and firms with high export ratios are more likely to invest abroad. Exporting thus seems to be an important learning experience for further internationalization. The intention to engage in FDI significantly increases with R&D intensity while a higher capital intensity (or

a lower degree of labor intensity) has a strong negative effect on the likelihood of conducting FDI. A firm with higher capital intensity will suffer less when wages rise, the cost saving motivation is not that essential and thus its hazard rate of investing abroad is lower. Indeed, cheap labor in the host country is one of the most important external factors that motivate SMEs to invest abroad. The major external factors motivating Taiwanese SMEs to conduct FDI in recent years are 'utilizing local labor', 'expanding markets', and 'following major clients'.

2.2.3 FDI and labor market effects

Theoretically, jobs in the parent firm and in the affiliate can be complements as well as substitutes. Both production-cost and market-access driven FDI can have positive as well as negative implications on employment at home. For both horizontal and vertical FDI, the demand for headquarter services may rise after FDI. The employment effects of horizontal FDI are positive if the foreign market is entered through FDI and has not been supplied before. In contrast, jobs at home and abroad are substitutes if the new production abroad replaces exports. For FDI that is driven by vertical motives, the employment effects are likely to be negative in the short run when labor-intensive stages of production are relocated abroad. In particular employment of low-skilled workers may decrease in the host country. On the other hand the firm can save production costs and can thereby improve its competitiveness in the long run such that its market share increases. This in turn could lead to an increasing demand for labor in the parent firm. But, on the aggregate level this effect may be negative as other firms lose market share and consequently shed jobs. Sethupathy (2010) calls this productivity or market share switching effect also the 'business-stealing' effect. Furthermore, the job dynamics after FDI affect different skill types differently. Vertically investing firms offshore low-skilled jobs while they create new jobs for high-skilled workers in the home country. Feenstra and Hanson (1996) were the first to mention this 'labor composition effect'.

2.2.4 Empirical evidence on labor market effects of FDI

A large empirical literature investigates the effects of trade, outsourcing, offshoring and FDI on job security, employment composition and wages for several countries, yet there is no specific research on SMEs.

We focus only on studies that investigate the effects of FDI on the employment level in the home country. Still, the results are to some extent ambiguous as the studies use different econometric approaches, aggregation levels and measures for international

activity. Mostly depending on the host country of FDI, some studies find negative effects of FDI on job changes in the home country, especially for low-skilled workers, others find positive or no significant effects. For this reason it is rather difficult to compare the results.

Just to name a few studies, Becker et al. (2005) come to the conclusion that affiliate employment of Swedish and German MNEs tends to substitute for employment at the parent level. Konings and Murphy (2006) analyze European MNEs from 1993-1998 and find small substitution effects of parent and affiliate employment. Falk and Wolfmayr (2010) investigate the elasticity of substitution for parent firms from 14 Western European countries and their affiliates in 25 European countries for the period 2000-2004. They also find a low elasticity of substitution for jobs in affiliates located in the 14 Western European countries. Yet, for affiliates in the CEEC they find no substitution effect. Debaere et al. (2010) reveal that in the period between 1968 and 1996 South Korean FDI to developed countries did not affect employment growth whereas firms with FDI to less developed countries had lower employment growth rates compared to their domestic counterparts. Barba Navaretti et al. (2009) use Italian and French data for the years 1993-2000 and find that FDI to least developed countries have had a positive effect on employment. Becker and Muendler (2008) show that German firms that expanded their FDI between 1999 and 2001 were more likely to secure jobs in the home country than their non-expanding competitors.

Recently, some authors addressed the question of why the results of existing empirical studies are ambiguous. Moser et al. (2009) claim that the results are contradictory since they have not been able to disentangle the two effects that determine the employment changes after vertical investment, the downsizing and the productivity or market share switching effect. Sethupathy (2010) follows this reasoning and formalizes the productivity effect theoretically. Horgos (2009) points out the importance of measurement for analyzing labor market effects of international outsourcing. He finds that differences in estimated effects are not only attributable to the use of different data, but depend strongly on differences in measurement and on the level of industry aggregation.

Differences in employment changes between SMEs and large firms are a topic only on the periphery of the literature. Most studies use industry level data, therefore the heterogeneity of firms cannot be captured. In firm level studies, firm size in terms of sales and/or number of employees is sometimes included as a control variable into the regressions. To draw a conclusion on the changes in employment related to size effects we review some of these studies. Munch (2010) estimates a standard duration model as well as a competing risks duration model to study the effect of outsourcing on

individual job separation in the Danish manufacturing sector for the period 1990-2003. He includes a dummy for whether the worker's workplace has 50 or more employees as a control variable without further discussing or interpreting the coefficient in the results. The coefficient has a negative sign and is significant on the 5% level, indicating that workers in firms that have 50 or more employees have a lower probability of losing their jobs after outsourcing. Harrison et al. (2007) explicitly distinguish between 'small' and 'large' firms by giving extra weights in the regressions to larger firms that hire relatively more workers. They find that small firms tend to have affiliates only in high-income countries while large firms tend to have affiliates in both high- and low-income countries. Buch and Kleinert (2006) state that Eastern enlargement is often viewed as the key trigger of German SMEs expansion into foreign markets, enabling them to benefit from lower labor costs and to relocate production abroad. The benefits in labor costs may however come with employment losses in the home countries of FDI. They also find that size of the parent has a positive impact on the probability of investing in Eastern Europe. German affiliates in the CEEC employ more labor than affiliates in Western Europe. Furthermore, German affiliates in Eastern Europe are smaller in terms of sales, though this may reflect the age of the affiliates since multinational activity in the CEEC started only in the 1990s.

Germany's Federal Statistical Office reports first descriptive evidence in a policy report based on a pilot survey (Destatis 2008): Firms with 100 to 250 employees are responsible for the largest share of jobs that have been relocated away from Germany. Moreover, these firms with 100 to 250 employees created only 45.5 new jobs per 100 relocated jobs while firms with 250 to 500 employees have a job turnover ratio of 58.8 new jobs per 100 relocated jobs. Firms with 500 to 1000 employees have a ratio of 66.9 and firms with 1000 and more employees contribute with 60.2 new jobs per 100 relocated jobs. Yet, an EU commissioned study on internationalization of SMEs concludes that internationally active SMEs report higher employment growth (European Commission 2010).

2.2.5 Implications for our work

According to the findings above discussed there is no reason to expect that SMEs invest for different reasons than large firms, nor that the impact of motivation and the host region on employment change is different. The theoretical effects of employment changes after FDI are multifaceted and depend on several factors that are not observable either in our data or in most other data sets. As a result, the existing empirical evidence is not unambiguous either. Therefore, it is difficult to derive well-defined pre-

dictions for our empirical results concerning the effects of motivation and host country on employment after FDI. Nonetheless, we expect that the employment changes after FDI are more positive for SMEs than for large firms as firm growth tends to decrease with firm size (Evans 1986). Although disputed (Davis et al. 1996), there is evidence that as a consequence net job creation rates are higher for SMEs than for large firms (OECD 1996, Hijzen et al. 2010).

2.3 Data and descriptives

The data set is based on the survey 'Going international - success factors in international business', which was collected by the German Chambers of Industry and Commerce (DIHK) in autumn 2005. The questionnaire was sent to 55,000 DIHK member firms from 55 industries that were known to have international business activities and were located in one of the sixteen German Federal States (excluding Lower Saxony). Most of the firms are based in the largest federal states Bavaria (17.4%), North Rhine-Westphalia (15.4%) and Baden-Württemberg (21.1%). The total number of responses was 4,325, which corresponds to a response rate of 8 percent. According to the DIHK, practically all firms in Germany that are internationally active are also members of one local Chamber of Industry and Commerce (IHK) as the membership is mandatory for all German firms that are active in industry and trade. The participating firms were not chosen randomly but from an internal IHK database that contains all members that operate internationally. Members have to report, at least once in three years, whether they import or export, produce abroad, have a subsidiary, agency, investment or licensing partners abroad. The survey further includes IHK members that have subscribed to an international business newsletter and firms that make use of the A.T.A. carnet, an international customs document for temporary admission of tax-free imports.

Apart from the fact that the dataset consists only of internationally active firms we do not expect to face a selection problem regarding IHK membership. Despite the low response rate the data set has several advantages that outweigh its drawbacks. In particular, it allows us to study the behavior of internationally active SMEs and offers detailed information on several international activities. One further advantage of the survey is that the firms were asked to report their motivation for the foreign activity, an important and theoretically decisive piece of information for the changes in employment after FDI which is often not included in official statistics. However, a shortcoming of the dataset is that most information is coded categorically.

2.3.1 International activities and regression sampling

Table 2.1 displays the international activities of large firms and SMEs in nine not mutually exclusive categories for seven world regions. The share of large firms that have stated to have a specific activity abroad is almost always higher than the share of corresponding SMEs. Only non-binding cooperation seems to matter more for SMEs than for large firms, although the difference is not statistically significant for every region. Exporting and sourcing of materials are the most common ways to access foreign markets, for SMEs as well as for large firms. We observe the largest gap between the activity shares of large firms and SMEs in the categories that can be defined as FDI: 'sales office', 'affiliate', 'joint venture', 'purchasing office' and 'R&D'. The share of large firms with these activities is - except for sales offices - more than twice as large as for SMEs. This points to the fact that FDI is still an activity that prevails for large firms whereas exports are almost likewise important for SMEs and for large firms. In this paper we give an assessment of the firms' employment changes in the home country after they have invested abroad. For the following analysis the data set is therefore constrained only to those firms that have at least one sales office, affiliate, joint venture, purchasing office or R&D abroad. This selection makes sure that we consider only firms that invest abroad. By considering only firms that have no missing information in the variables that are relevant for the regression, the sample reduces to 1,051 observations. All the following statistics and results refer to this reduced sample of FDI firms.[1]

[1]For a description of the types and regions of the activities for the firms in the regression sample see Appendix Table 2.8.

Table 2.1: Types and regions of international activity

The numbers refer to percentages of active SMEs in the sample, percentages for large firms in parenthesis. N SMEs=3,630; N large firms=695.

	EU 15 / EFTA	10 new EU members since 2004	EU candidates for membership in 2004[1]/ CIS	USA / Canada	Asia / Pacific	Latin America	Africa	activity in at least one region
Export	70.6***	45.8***	31.4***	31.8***	37.2***	16.4***	15.4***	80.4***
	(81.0)	(64.9)	(52.5)	(52.1)	(57.7)	(38.3)	(33.7)	(85.8)
Sourcing of materials	35.7***	20.3***	6.0***	7.9***	19.1***	1.7***	1.2***	50.6***
	(52.1)	(33.2)	(10.2)	(18.1)	(31.2)	(7.2)	(3.4)	(62.9)
Import	16.6***	8.9***	3.8*	3.9***	11.5*	1.2***	1.0***	25.1
	(21.4)	(14.8)	(6.0)	(8.2)	(14.0)	(4.3)	(3.0)	(27.2)
Non-binding cooperation	17.6**	12.7	8.5	7.4	10.7	3.9***	3.3***	30.1
	(14.1)	(11.9)	(9.8)	(5.9)	(11.5)	(6.6)	(6.5)	(27.9)
Sales office	18.4***	9.6***	7.7***	8.0***	12.1***	3.7***	2.8***	29.5***
	(36.0)	(24.0)	(23.9)	(20.1)	(30.1)	(14.4)	(10.9)	(50.8)
Affiliate	8***	6.3***	2.9***	5.5***	4.3***	1.2***	0.5***	18.6***
	(48.1)	(29.6)	(13.1)	(32.4)	(26.3)	(15.8)	(9.9)	(62.3)
Joint venture	3.2***	2.0***	1.9***	1.4***	3.7***	0.7**	0.8**	9.5***
	(8.5)	(4.5)	(5.3)	(4.2)	(13.7)	(2.2)	(2.0)	(24.9)
Purchasing office	1.3	0.5	0.4	0.2	1.9	0.1	0.1	3.8
	(3.2)	(1.4)	(1.4)	(1.7)	(6.0)	(1.3)	(0.1)	(9.1)
R&D	3.8***	1.1***	1.0	1.2***	1.3***	0.1***	0.2	6.5***
	(13.5)	(3.3)	(1.0)	(7.5)	(5.3)	(2.2)	(0.6)	(18.0)
At least one activity	78.6***	57.8***	38.5***	38.5***	50.8***	20***	18.3***	
in region	(91.9)	(80.9)	(64.0)	(64.3)	(72.2)	(48.1)	(41.1)	

Notes: Only firms that have at least one sales office, affiliate, joint venture, purchasing office or R&D are included in the further analysis.
Two-sample t-test under the assumption of equal variances. *, ** and *** indicate significance at the 10 %, 5 % and 1 % levels, respectively.
[1] Bulgaria, Romania, Croatia and Turkey.

2.3.2 Motivations for international activity

The questionnaire includes 17 not mutually exclusive response options to inquire about the motivation for the firms' international activities. Table 2.2 shows the share of large firms vs. SMEs that agreed to the respective pre-formulated reasons for their international activity.

Table 2.2: Motivation for FDI

(in percent of affirmative answers)	large firms	SMEs	t-test p-value
Horizontal motivations			
Opening up new markets (sale)	96.6	94.7	0.139
Opening up new markets (purchase)	56.8	62.9	0.065*
Customer request / proximity to customer	69.3	59.6	0.002***
Favourable competitive environment / market conditions	59.0	60.4	0.664
Service / aftersale	29.5	33.4	0.205
Vertical motivations			
Lower labor costs / material costs	45.9	42.9	0.371
Lower taxes and social security contributions	28.6	30.3	0.561
Better employment law abroad	28.6	28.8	0.937
Higher productivity	21.3	24.7	0.224
Other motivations			
Less regulation / bureaucracy	26.1	33.8	0.011**
Promotion and support programmes	23.1	28.3	0.073*
Personal reasons / coincidental contacts	19.1	31.6	0.000***
Lower customs	20.4	24.6	0.118
Avoidance of other, non-tariff-related barriers to trade	18.5	21.5	0.267
Better availability and qualification of employees	18.2	24.5	0.019**
Better know how in R&D	17.0	21.2	0.106
Better infrastructure	17.6	20.4	0.291
N	329	722	

Notes: No category for other, non-preformulated answers available. Two-sample t-test under the assumption of equal variances. *, ** and *** indicate significance at the 10 %, 5 % and 1 % levels, respectively.

Five out of the 17 possible answers can be denoted as horizontal (or market seeking) and four as vertical (or cost saving) motivation. The remaining other potential answers are neither clearly horizontal nor vertical and are subsumed in the category 'other motivations'. This category also contains the traditional reasons for FDI like 'lower customs' and 'non-tariff-related barriers to trade'. The most important reasons for FDI

are clearly horizontal. 96.6% of large firms and 94.7% of SMEs agreed that opening up new markets for selling products is one of their main reasons for being active abroad. Among the remaining horizontal reasons proximity to customers seems to be more of an issue for large firms whereas opening up new markets for puchasing is more important for SMEs. Cost saving reasons come second, both for large firms and for SMEs. This is in line with Buch et al. (2005) who find that German FDI is mostly driven by market access motives. Regarding the other non-horizontal and non-vertical motivations, there are some differences between SMEs and large firms that are noteworthy: Remarkably, a higher share of SMEs agree that bureaucratical reasons and support programmes are an important issue for internationalization. Better availability and qualification of employees are on average more important for SMEs than for large firms as are personal reasons and coincidental contacts.

From these answers we construct a categorical variable for motivation that will later serve as explanatory variable. For this purpose we create an index that captures a firm's motivation to invest abroad in five categories ranging from purely vertical to purely horizontal. This index is generated from the ratio of horizontal to vertical answers that a firm has indicated, giving equal weight to all stated reasons. For example, the index for a firm which agreed to three out of five horizontal reasons and to one out of four vertical reasons is $\frac{3/5}{1/4} = 2.4$. The resulting values from these calculations ranging from 0 to 4 are subsumed to four ordered categories. For firms with purely horizontal reasons the index is incalculable, we assign them the highest value of the index. Hence, the variable 'motivation' consists of the five following categories:

- 1 - predominantly vertical motivation (index<1)
- 2 - equal vertical and horizontal motivation (index=1)
- 3 - rather horizontal motivation (1<index<2) or solely other motivations than horizontal or vertical indicated
- 4 - predominantly horizontal motivation (2<index<4)
- 5 - purely horizontal motivation (no vertical motives and at least one horizontal motive, index incalculable)

According to this scheme the firm in the example above belongs to category 4.

Table 2.3: Summary statistics regression sample

	large firms	SMEs	t-test p-value
N	329	722	
Employment change at home (c)			
decreased	24.6	26.0	0.623
unchanged	27.7	37.8	0.001***
increased	47.7	36.2	0.000***
Employment change abroad (c)			
decreased	5.5	9.8	0.009***
unchanged	15.2	36.7	0.000***
increased	79.3	53.5	0.000***
Number of employees in 2004 (c)			
<20	9.1	38.4	0.000***
20-49	3.0	24.0	0.000***
50-99	4.9	17.4	0.000***
100-199	8.8	20.2	0.000***
>200	74.2	-	
Sales in 2004 in EUR (c)			
<=0.5mio	-	7.8	
0.5-2.5mio	0.6	18.3	0.000***
2.5-10mio	3.3	39.2	0.000***
10-25mio	7.9	24.6	0.000***
25-50mio	17.0	10.1	0.000***
>50mio	71.1	-	
Amount invested abroad in the last 5 years in EUR (c)			
<200t	13.7	56.4	0.000***
200-500t	7.9	18.7	0.000***
500t-1mio	13.4	10.1	0.137
1-5mio	27.7	12.2	0.000***
>5mio	37.4	2.6	0.000***
Relocation of production (d)	63.1	47.3	0.000***
Motivation (c)			
purely vertical (1)	5.7	4.9	0.606
prevailingly vertical (2)	11.7	15.6	0.103
likewise vert. and hor./other (3)	16.1	14.4	0.489
prevailingly horizontal (4)	17.1	10.2	0.006***
purely horizontal (5)	49.3	55.0	0.107
FDI to Eastern Europe (d)	70.5	52.9	0.000***
FDI to Western Europe (d)	84.8	62.7	0.000***
FDI to USA/Canada (d)	57.1	35.0	0.000***
FDI to Asia (d)	57.5	39.9	0.000***

Notes: Summary statistics in percent. N=1,051. SMEs are firms that have less than 200 employees and a sales volume of less than 50 mio EUR. Comparison of means with two-sample t-tests under the assumption of equal variances. *, ** and *** indicate significance at the 10 %, 5 % and 1 % levels, respectively. d = dummy variable, c = categorical variable.

2.3.3 Summary statistics

Table 2.3 displays the descriptive statistics for the variables used in the estimation of the bivariate ordered probit model on employment changes after FDI. SMEs are defined as firms that have less than 200 employees and a sales volume of less than 50 million Euro.[2] We cannot quantify aggregate employment effects as the dataset does not contain the exact number of dismissed and newly hired employees. However, we know the direction of the employment changes at home and abroad and the motivations for FDI. The firms were asked if the number of employees at home and abroad has decreased, increased or stayed the same since the beginning of the international activity. Accordingly, the two dependent variables in the bivariate ordered probit regressions are the change in employment at home and the change in employment abroad, each with the three categories 'decreased', 'unchanged' and 'increased'.

2.4 Analysis of employment changes after FDI

We analyze empirically whether FDI leads to job losses or job gains in the home country while taking into account employment changes in the host country. Our variable of interest 'employment change at home' is ordered in three categories. An ordered probit model could therefore provide empirical evidence about the changes in a firm's work force in the home country after an FDI. However, it can be assumed that while deciding whether to increase, decrease or to keep the workforce at home constant a firm also considers the changes in employment abroad. Hence, employment change at home and abroad are not independent from each other. In fact they are both a function of possibly the same firm-specific characteristics. Therefore, the estimation of an ordered probit framework would lead to the following problems: Not considering the employment change abroad in the regression could result in an omitted variable bias. In contrast, including the change in employment abroad as explanatory variable would neglect the endogeneity of the variable, leading to potentially biased parameter estimates. In order to take account of this fact, the empirical analysis is based on the estimation of a bivariate ordered probit model with two dependent variables, the changes in employment abroad and at home. This bivariate approach can capture to some extent the interactions and tradeoffs between the two interdependent decisions.

[2]This definition slightly differs from the definition of the EU commission (less than 250 employees and a sales volume of less than 50 million Euro) because the information on sales and the number of employees is only available in categories.

2.4.1 The bivariate ordered probit model

The estimation of the joint probability distribution of two ordered categorical variables is not very common in the economic literature, although it is applicable in a variety of settings. Sajaia (n.d.) provides the Stata routine 'bioprobit' to estimate the joint probability distribution of two ordered categorical variables. The program computes the general full-information maximum likelihood (FIML) estimates of this model for two variants, the simultaneous and the seemingly unrelated (SUR) variant. As for the binary probit model, the model specification for bivariate ordered probit can be derived from the latent variable model (Sajaia n.d.). The idea behind ordered probit models is that the observed variable represents ranges of an unobserved latent variable whose cut-offs are unknown. The general specification for a two-equation model with correlated error terms and the dependent variables y_{1i}^* and y_{2i}^* is:

$$y_{1i}^* = \mathbf{x}_{1i}^{'}\beta_1 + \varepsilon_{1i} \tag{2.1}$$

$$y_{2i}^* = \mathbf{x}_{2i}^{'}\beta_2 + \gamma y_{1i}^* + \varepsilon_{2i} \tag{2.2}$$

where β_1 and β_2 are vectors of unknown parameters, γ is an unknown scalar, ε_1 and ε_2 are the error terms. The explanatory variables in the model satisfy the conditions of exogeneity such that $E(x_{1i}\varepsilon_{1i}) = 0$ and $E(x_{2i}\varepsilon_{2i}) = 0$. It can be assumed that ε_1 and ε_2, the error terms of the two equations, are correlated, because they represent unobserved factors that may be relevant for both processes, the change in employment after FDI at home and abroad. The bivariate ordered probit model takes account of this correlation of the two error terms. The two observed variables 'employment change abroad' (y_{1i}^*) and 'employment change at home' (y_{2i}^*) are both categorical with three possible outcomes and two unknown cutoffs where $c_{11} < c_{12}$ and $c_{21} < c_{22}$:

$$y_{1i} = \begin{cases} 1 \text{ (decreased)} & \text{if} \quad y_{1i}^* \leq c_{11} \\ 2 \text{ (unchanged)} & \text{if} \quad c_{11} < y_{1i}^* \leq c_{12} \\ 3 \text{ (increased)} & \text{if} \quad c_{12} < y_{1i}^* \end{cases} \qquad y_{2i} = \begin{cases} 1 & \text{if} \quad y_{2i}^* \leq c_{21} \\ 2 & \text{if} \quad c_{21} < y_{2i}^* \leq c_{22} \\ 3 & \text{if} \quad c_{22} < y_{2i}^* \end{cases}$$

The probability that e.g. $y_{1i} = j$ and $y_{2i} = k$ with j,k = 1,2,3 is:

$$\begin{aligned} Pr(y_{1i} = j,\ y_{2i} = k) &= Pr(c_{1j-1} < y^*_{1i} \leq c_{1j},\ c_{2k-1} < y^*_{2i} \leq c_{2k}) \\ &= Pr(y^*_{1i} \leq c_{1j},\ y^*_{2i} \leq c_{2k}) - Pr(y^*_{1i} \leq c_{1j-1},\ y^*_{2i} \leq c_{2k}) \\ &- Pr(y^*_{1i} \leq c_{1j},\ y^*_{2i} \leq c_{2k-1}) + Pr(y^*_{1i} \leq c_{1j-1},\ y^*_{2i} \leq c_{2k-1}) \end{aligned} \tag{2.3}$$

If the two error terms ε_1 and ε_2 are distributed bivariate standard normal with correlation ρ, the individual contribution to the likelihood function can be expressed as:

$$\begin{aligned} Pr(y_{1i} = j,\ y_{2i} = k) = \Phi_2(&c_{1j} - x^{'}_{1i}\beta_1, (c_{2k} - \gamma x^{'}_{1i}\beta_1 - x^{'}_{2i}\beta_2)\zeta, \tilde{\rho}) \\ -\Phi_2(&c_{1j-1} - x^{'}_{1i}\beta_1, (c_{2k} - \gamma x^{'}_{1i}\beta_1 - x^{'}_{2i}\beta_2)\zeta, \tilde{\rho}) \\ -\Phi_2(&c_{1j} - x^{'}_{1i}\beta_1, (c_{2k-1} - \gamma x^{'}_{1i}\beta_1 - x^{'}_{2i}\beta_2)\zeta, \tilde{\rho}) \\ +\Phi_2(&c_{1j-1} - x^{'}_{1i}\beta_1, (c_{2k-1} - \gamma x^{'}_{1i}\beta_1 - x^{'}_{2i}\beta_2)\zeta, \tilde{\rho}) \end{aligned} \tag{2.4}$$

where Φ_2 is the bivariate standard normal cumulative distribution function with $\zeta = \frac{1}{\sqrt{1+2\gamma\rho+\gamma^2}}$ and $\tilde{\rho} = \zeta(\gamma + \rho)$.

If $\gamma \neq 0$, the specification is denoted as simultaneous bivariate ordered probit model. In this case an exclusion restriction has to be imposed for identification of the parameters in equations (2.1) and (2.2). At least one element in x_{1i} that is correlated with y^*_{1i} but independent of ε_{1i} must not be comprised in x_{2i} in order to obtain consistent estimates of γ, β_2 and ρ. This variable is interpreted as a valid instrument to correct the endogeneity bias when we estimate the parameters of (2.2).

Under the assumption that γ=0, the model simplifies to the seemingly unrelated model (SUR) where ζ=1 and $\tilde{\rho}$=ρ. In this case the equations (2.1) and (2.2) are not directly related to each other, but through the correlation in the error terms ρ. The logarithmic likelihood of an observation i is then

$$lnL_i = \sum_{j=1}^{J}\sum_{k=1}^{K} I(y_{1i} = j, y_{2i} = k)\ \ lnPr(y_{1i} = j, y_{2i} = k) \tag{2.5}$$

To get the log likelihood for the entire sample of size N we can sum up (2.5) across all observations, under the assumption that the observations are independent:

$$ln\ \mathfrak{L}_i = \sum_{i=1}^{N}\sum_{j=1}^{J}\sum_{k=1}^{K} I(y_{1i} = j, y_{2i} = k)\ \ lnPr(y_{1i} = j, y_{2i} = k) \tag{2.6}$$

For our analysis we assume that the processes that determine the two outcomes, i.e. the change in employment at home and abroad, are not only related through the correlation of the error terms but have a direct effect on each other, such that $\gamma \neq 0$. More specifically, the employment situation abroad is crucial for a firm deciding about employment changes at home. Accordingly, we estimate the simultaneous variant. We determine equation (2.1) to stand for the employment change at home and equation (2.2) for the employment abroad, because we implement the exclusion restriction, the explanatory variable 'amount of FDI', in equation (2.2). In the SUR specification without exclusion restriction the ordering of the equations is irrelevant.

2.4.2 Regression results

Table 2.4 shows the results of four different simultaneous bivariate ordered probit regressions. The two dependent variables are the change in employment at home and the change in employment abroad, each with the three categories: decreased, unchanged and increased (in ascending order). The regression results for employment change at home and abroad are given separately for each regression.

We include the amount of FDI in the last five years as additional explanatory variable for employment changes abroad. This serves as exclusion restriction, as the amount of FDI is part of x_{1i} in equation (2.1) but not of x_{2i} in (2.2). We assume that the level of FDI affects the change in employment abroad directly but has no direct impact on the change in employment at home, except through the influence of the changes in employment abroad. It is reasonable to expect that a higher amount of FDI results in more positive changes in employment abroad, but that it is not related to the employment changes at home. Admittedly, the use of this instrument can be viewed as critical. However, the choice of the exclusion restriction is not that crucial as we repeat our estimation with the SUR specification, where no exclusion restriction is needed, in the next section. All other exogenous variables that explain the changes in the levels of the latent dependent variables appear in both equations of the model. As for probit and ordered probit regressions, the regression coefficients can not be interpreted quantitatively. The increase in probability attributed to a one-unit increase in a given explanatory variable depends both on the values of the other variables and the starting value of the given variable. The interpretations of the regression coefficients are therefore based only on the significance and the sign of the coefficient, which indicates the direction of influence. A positive coefficient means that an increase in the explanatory variable leads to an increase in the probability of higher outcomes for the dependent variable and vice versa.

Table 2.4: Estimation results of the bivariate ordered probit model - simultaneous regression

	A		B		C		D	
employment change	abroad	at home	abroad	at home	abroad	at home	abroad	at home
amount of FDI	0.158***		0.164***		0.164***		0.162***	
	(0.034)		(0.033)		(0.033)		(0.033)	
sales <0.5 mio							-0.434*	-0.886***
							(0.234)	(0.242)
sales 0.5-2.5 mio	0.247	0.201	0.355**	0.134	0.358**	0.134	-0.075	-0.762***
	(0.164)	(0.170)	(0.156)	(0.174)	(0.157)	(0.174)	(0.219)	(0.203)
sales 2.5-10 mio	0.251	0.409**	0.329**	0.397**	0.329**	0.396**	-0.103	-0.528***
	(0.165)	(0.174)	(0.153)	(0.170)	(0.153)	(0.170)	(0.207)	(0.188)
sales 10-25 mio	0.430**	0.562***	0.507***	0.539***	0.508***	0.539***	0.061	-0.429**
	(0.181)	(0.196)	(0.170)	(0.201)	(0.171)	(0.201)	(0.193)	(0.173)
sales 25-50 mio	0.600***	0.710***	0.551***	0.619***	0.552***	0.618***	0.031	-0.326*
	(0.227)	(0.246)	(0.207)	(0.239)	(0.207)	(0.239)	(0.185)	(0.169)
sales >50 mio	0.673***	0.792***	0.661***	0.715***	0.661***	0.715***		
	(0.211)	(0.251)	(0.197)	(0.251)	(0.197)	(0.251)		
20-49 empl	-0.070	-0.069	-0.046	-0.067	-0.045	-0.067		
	(0.134)	(0.128)	(0.125)	(0.124)	(0.125)	(0.124)		
50-99 empl	0.061	-0.004	0.077	-0.038	0.078	-0.038		
	(0.142)	(0.145)	(0.135)	(0.140)	(0.135)	(0.140)		
100-199 empl	-0.136	-0.232	-0.061	-0.272*	-0.060	-0.272*		
	(0.153)	(0.146)	(0.145)	(0.142)	(0.145)	(0.142)		
>200 empl	0.018	-0.282*	0.007	-0.368**	0.007	-0.369**		
	(0.173)	(0.170)	(0.160)	(0.163)	(0.160)	(0.163)		
SME							-0.250	0.438***
							(0.169)	(0.165)
Eastern Europe	0.238***	-0.269***	0.297***	-0.280***	0.297***	-0.281***	0.301***	-0.301***
	(0.086)	(0.104)	(0.083)	(0.103)	(0.083)	(0.103)	(0.083)	(0.104)
Western Europe	0.053	-0.057	0.107	-0.058	0.106	-0.058	0.101	-0.069
	(0.101)	(0.089)	(0.094)	(0.088)	(0.095)	(0.088)	(0.094)	(0.089)
USA/Canada	0.063	0.318***	0.101	0.296***	0.100	0.296***	0.102	0.279***
	(0.094)	(0.087)	(0.092)	(0.089)	(0.092)	(0.089)	(0.092)	(0.090)
Asia	0.254***	-0.013	0.251***	-0.024	0.251***	-0.024	0.252***	-0.039
	(0.089)	(0.099)	(0.085)	(0.098)	(0.085)	(0.098)	(0.085)	(0.099)
motivation (index)	0.028	0.077**						
	(0.033)	(0.030)						
horizontal			0.049	0.267***	0.046	0.266***	0.048	0.265***
			(0.088)	(0.083)	(0.088)	(0.084)	(0.088)	(0.084)
vertical					-0.050	-0.017	-0.041	-0.023
					(0.189)	(0.182)	(0.189)	(0.184)
reloc. prod.			0.077	-0.192**	0.078	-0.192**	0.078	-0.198**
			(0.093)	(0.093)	(0.093)	(0.093)	(0.093)	(0.093)
gamma	0.175		0.344*		0.345*		0.387*	
	(0.199)		(0.197)		(0.197)		(0.199)	
rho	0.341		0.179		0.178		0.146	
	(0.201)		(0.194)		(0.195)		(0.193)	
Observations	1,051		1,051		1,051		1,051	
Wald Chi2	194.29		218.91		219.04		221.89	
	(df=47)		(df=48)		(df=49)		(df=46)	
Prob>chi2	0.000		0.000		0.000		0.000	
Wald test of ind.equ.								
Chi2(1)	3.18		0.87		0.86		0.55	
Prob>chi2	0.074		0.350		0.354		0.458	

Notes: The dependent variable is employment change abroad and at home in 3 categories: decreased, unchanged, increased. Each regression includes dummies for industry and region. Robust standard errors in parentheses. *, ** and *** indicate significance at the 10 %, 5 % and 1 % levels, respectively. The reference category are firms with less than 20 employees and a sales volume of less than 0.5 mio Euro (regressions A-C) or large firms with more than 200 employees and a sales volume of more than 50 mio Euro (regression D).

Motivation and Relocation

We include the categorical variable for a firm's motivation that ranges from predominantly vertical motivation (lowest value) to purely horizontal motivation (highest value) only in specification A. In all other specifications the motivation enters through two dummy variables for predominantly vertical and purely horizontal motivation, with the other values in between the two as the reference category.

The coefficient estimates for the dummy variable for horizontal motivation are significant and positive in the home country equations, suggesting a higher probability of unchanged or increasing employment level at home after investing abroad for firms with horizontal motivations. Firms with vertical reasons for investment do not significantly differ from firms with mixed or other motivations, but the coefficient shows the expected negative sign. Vertical motivations are very often associated with relocation of production. However, not all firms that indicate vertical motives have also relocated their production, therefore vertical motivations do not necessarily lead to job losses. We have excluded the dummy variable for vertical motivation in specification B to test whether the dummy for relocation of production captures this effect. This does not seem to be the case. However, firms that have relocated their production are significantly more inclined to reduce their workforce in the home country. For the changes in employment abroad, however, production relocations and the motivation of the firm do not have any significant explanatory power.

Regions

The coefficients for the host regions of FDI are more telling. This group of dummy variables has no reference category as a firm may have investments in more than one region, therefore the variables are not perfectly multicollinear.[3] For investment to countries with similar factor endowments such as Western Europe and USA/Canada we would expect a positive or a negative job change in the home country depending on whether the investments are substituting for exports or not. Investment to regions with different factor endowments should lead to a decrease in employment at home. Thus, for Eastern Europe we expect a negative coefficient. The category for the Asia/Pacific region contains countries with similar (Japan, Korea) as well as different (China, Vietnam) factor endowments which makes it difficult to make predictions about the resulting coefficient. The positive coefficient estimate for FDI to Eastern Europe in the abroad-equations indicates a high probability of an increase in

[3]However, as a sensitivity check we have estimated the regressions without the dummy for Western Europe, see Appendix Table 2.9.

employment abroad after FDI. In the home-equations the coefficient has a negatively significant sign, confirming the presumption that FDI to Eastern Europe has negative effects on employment in the home country. In contrast, FDI to Western Europe, though having a negative sign in the home equations, does not have any significant influence on employment changes either at home or abroad. The coefficients for FDI to USA/Canada are again very clear-cut. FDI to USA/Canada does significantly affect the employment at home in a positive way such that firms investing there have a higher probability of creating new jobs in the home country. The coefficient for Asia is difficult to interpret as the countries within this region have very heterogeneous factor endowments. However, FDI to Asia does not have a significant influence on employment at home although the coefficient is negative. The probability of job creation abroad in contrast increases with FDI to Asia. The overall results for the regions support the hypothesis that investment to countries with lower labor costs usually leads to employment losses at home and vice versa. The differences in the coefficients for Western Europe and USA/Canada for investment to countries with similar factor endowment bring out the importance of distance. Investment to the more distant region USA/Canada increases employment at home, whereas investment to Western Europe does not have a significant impact but a negative sign. We suspect that in order to explore a neighboring market firms start with exports and if this proves to be successful, the firm replaces the exports by production in subsidiaries abroad. This could explain the negative sign for Western Europe. For more distant regions, exports may not be profitable and so the firm enters the market from the beginning through FDI, therefore employment at home increases through an increase in headquarter services in the home country.

Sales and number of employees

Size in terms of sales is positively correlated with the probability of positive changes in employment at home. The higher the sales of a firm, the lower the probability that this firm will shed jobs after FDI. Regarding the number of employees, firms with more than 200 employees are less likely to have positive or neutral employment changes after FDI. In regression D we include a dummy variable for SMEs instead of the employment categories. The coefficient for SMEs has a positive and significant coefficient estimate in the home-equation, suggesting that for SMEs the probability of a positive employment change in the home country after FDI is higher, all else being equal. Yet, SMEs with a higher sales volume have a higher probability of a positive or neutral job turnover at home.

Gamma and rho

The coefficient γ that stands for the partial correlation of the employment changes abroad and at home is weakly significant in three specifications and has a positive sign, indicating that there is a positive relationship between employment changes abroad and at home. This points to the fact that jobs abroad and at home are rather complements than substitutes. The correlation coefficient for the correlation of the error terms ρ lies between 15 and 35 percent and is statistically not significant. This means that after controlling for the interdependence captured by γ there remains no significant correlation in the error terms of the two equations.

Furthermore the table reports two Wald tests. The first one tests the joint significance of the estimation coefficients. The second one tests the hypothesis that the two equations are independent. As expected, given the comparatively low values of ρ, the null cannot be rejected, except for the first regression at the 10% level.

Marginal probabilities

Table 2.5 reports the changes in the marginal probabilities for the three possible marginal outcomes of the home equation if the respective significant dummy variable changes its value from zero to one.

Table 2.5: Percentage changes in predicted marginal probabilities

employment at home	decreased	unchanged	increased
Motivation horizontal	-36.7%	-4.9%	38.9%
Relocation of Production	31.3%	2.4%	-17.7%
USA/Canada	-41.3%	-5.6%	43.6%
Eastern Europe	16.3%	0.9%	-9.7%
SME	-22.5%	2.6%	18.7%

Notes: Results based on simultaneous regression D from Table 2.4, only significant variables included.

The probability that an average SME in our sample reports that it has decreased its employment at home after FDI is 22.3% lower than for a comparable large firm. Concurrently, the probability that a firm's employment remains unchanged after FDI is 2.9% lower for SMEs whereas the probability that a firm increases its employment is 18.8% higher for SMEs. All else being equal, SMEs are less likely to report job losses after FDI than large firms. The strongest changes in marginal probability can be noted for firms that have invested in USA/Canada: the probability that employment in the home country increases, increases by 43.7% if a firm had invested to USA/Canada compared to firms that have not invested in this region. Finally, firms that have relo-

cated their production show the most negative employment effects. Their probability of a decrease in employment at home is 31.3% higher relative to firms that have not relocated their production.

Predicted outcomes

In Table 2.6 we compare the predicted probabilities for each combination of outcomes for the change in employment abroad and at home as given by the estimated model with the actual probabilities in the sample. The percentage of correctly predicted outcomes is 86.8% opposed to a hit rate of 64.5% with the unconditional probability of 1/9 for each of the 9 possible outcomes.

Table 2.6: Predicted outcomes for changes in employment after FDI

(in percent predicted by the model, real sample probabilities in parenthesis

	employment change at home			
employment change abroad	decreased	unchanged	increased	total
decreased	5 (6.0)	2.7 (1.2)	1 (1.2)	8.7 (8.4)
unchanged	10.8 (6.3)	11.3 (18.3)	7.4 (5.4)	29.5 (30)
increased	9.8 (13.3)	20.4 (15.1)	31.7 (33.1)	61.9 (61.5)
total	25.6 (25.6)	34.4 (34.6)	40.1 (39.7)	100 (100)

Percent correctly predicted by the model	86.8
Percent correctly predicted by p=1/9 for each outcome	64.5

Notes: Results based on simultaneous regression D from Table 2.4.

2.4.3 Robustness check

The coefficients for γ in three regressions of the simultaneous specification in Table 2.4 are weakly but still significantly different from zero, suggesting that the two processes are simultaneous rather than seemingly unrelated and that there is a direct effect that relates the changes in employment abroad and at home. However, to test the robustness of the simultaneous specification we re-estimate the bivariate ordered probit model in its SUR version where we assume that the changes in a firm's employment abroad and at home after FDI have no direct effect on each other, i.e. γ=0. Both processes are determined by the same set of explanatory variables (x_1=x_2) and by the same firm-specific unobserved effects that may lead to correlation in the error terms.

Table 2.7: Estimation results of the bivariate ordered probit model - seemingly unrelated regression

	A		B		C		D	
employment change	abroad	at home	abroad	at home	abroad	at home	abroad	at home
amount of FDI	0.158***	0.026	0.164***	0.050*	0.164***	0.051*	0.162***	0.056*
	(0.034)	(0.030)	(0.033)	(0.030)	(0.033)	(0.030)	(0.033)	(0.030)
sales <0.5 mio							-0.075	-0.704***
							(0.219)	(0.197)
sales 0.5-2.5 mio	0.247	0.227	0.355**	0.229	0.358**	0.231	-0.103	-0.506***
	(0.164)	(0.162)	(0.156)	(0.154)	(0.157)	(0.154)	(0.207)	(0.180)
sales 2.5-10 mio	0.251	0.422**	0.329**	0.458***	0.329**	0.458***	0.061	-0.361**
	(0.165)	(0.169)	(0.153)	(0.157)	(0.153)	(0.157)	(0.193)	(0.169)
sales 10-25 mio	0.430**	0.595***	0.507***	0.640***	0.508***	0.640***	0.031	-0.280*
	(0.181)	(0.181)	(0.170)	(0.169)	(0.171)	(0.169)	(0.185)	(0.163)
sales 25-50 mio	0.600***	0.760***	0.551***	0.725***	0.552***	0.725***	-0.434*	-0.938***
	(0.227)	(0.221)	(0.207)	(0.205)	(0.207)	(0.205)	(0.234)	(0.214)
sales >50 mio	0.673***	0.848***	0.661***	0.846***	0.661***	0.846***	0.434*	0.938***
	(0.211)	(0.213)	(0.197)	(0.196)	(0.197)	(0.196)	(0.234)	(0.214)
20-49 empl	-0.070	-0.075	-0.046	-0.075	-0.045	-0.074		
	(0.134)	(0.124)	(0.125)	(0.115)	(0.125)	(0.116)		
50-99 empl	0.061	0.006	0.077	-0.011	0.078	-0.010		
	(0.142)	(0.141)	(0.135)	(0.134)	(0.135)	(0.134)		
100-199 empl	-0.136	-0.239*	-0.061	-0.263*	-0.060	-0.262*		
	(0.153)	(0.143)	(0.145)	(0.137)	(0.145)	(0.137)		
>200 empl	0.018	-0.260	0.007	-0.328**	0.007	-0.328**		
	(0.173)	(0.161)	(0.160)	(0.151)	(0.160)	(0.151)		
SME (d)							-0.250	0.303**
							(0.169)	(0.144)
Eastern Europe	0.238***	-0.212***	0.297***	-0.160**	0.297***	-0.160**	0.301***	-0.164**
	(0.086)	(0.079)	(0.083)	(0.075)	(0.083)	(0.075)	(0.083)	(0.075)
Western Europe	0.053	-0.045	0.107	-0.019	0.106	-0.020	0.101	-0.027
	(0.101)	(0.086)	(0.094)	(0.082)	(0.095)	(0.082)	(0.094)	(0.082)
USA/Canada	0.063	0.306***	0.101	0.297***	0.100	0.296***	0.102	0.284***
	(0.094)	(0.087)	(0.092)	(0.084)	(0.092)	(0.084)	(0.092)	(0.084)
Asia	0.254***	0.029	0.251***	0.056	0.251***	0.056	0.252***	0.052
	(0.089)	(0.082)	(0.085)	(0.078)	(0.085)	(0.078)	(0.085)	(0.078)
motivation (index)	0.028	0.076**						
	(0.033)	(0.030)						
horizontal			0.049	0.255***	0.046	0.253***	0.048	0.253***
			(0.088)	(0.080)	(0.088)	(0.081)	(0.088)	(0.081)
vertical					-0.050	-0.030	-0.041	-0.035
					(0.189)	(0.166)	(0.189)	(0.167)
reloc. prod.			0.077	-0.148*	0.078	-0.148*	0.078	-0.149*
			(0.093)	(0.084)	(0.093)	(0.084)	(0.093)	(0.085)
rho	0.481***		0.469***		0.469***		0.474***	
	(0.056)		(0.053)		(0.053)		(0.053)	
Observations	1,051		1,051		1,051		1,051	
Wald chi2	194.29		218.91		219.04		221.89	
	(df=47)		(df=48)		(df=49)		(df=46)	
Prob>chi2	0.000		0.000		0.000		0.000	
Wald test of ind.equ.								
Chi2(1)	88.47		92.86		92.64		94.09	
Prob>chi2	0.000		0.000		0.000		0.000	

Notes: The dependent variable is employment change abroad and at home in 3 categories: decreased, unchanged, increased. Each regression includes dummies for industry and region. Robust standard errors in parentheses. *, ** and *** indicate significance at the 10 %, 5 % and 1 % levels, respectively. The reference category are firms with less than 20 employees and a sales volume of less than 0.5 mio Euro (regressions A-C) or large firms with more than 200 employees and a sales volume of more than 50 mio Euro (regression D).

Table 2.7 displays the SUR regression results. Unlike the simultaneous case, we do not need an exclusion restriction, therefore we include the variable 'amount of FDI' in both equations. The coefficients for the abroad-equation - which is again specified as the first estimated equation - are by definition the same as in the simultaneous specification. The coefficients of the home-equation do not change substantially. The coefficient for the amount of FDI has a slightly significant impact on the change of a firm's employment at home in two regressions; this indicates that it is only a weak instrument for identification in the simultaneous case. In the SUR regressions, the estimates of the correlation of the error terms ρ are statistically significant and about 30 percentage points higher than in the simultaneous regressions. This points to the fact that in the simultaneous model part of this effect is captured by γ. If γ is assumed to be zero but in fact is not zero, the correlation of the error terms must increase. The Wald test for independence of the two equations can be strongly rejected in the SUR specification. These findings suggest that the two processes are simultaneous rather than seemingly unrelated, despite the weakness of our exclusion restriction.

2.5 Conclusion

By contrast to previous literature on employment effects of FDI we focus particularly on SMEs. First, we describe how they differ from large firms in their international activities and in their motivation for FDI. We then analyze empirically employment changes at home and abroad after FDI for all firms. The results of a bivariate ordered probit model reveal that SMEs are more likely to have positive employment changes in the home country. Horizontal motivations and investment to USA/Canada increase the probability of positive employment changes. Firms that invest to Eastern Europe and relocate their production are more likely to have negative employment changes. Furthermore we gain insights on the interdependence of employment decisions in the home country and in the host country after FDI. Our results support the hypothesis that the changes in employment at home and abroad are not independent from each other, we find a positive relationship. The methodological approach of a bivariate ordered probit model is very promising. However, our conclusions need further empirical confirmation. In particular, exact numbers on job turnover and information on employees' qualifications would enable deeper insights. Nevertheless, our results offer a starting point for further research on SMEs, their investment activities abroad and the resulting employment changes.

2.6 Appendix

Table 2.8: Types and regions of international activity (regression sample)

The numbers refer to percentages of active SMEs in the regression sample, percentages for large firms in parenthesis.

	EU 15 / EFTA	10 new EU members since 2004	EU candidates for membership in 2004[1]/ CIS	USA / Canada	Asia / Pacific	Latin America	Africa	activity in at least one region
Sales office	44.6	23.4*	18.8***	19.7***	30.0*	7.6***	4.8***	70.1**
	(43.8)	(29.2)	(26.7)	(23.1)	(33.4)	(16.4)	(10.6)	(62.6)
Affiliate	22.7***	18.6***	7.2***	15.4***	11.5***	3.0***	0.5***	52.1***
	(67.2)	(43.2)	(16.4)	(43.5)	(34.9)	(21.6)	(11.5)	(84.8)
Joint venture	8.0***	4.6**	4.6	3.5	8.2***	1.8	1.5	22.8***
	(12.2)	(7.6)	(7.0)	(5.5)	(16.1)	(3.0)	(2.7)	(33.1)
Purchasing office	3.6	1.8	1.4	1.5*	5.0	0.2	0.1	10.5
	(3.6)	(1.5)	(1.2)	(0.3)	(6.7)	(1.2)	(0.3)	(9.4)
R&D	9.7***	2.6	1.8	2.5***	2.6**	0.4**	0.1	15.4***
	(16.4)	(4.6)	(0.9)	(9.1)	(5.8)	(2.7)	(0.6)	(22.8)
At least one activity in region	62.7***	41.1***	26.6***	31.2***	39.9***	10.9***	6.8***	
	(84.8)	(62.3)	(41.3)	(52.9)	(57.7)	(33.7)	(21.0)	

Notes: Two-sample t-test under the assumption of equal variances. *, ** and *** indicate significance at the 10 %, 5 % and 1 % levels, respectively.
[1]Bulgaria, Romania, Croatia and Turkey. N SMEs=722, N large firms=329.

Table 2.9: Estimation results simultaneous regression - without Western Europe

	A		B		C		D	
employment change	abroad	at home	abroad	at home	abroad	at home	abroad	at home
amount of FDI	0.158***		0.164***		0.164***		0.162***	
	(0.034)		(0.033)		(0.033)		(0.033)	
sales <0.5 mio							-0.447*	-0.875***
							(0.235)	(0.243)
sales 0.5-2.5 mio	0.245	0.202	0.350**	0.136	0.353**	0.136	-0.093	-0.748***
	(0.164)	(0.170)	(0.156)	(0.174)	(0.157)	(0.174)	(0.218)	(0.204)
sales 2.5-10 mio	0.252	0.408**	0.329**	0.397**	0.329**	0.396**	-0.115	-0.518***
	(0.165)	(0.174)	(0.153)	(0.170)	(0.153)	(0.170)	(0.207)	(0.189)
sales 10-25 mio	0.434**	0.558***	0.512***	0.536***	0.512***	0.535***	0.056	-0.424**
	(0.181)	(0.196)	(0.171)	(0.201)	(0.171)	(0.201)	(0.193)	(0.173)
sales 25-50 mio	0.604***	0.704***	0.558***	0.614**	0.558***	0.614**	0.028	-0.323*
	(0.227)	(0.246)	(0.207)	(0.240)	(0.207)	(0.240)	(0.186)	(0.169)
sales >50 mio	0.679***	0.783***	0.675***	0.707***	0.675***	0.706***		
	(0.210)	(0.251)	(0.196)	(0.252)	(0.196)	(0.252)		
20-49 empl	-0.072	-0.068	-0.049	-0.065	-0.048	-0.065		
	(0.134)	(0.128)	(0.124)	(0.124)	(0.124)	(0.124)		
50-99 empl	0.062	-0.006	0.081	-0.041	0.083	-0.040		
	(0.142)	(0.145)	(0.135)	(0.140)	(0.135)	(0.141)		
100-199 empl	-0.131	-0.238	-0.051	-0.277*	-0.0501	-0.276*		
	(0.152)	(0.146)	(0.145)	(0.142)	(0.145)	(0.142)		
>200 empl	0.023	-0.289*	0.017	-0.373**	0.017	-0.374**		
	(0.172)	(0.170)	(0.159)	(0.164)	(0.159)	(0.164)		
SME							-0.258	0.442***
							(0.169)	(0.165)
Eastern Europe	0.233***	-0.266**	0.284***	-0.273***	0.285***	-0.274***	0.289***	-0.293***
	(0.085)	(0.103)	(0.082)	(0.101)	(0.082)	(0.101)	(0.082)	(0.102)
Western Europe								
USA/Canada	0.0691	0.309***	0.115	0.287***	0.113	0.287***	0.115	0.269***
	(0.092)	(0.085)	(0.090)	(0.088)	(0.090)	(0.088)	(0.091)	(0.089)
Asia	0.250***	-0.010	0.244***	-0.020	0.244***	-0.020	0.245***	-0.035
	(0.089)	(0.099)	(0.085)	(0.097)	(0.085)	(0.097)	(0.085)	(0.098)
motivation (index)	0.029	0.076**						
	(0.033)	(0.030)						
horizontal			0.051	0.265***	0.047	0.264***	0.049	0.264***
			(0.087)	(0.082)	(0.088)	(0.084)	(0.088)	(0.084)
vertical					-0.057	-0.014	-0.048	-0.020
					(0.189)	(0.181)	(0.189)	(0.184)
reloc. prod.			0.069	-0.187**	0.070	-0.187**	0.071	-0.192**
			(0.092)	(0.093)	(0.093)	(0.093)	(0.093)	(0.093)
gamma	0.175		0.344*		0.343*		0.386*	
	(0.201)		(0.197)		(0.196)		(0.198)	
rho	0.338		0.177		0.176		0.143	
	(0.176)		(0.188)		(0.188)		(0.193)	
Observations	1,051		1,051		1,051		1,051	
Wald Chi2	192.60		217.59		217.67		220.77	
	(df=46)		(df=47)		(df=49)		(df=45)	
Prob>chi2	0.000		0.000		0.000		0.000	
Wald test of ind.equ.								
Chi2(1)	3.14		0.85		0.84		0.54	
Prob>chi2	0.076		0.355		0.359		0.464	

Notes: The dependent variable is employment change abroad and at home in 3 categories: decreased, unchanged, increased. Each regression includes dummies for industry and region. Robust standard errors in parentheses. *, ** and *** indicate significance at the 10 %, 5 % and 1 % levels, respectively. The reference category are firms with less than 20 employees and a sales volume of less than 0.5 mio Euro (regressions A-C) or large firms with more than 200 employees and a sales volume of more than 50 mio Euro (regression D).

2.7 References

Barba Navaretti, G. and A. J. Venables (2004). *Multinational Firms in the World Economy*, Princeton University Press.

Barba Navaretti, G., Castellani, D. and A. Disdier (2009). How does investing in cheap labour countries affect performance at home? Firm-level evidence from France and Italy, *Oxford Economic Papers* 62(2), 234-260, Oxford University Press.

Becker, S. O., Ekholm, K., Jäckle, R. and M. Muendler (2005). Location choice and employment decisions: A comparison of German and Swedish multinationals, *Review of World Economics* 141(4), 693-731.

Becker, S. O. and M. Muendler (2008). The effect of FDI on job security. *The B.E. Journal of Economic Analysis & Policy* 8(1), Article 8.

Buch, C. M. and J. Kleinert (2006). Who goes East? The impact of enlargement on the patterns of specialization and investment, *IAW Discussion Paper* 24, Institut für Angewandte Wirtschaftsforschung (IAW).

Buch, C. M., Kleinert, J., Lipponer, A. and F. Toubal (2005). Determinants and effects of foreign direct investment: evidence from German firm-level data, *Economic Policy* 20(41), 52-110.

Buckley, P. (1989). Foreign direct investment by small and medium sized enterprises: The theoretical background, *Small Business Economics* 1, 89-100.

Davis, S. J., Haltiwanger, J. and S. Schuh (1996). Small business and job creation: Dissecting the myth and reassessing the facts, *Small Business Economics* 8(4), 297-315.

Debaere, P., Lee, H. and J. Lee (2010). It matters where you go: Outward foreign direct investment and multinational employment growth at home, *Journal of Development Economics* 91(2), 301-309.

Destatis (2008). Verlagerung wirtschaftlicher Aktivitäten - Ergebnisse der Piloterhebung, Statistisches Bundesamt, Wiesbaden.

European Commission (2003). Internationalisation of SMEs. Observatory of European SMEs, No. 4, Enterprise DG.

European Commission (2009). European SMEs under pressure, annual report on EU small and medium-sized enterprises. EIM Business & Policy Research, Netherlands.

European Commission (2010). Internationalisation of European SMEs. EIM Business & Policy Research, Netherlands.

Evans, D. S. (1986). The relationship between firm growth, size, and age: Estimates for 100 manufacturing industries, *Journal of Industrial Economics* 35(4), 567-81.

Falk, M. and Y. Wolfmayr (2010). The substitutability between parent company and foreign affiliate employment in Europe, *Empirica* 37(1), 87-100.

Feenstra, R. C. and G. Hanson (1996). Globalization, outsourcing, and wage inequality, *The American Economic Review* 86(2), Papers and Proceedings of the Hundredth and Eighth Annual Meeting of the American Economic Association, 240-245.

Feinberg, S. E. and M. P. Keane (2006). Accounting for the growth of MNC-based trade using a structural model of U.S. MNCs, *American Economic Review* 96(5), 1515-1558.

Fujita, M. (1995). Small and medium-sized transnational corporations: Trends and patterns of foreign direct investment, *Small Business Economics* 7, 183-204.

Harrison, A., McMillan, M. and C. Null (2007). U.S. multinational activity abroad and U.S. jobs: substitutes or complements?, *Industrial Relations* 46(2), 347-65.

Helpman, E. (1984). A simple theory of international trade with multinational corporations, *Journal of Political Economy* 92, 451-471.

Helpman, E., Melitz, M., and S. R. Yeaple (2004). Export versus FDI with heterogeneous firms, *American Economic Review* 94(1), 300-316.

Hijzen, A., Upward, R. and P. W. Wright (2010). Job creation, job destruction and the role of small firms: Firm-level evidence for the UK, *Oxford Bulletin of Economics and Statistics* 72(5), 621-647.

Horgos, D. (2009). Labor market effects of international outsourcing: How measurement matters, *International Review of Economics and Finance* 18, 611-623.

Konings, J. and A. Murphy (2006). Do multinational enterprises relocate employment to low-wage regions? Evidence from European multinationals, *The Review of World Economics* 142(1), 1-20.

Kuo, H. and Y. Li (2003). A dynamic decision model of SMEs' FDI, *Small Business Economics* 20, 219-231.

Leung, D., Meh, C. and Y. Terajima (2008). Firm size and productivity, Bank of Canada Working Paper 2008-45.

Markusen, J. R. (1984). Multinationals, multi-plant economies, and the gains from trade, *Journal of International Economics* 16(3-4), 205-226.

Melitz, M. J. (2003). The impact of trade on intra-industry reallocations and aggregate industry productivity, *Econometrica* 71(6), 1695-1725.

Moser, C., Weder di Mauro, B. and D. Urban (2009). Offshoring, firm performance and establishment-level employment: Identifying productivity and downsizing effects, CEPR Discussion Paper No. 7455.

Munch, J. (2010). Whose job goes abroad? International outsourcing and individual job separations, *Scandinavian Journal of Economics* 112(2), 339-360.

OECD (1996). Small businesses, job creation and growth: facts, obstacles and best practices. Paris.

Prasad, S. (1999). Globalization of smaller firms: Field notes on processes, *Small Business Economics* 13, 1-7.

Sajaia, Z. (n.d.). Maximum likelihood estimation of a bivariate ordered probit model: implementation and Monte Carlo simulations, forthcoming in *The Stata Journal*.

Sethupathy, G. (2010). Offshoring, wages, and employment: Theory and evidence, Working Paper.

Taymaz, E. (2005). Are small firms really less productive?, *Small Business Economics* 25, 429-445.

Chapter 3

Male vs. female business owners: Are there differences in investment behavior?

3.1 Introduction

Female participation in business and entrepreneurship has increased considerably in the last decades. Nonetheless, the gender gap between the entrepreneurial activity of men and women is substantial, particularly in industrialized countries (Allen et al. 2007). Furthermore, firms that are owned by women differ significantly from male-owned firms. Female entrepreneurs have smaller firms, they start with less capital and are more likely to be found in the service sector. Moreover, female-owned firms seem to underperform male-owned firms in profitability, innovativeness and firm growth (Fairlie and Robb 2009, Gottschalk and Niefert 2011, Tonoyan and Strohmeyer 2005).

Most studies find that this gender gap in firm performance - or at least a large part of it - is attributable to differences in industry, human capital of the firm owner, professional experience or access to finance and networks (Robb and Watson 2010, Du Rietz and Henrekson 2000). Yet, particularly for the performance indicators of sales growth and firm size, there still remains a gender gap that cannot be explained with the usually observed firm- and owner-specific characteristics. The standard explanations for this phenomenon can be subsumed to two concepts: differences in growth and size between female- and male-owned firms are caused either by discrimination or by preferences. Indeed, there is evidence that women prefer to keep their businesses smaller and more manageable and that they are less likely to have growth on their entrepreneurial agenda (Cliff 1998). Regarding discrimination in the form of financial constraints, the proposition that women have more difficult access to external finance

cannot be validated for industrialized countries (Cole and Mehran 2009).[1]

So far there is little knowledge about the underlying entrepreneurial decisions that reflect those gender differences in preferences and also determine the differences in firm size. We do not know much about how men and women act as firm owners and managers and how successful they are. Particularly, gender differences in investment behavior are not well explored yet. This question is highly relevant though, as firm investment is an important driver of firm growth.

The aim of this paper is to gain new insights into gender differences in investment activity in order to contribute to a better understanding of observed lower growth rates and smaller firm sizes of female-owned firms. For this purpose, we attempt to disentangle the impact of gender on investment activity that remains after controlling for firm- and owner-specific characteristics, such as industry, firm age, firm size, management team size, expectations, innovation activity, cash flow as well as age and education of the firm owner. Using the KfW Mittelstandspanel, a data set consisting of roughly 35,000 German SMEs that were observed from 2003 to 2009, we focus on the extensive and intensive margin of investment as well as on stated investment goals. Our analysis is threefold: first, we estimate a linear probability model (LPM) with the binary investment decision as the dependent variable to examine the extensive margin of investment. Second, we analyze the investment rate, i.e. the intensive margin of investment, by using a simple reduced form investment model with time-averaged data. Third, we examine the investment goals of investing firms. We consider both standard explanations for women's lower firm sizes: discrimination in the form of financial constraints and preferences. The inclusion of cash flow into the analysis of the extensive and intensive margin of investment serves as a control for financial constraints. The analysis of investment goals sheds light on gender differences in preferences.

Our results reveal that female firm owners are less inclined to invest, both at the extensive and intensive margin. The probability that they make an investment is lower and if they invest, the relative amount of their investment is lower on average, too. Moreover, we find that the availability of internal funds in the form of cash flow does not have the same impact on male and female firm owners' investment behavior. The investment rate in female-owned firms reacts less to a marginal increase in the availability of cash flow. This means that under the presence of the same financial endowment women are more reluctant to invest. The explanation for this behavior cannot directly be assessed within the estimation framework, but a further analysis of the firms' investment goals suggests that women are indeed less growth-oriented as

[1] We will discuss this issue in detail in Chapter 4.

they are less likely to name sales increases, innovation/R&D and implementation of new products as their investment goals.

We conclude that women's lower propensity to invest and consequently also their lower firm sizes are a consequence of preferences rather than financial constraints. We are not able to draw any conclusion on the underlying causes for these gender differences in investment goals. We have no information on personal conditions and resources of the firm owners that may affect investment behavior and growth aspirations, such as attitudes towards risk taking, family status and non-entrepreneurial responsibilities. However, previous research on gender differences confirms that women are on average more risk and competition averse, less overconfident, less ambitious and less work-centered. These findings may not only hold for the average women but also to some extent for female entrepreneurs, particularly for owners of small, non-growing firms.

3.2 Literature review on gender differences

Two strands of the economic literature are related to this paper: that on firm investment and that on gender economics. Investment theory provides the background for the estimation of the reduced form investment model and will briefly be discussed in Section 3.4.1. In the following, we review the literature on gender differences in risk aversion, overconfidence, competition and personal preferences. We discuss the impact of these findings on investment behavior of firm owners.

Research on gender differences in investment behavior has concentrated on private investment; there exists no evidence for firm investment. For private investors, Sunden and Surette (1998) find that women choose retirement plan assets that are less risky than the average man's choice.

Gender differences in risk attitudes have been explored in field and laboratory experiments. Most studies, in different environments and across a range of tasks, find that women have on average a lower risk propensity than men (Dohmen and Falk 2011). Croson and Gneezy (2009) outline three possible reasons for gender differences in risk taking: different evaluations of risk, differences in the perceptibility of emotions and male overconfidence. On average, men regard risk as challenge while women perceive it as threat. Moreover, women report more intense nervousness and fear than men in anticipation of negative outcomes, they are therefore more reluctant when it comes to a risky decision. These two explanations refer to different assessments of identical situations. Overconfidence in contrast refers to differences in the self-evaluation of one's own abilities, knowledge and possibilities. Overconfident people underestimate

risk because they believe they are more capable than they actually are. Risk-aversion should not be confounded with overconfidence (or even overoptimism), although the two concepts are closely related. Rational non-overconfident people may differ in their true risk preferences, while overconfident people underestimate risk because they are too confident about their ability. Overoptimistic people, in contrast, have unrealistic and overly positive expectations about the future. The literature indeed finds that men are more overconfident than women, and particularly so in male-dominated areas such as finance (Odean and Barber 2001).

Schubert et al. (1999) argue that observed gender differences in risk attitudes in the average population are possibly confounded with financial literacy and wealth effects due to gender-specific income differences outside the laboratory. They claim that the experimental results may not reflect true male and female attitudes towards financial risks, but may stand for differences in individual opportunity sets. Under controlled economic conditions they find that the comparative risk propensity in financial choices strongly depends on the decision frame and that women do not generally make less risky financial choices than men.

Furthermore, while laboratory experiments may provide strong control of the economic environment surrounding risky decisions they may not be adequate for drawing conclusions on gender-specific risk attitudes of investors and managers. Indeed, most of these studies were carried out with a subsample of the general population or with university students. Croson and Gneezy (2009) point out that with a subsample consisting exclusively of business owners and managers, gender differences in financial risk preferences may be smaller or not observable. Entrepreneurs are a special subsample of the population with higher risk preferences than the average. The fact that very few women decide to become business owners could therefore be partly the result of self-selection due to individual attitudes in risk aversion. Even though the attitude towards risk is not the central determinant of becoming an entrepreneur, people that choose entrepreneurial positions are on average more risk-taking (Blanchflower and Oswald 1998, Caliendo et al. 2009). Women who opt for entrepreneurial positions therefore might have risk preferences similar to men. Yet, it also seems plausible that even within the group of entrepreneurs there are gender differences in risk attitudes and behavior, particularly within owners of small firms. Indeed, there is evidence that female entrepreneurs are less risk-taking compared to their male counterparts (Sexton and Bowman-Upton 1990, Orobia et al. 2011). Yet, there is also evidence on the opposite: Johnson and Powell (1994) investigate decision-making characteristics of men and women in a 'non-managerial' population with those of a 'managerial' population. Males and females in the managerial population exhibit similar risk propensity and

make decisions of equal quality, while in the non-managerial population women are more risk averse than men. Dwyer et al. (2002) come to a similar finding in a different setting. They analyze whether the gender of an investor is related to risk taking in mutual fund investment decisions. In line with the experimental literature they find that women are less risk taking than men, but the impact of gender falls significantly when they control for knowledge of financial markets.

Gender differences in attitudes toward competitive environments have been investigated in a number of laboratory experiments, too. Gneezy et al. (2003) run an experiment where they test for gender differences in performance generated by different incentive schemes. They observe that with increasing competitiveness of the environment, the performance of men increases but not that of women. However, in non-competitive environments there is no gender difference in performance. Then again, when women compete in a purely female environment their performance increases. It seems that women like to compete with other women but not against men. As possible reasons the authors name women's lower feelings of confidence and competence and differences in the way how men and women compete against each other. Niederle and Vesterlund (2007) have found that in choosing incentive schemes in an experimental setting men select twice as often the competitive environment of a tournament, although ex-post there are no gender differences in performance. This tournament-entry gap is driven by gender differences in preferences for competitive environments and by male overconfidence. They conclude that 'women shy away from competition and men embrace it' (Niederle and Vesterlund 2007, p. 1067).

Regarding differences in preferences, there is evidence that women on average do not measure success by the traditional 'male' indicators of growth and profitability and have different motivations for opening their own businesses. Likewise, women view the value of work differently than men. Hakim (2002) distinguishes three different lifestyles that are attributed to social preferences: home-centered, work-centered and adaptive. She finds that a majority of men but only very few women are 'work-centered', meaning that work dominates their lives, even though women have similar educational attainments and despite increasing female work participation over the past three decades. Most women are 'adaptive', they prefer to combine employment and family work in a balanced manner. Fairlie and Robb (2009) find that female business owners may have different objectives for their businesses and that they work fewer hours. One major difference between men and women is that women are more likely to report that they own a business in order to be able to meet family responsibilities. These stated preferences are presumably a result of social norms. Women traditionally take more responsibility for family and child care. They need to balance work and family on average more

than work-centered men do. This of course may have implications for the outcomes of female-owned businesses and may induce women to keep their firms smaller and more manageable.

The objective of this paper is to find out whether and how male and female business owners differ in their investment decisions. We summarize the discussed findings as follows: in economic experiments and laboratory settings, women are on average more risk-averse, less overconfident and less eager to participate in competitive environments. Moreover, women have different preferences and entrepreneurial objectives, they are less growth-oriented and have lower goals concerning their desired firm size. There are good reasons to believe that the described personal attributes have an impact on investment behavior. Lower growth aspirations may result in lower investment rates. Moreover, firm investment involves risk-taking and requires certain confidence in the assessment of the ex-ante unknown profitability of the investment. Based on these considerations we expect - if the discussed findings hold for female business owners, too - the following two results: first, women are less likely to invest, and second, if they invest, they invest lower amounts.

3.3 Data and descriptives

3.3.1 Data source

The analysis is based on the KfW Mittelstandspanel, an annual firm survey which has been conducted since 2003 by the KfW Bankengruppe, a German public bank in the ownership of the Federal Republic of Germany and the Federal States. Among other business activities, the KfW offers financial support to small and medium-sized enterprises (SMEs). The collection of the data was initialized by the KfW Research Division in order to learn more about SMEs as their main clients - their financing needs, innovative behavior, activities abroad, economic situation, earnings situation, equity resources, expectations, access to investment and venture capital, in short: everything that is relevant to SMEs and SME policy. The data set is available to external researchers only upon request and only for research on predetermined topics. The KfW-Mittelstandspanel is the only panel data set which is representative of all German SMEs. It includes firms with maximum annual sales of 500 million Euro without having restrictions on the number of employees. The inclusion of very small firms is important for our analysis, as female-owned firms are typically very small. Furthermore, the survey provides information on characteristics of the firm owner such as gender,

age and education - a feature that is not available in most public data sets. The owner characteristics are available only for one firm owner or associate even if the firm has more than one owner, so we assume that the information holds for the most influential owner. Additionally, we have information on the size of the management team, consisting of active and responsible executive directors, owners and associates of the firm. The sample of the survey was selected using stratified random sampling. The stratification was done according to six size groups (less than 5 employees, 5-9, 10-19, 20-49, 50-99 and 100 or more employees), five industries (manufacturing, construction, retail, wholesale and services), region (West and East Germany), and participation in a KfW support program for SMEs. Firms that are located in East Germany are oversampled. Small and service firms are underrepresented compared to the population, therefore the share of large and industry firms is higher in the sample than in the population. As a result, the share of female-owned firms is underrepresented as these are prevalently small and belong to the service sector. Yet, in the regressions we control for all stratification variables. The survey, which is six pages long, was sent by mail to the firms for the first time in 2003 and has been repeated in every following year. Participation in the survey is voluntary, some firms dropped out, others did not respond in every single year. New firms were included in 2005, 2007 and 2009 in order to keep the sample size constant. The survey achieved response rates between 18.2% and 23.4%, which is in the typical range for medium-length mail surveys without incentive to participate for SMEs.[2] This corresponds to 9,000 to 15,000 observations for each year. The panel is unbalanced, therefore the time dimension of the data is limited. 58% of the firms are observed only once, 6,800 firms have participated at least three times and more than 1,000 SMEs have participated in all years.[3]

3.3.2 Regression sampling and descriptives

The analysis is based on three sub-samples. For the first regression in Section 3.4.4 we use the largest sub-sample, which is based on 34,234 firms with a total of 80,543 observations over time. We exclude observations with extreme values. These are those below the 0.5th and above the 99.5th percentiles-bound for the variables sales, sales growth, employment growth and return on sales. The use of lagged values requires at least two subsequent observations for each firm and with the further restriction of

[2]Mail survey response rates for SMEs are lower than for large firms. Bartholomev and Smith (2006) have reviewed mail surveys published in 'Entrepreneurship Theory and Practice' and 'Journal of Small Business Management' over the period 1998-2004 and have found an average response rate of 27%.

[3]A detailed description of the data set in German language can be found in Reize (2010).

non-missing entries in the regression variables the number of observations reduces to 20,254 in the first regression. The second regression in Section 3.4.5 restricts the data set to firms that are observed in every single year between 2006 to 2009, therefore the sample shrinks to 1,389 observations. For the third regression, which is discussed in Section 3.4.6, we consider only those firms that have invested and have stated their investment goals, reducing the sample size therefore to 7,194 observations.

Table 3.1 provides the variable descriptions and Table 3.2 descriptive statistics disaggregated by gender for the first and largest regression sample. There are statistically significant gender differences in several dimensions. Female entrepreneurs are on average three years younger and their firms are younger, too. As expected, female-owned firms are smaller in terms of sales and employees and they are more likely to be organized as sole proprietorships and less likely as a corporation. Consequently a larger share of male-owned firms have more than three owners and/or managers. Female-owned firms are rarely active in the manufacturing and construction industries and more often active in services, particularly retail and hotel and restaurant industries.[4] Female-owned firms' propensity to invest and to innovate is lower and they are less likely to have positive sales expectations.

In Figure 3.1 we present results from kernel density estimates of the distributions of the logs of number of employees and sales for female- and male-owned firms. The dashed line represents male-owned firms while the solid line depicts female-owned firms. The Kolmogorov-Smirnov test rejects the null hypothesis that the male and female distributions are equally distributed with a p-value of 0.000 for both variables.

Since the interpretation of simple means of performance measures may be misleading, we run a simple random effects GLS regression of firm performance in terms of sales growth (Table 3.3). We control for education, age of the firm and the owner, firm size, management team size and industry. We find that female owners have significantly lower growth rates, which is in line with previous findings on gender and firm growth. We are aware that this regression is just a very basic attempt to separate the impact of female ownership from other underlying variables that might have an influence on growth and may be correlated with female ownership. However, the aim of this simple regression is to confirm the finding that female-owned firms have lower growth rates with our data. Our main question of interest is investment behavior. As investment is an important determinant of firm growth and size, our analysis contributes to a better understanding of existing differences in firm size and growth.

[4]The data set contains firms from 55 industries according to the NACE industry classification. In order to create industry dummy variables that comprise a reasonable number of female-owned firms, we merge these 55 industries into eight categories.

Table 3.1: Variable descriptions

Owner characteristics	
Female owner (d)	1 if the principal firm owner/manager is female, 0 else
Graduate (d)	1 if the firm owner has graduated from an institution of higher education, 0 else
Age firm owner (c)	Age of the firm owner
Firm characteristics	
FTE (c)	Number of full time employees (FTEs) including the firm owner
Sales (c)	Amount of sales in Euro
FTE (log) (c)	Logarithm of the number of full time employees (FTEs) incl. firm owner
Sales (log) (c)	Logarithm of the amount of sales
Sales growth (c)	Growth rate of sales
Cash flow (c)	Earnings before taxes+depreciation
Cash flow/sales (c)	Cashlow divided by total lagged sales
Demeaned cashflow (c)	Deviation of cashflow from the sample mean
Firm age <5 years (d)	1 if the firm is less than 5 years old, 0 else (reference category)
Firm age 5-10 years (d)	1 if the firm is between 5 and 10 years old, 0 else
Firm age 11-20 years (d)	1 if the firm is between 11 and 20 years old, 0 else
Firm age >20 years (d)	1 if the firm is more than 20 years old, 0 else
1 owner-manager (d)	1 if the firm has 1 active owner-manager, 0 else (reference category)
2 owners/managers (d)	1 if the firm has 2 active owners/managers, 0 else
3 or more owners/managers (d)	1 if the firm has 3 or more active owners/managers, 0 else
Investment (d)	1 if the firm has invested, 0 else
Innovation (d)	1 if the firm has innovation activities, 0 else
Sales expectations positive (d)	1 if the expectation for next year's sales is positive, 0 else
Stratification variables and industry dummies	
KfW support (d)	1 if the firm has received a KfW promotional loan, 0 else
Region (d)	1 if the firm is located in East Germany, 0 if the firm is located in West Germany
Manufacturing (d)	1 if the firm is in manufacturing industry, 0 else (reference category)
Construction (d)	1 if the firm is in construction industry, 0 else
Retail and wholesale (d)	1 if the firm is in retail and wholesale industry, 0 else
Hotel and restaurants (d)	1 if the firm is in hotel and restaurant industry, 0 else
Transport, finance, data processing (d)	1 if the firm is in transport, finance or data processing industry, 0 else
Commercial services (d)	1 if the firm is in commercial services, 0 else
Other business-related services (d)	1 if the firm is in other business-related services, 0 else
Other industry (d)	1 if the firm is in another industry, 0 else
Legal form dummies	
Sole proprietorship (d)	1 if the firm is in sole proprietorship, 0 else (reference category)
Private limited company (d)	1 if the firm is a private limited company, 0 else
Limited liability company (d)	1 if the firm is a limited liability company, 0 else
Corporation (d)	1 if the firm is a corporation, 0 else
Other legal form (d)	1 if the firm has another legal form, 0 else

Notes: d = dummy variable, c = continuous variable

Table 3.2: Summary statistics regression sample

Gender variable	Mean	St.dev.	Min.	Max.					
Female owner (d)	0.116	0.321	0	1					
	Male owner				Female owner				t-test
	Mean	St.dev.	Min.	Max.	Mean	St.dev.	Min.	Max.	p-value
Owner characteristics									
Graduate (d)	0.540	0.498	0	1	0.524	0.499	0	1	0.140
Age firm owner	48.432	9.944	20	80	44.909	9.025	23	78	0.000***
Firm characteristics									
FTE	33.3	54.2	0.5	1253	20.2	36.0	0.5	462	0.000***
Sales (in million Euro)	5.349	10.030	10	104	2.620	6.894	10	102	0.000***
Sales growth	0.041	0.298	-1.542	2.037	0.038	0.276	-1.538	2.004	0.745
Cash flow (in thousand Euro)	327	669	-320	8,150	189	510	-307	6,800	0.000***
Firm age	31.280	36.29	1	384	27.022	34.579	1	312	0.000***
Firm age <5 years (d)	0.151	0.358	0	1	0.242	0.428	0	1	0.000***
Firm age 5-10 years (d)	0.160	0.366	0	1	0.187	0.390	0	1	0.001***
Firm age 11-20 years (d)	0.285	0.452	0	1	0.239	0.427	0	1	0.000***
Firm age >20 years (d)	0.404	0.491	0	1	0.332	0.471	0	1	0.000***
1 owner-manager (d)	0.586	0.492	0	1	0.604	0.489	0	1	0.093
2 owners/managers (d)	0.274	0.446	0	1	0.272	0.445	0	1	0.848
3 or more owners/managers (d)	0.107	0.310	0	1	0.079	0.269	0	1	0.000***
Investment (d)	0.650	0.477	0	1	0.537	0.499	0	1	0.000***
Innovation (d)	0.505	0.500	0	1	0.399	0.490	0	1	0.000***
Sales expectations positive (d)	0.309	0.462	0	1	0.272	0.445	0	1	0.000***
Stratification variables									
KfW support (d)	0.682	0.466	0	1	0.687	0.009	0	1	0.602
Region (d)	0.404	0.491	0	1	0.432	0.010	0	1	0.007***
Industry dummies									
Manufacturing (d)	0.298	0.457	0	1	0.185	0.389	0	1	0.000***
Construction (d)	0.187	0.390	0	1	0.082	0.274	0	1	0.000***
Retail and wholesale (d)	0.263	0.440	0	1	0.313	0.464	0	1	0.000***
Hotel and restaurants (d)	0.032	0.175	0	1	0.080	0.272	0	1	0.000***
Transport, finance, data processing (d)	0.040	0.196	0	1	0.035	0.183	0	1	0.206
Commercial services (d)	0.094	0.291	0	1	0.102	0.302	0	1	0.219
Other business-related services (d)	0.070	0.256	0	1	0.195	0.396	0	1	0.000***
Other (d)	0.016	0.124	0	1	0.007	0.002	0	1	0.002***
Legal form dummies									
Sole proprietorship (d)	0.306	0.461	0	1	0.488	0.500	0	1	0.000***
Private limited (d)	0.074	0.262	0	1	0.078	0.269	0	1	0.503
Limited partnership (d)	0.110	0.313	0	1	0.070	0.255	0	1	0.000***
Limited liability corporation (d)	0.502	0.500	0	1	0.354	0.010	0	1	0.000***
Other legal form (d)	0.007	0.083	0	1	0.010	0.098	0	1	0.139

Notes: This table provides summary statistics for the sample used in the estimation of a linear probability random effects panel GLS model of investment in Table 3.4. N = 20,254. Comparison of means with two-sample t-test of equality of means under the assumption of equal variances. *,** and *** indicate significance at the 10%, 5% and 1% levels, respectively.

Figure 3.1: Kernel density estimates, size in terms of sales and number of employees

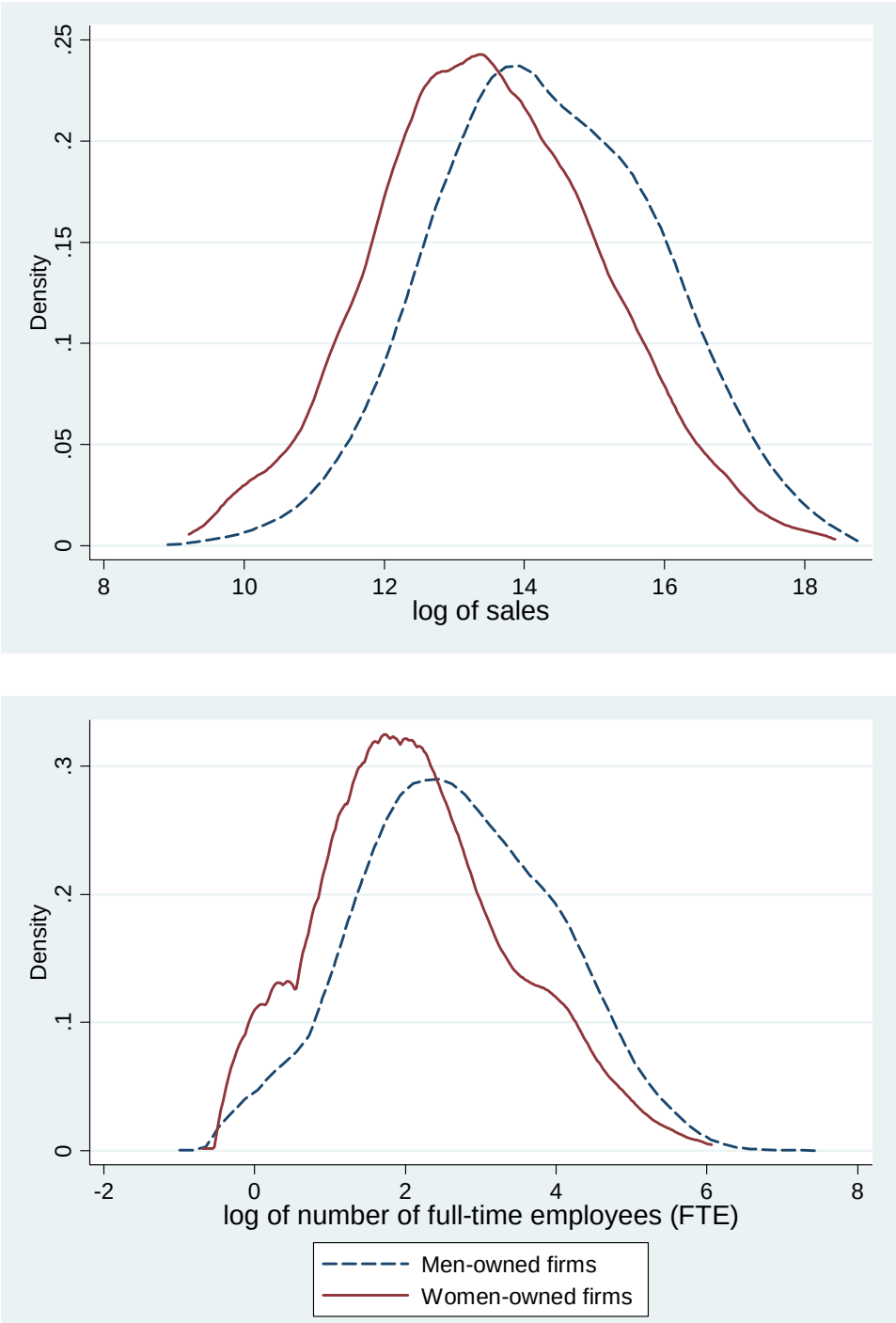


Table 3.3: Random effects panel GLS regression of firm growth

Dependent variable:	**Sales growth**
Female owner (d)	**-0.044*** **
	(0.007)
Graduate owner (d)	0.013**
	(0.005)
Age firm owner	-0.001**
	(0.0002)
Lagged FTE (log)	0.101***
	(0.006)
Lagged sales (log)	-0.122***
	(0.005)
Firm age 5-10 years (d)	-0.089***
	(0.009)
Firm age 11-20 years (d)	-0.109***
	(0.008)
Firm age >20 years (d)	-0.110***
	(0.008)
2 owners/managers (d)	0.024***
	(0.006)
3 or more owners/managers (d)	0.035***
	(0.008)
Constant	1.538***
	(0.064)
R-squared (overall)	0.070
Observations	20,254
Female observations	2,361
Firms	9,949
Avg. obs. per firm	2.0

Notes: This table presents the results of a random effects panel GLS regression for the years 2003-2009 with firm-level cluster-robust standard errors. The regression includes time, industry and legal form dummies as well as the stratification variables. The reference category are manufacturing firms in sole proprietorship that are younger than 5 years and have one manager. *,** and *** indicate significance at the 10%, 5% and 1% levels, respectively.

3.4 Econometric analysis of gender and firm investment

3.4.1 Estimating investment functions

Several theoretical models attempt to describe the complex process of firm investment. Common to almost all recent models is that investment is considered as a dynamic optimization problem. Hence, a firms lives many periods and increases its optimal, long-run or equilibrium level capital stock by investing. Firms decide to invest or not given real and financial factors. Due to limited funds current and future investment are interdependent. Moreover, investment and its financing have further intertemporal effects on future profitability and future financing constraints.

When it comes to the empirical estimation of the investment process, a large part of the empirical investment literature is based on the Q investment model (Tobin and Brainard 1977) where investment opportunities are measured by the ratio of market to book value of a firm's assets. For the present analysis the Q model is not applicable as the KfW Mittelstandspanel does not provide information on stock market participation. Anyhow, as most of the firms are rather small, it can be assumed that they are not listed on the stock market. In neoclassical models investment demand is determined by measures of output and cost of capital. However, the data set does not contain information on firm-specific cost of capital. The use of an Euler equation as theoretical underpinning does not come into consideration, either, because of the strictly implied assumption of convex adjustment costs of investment. Convex adjustment costs imply that with increasing amounts of investment the adjustment costs that a firm has to bear grow over-proportionally. This results in investment smoothing: yearly firm investment is continuous over the years and there are no investment spikes over time. This assumption may hold for large firms, but what we observe in the data is that a significant fraction of firms show large variation in investment activity between years. Particularly for small firms investment is a lumpy activity, most of them do not invest in every year. Periods of larger amounts of investment are followed by periods of zero investment. The reason for this behavior is that larger investment projects (e.g. purchase of a production facility) cannot be smoothed over time and many firms cannot afford to invest every year or rather do not need or want to invest in every year.

Based on these technical limitations we start our analysis with an estimation of a linear probability random effects panel GLS model of the investment decision in order to assess gender differences in the probability of investing. To analyze the investment

rate, we opt for a reduced form model of investment which is not explicitly derived from an optimal investment behavior assumption and has no specified structure of adjustment costs.[5] Furthermore we investigate gender differences in investment goals, also with a linear probability random effects panel GLS model. Finally, we conduct several robustness checks. We re-estimate the investment decision and the investment goals with a panel probit model and the investment rate, with a panel tobit approach. Furthermore, we reduce the two samples to firms with only one owner-manager to make sure that the decision maker in the firm is indeed female. These modifications in sample size and estimation method do not alter our central findings.

3.4.2 Cash flow as indicator for financial constraints

Cash flow, the amount of internal funds that are available to a firm for financing investment projects and other expenses, is a measure for a firm's financial power. Financial factors such as the availability of internal funds, access to external finance as well as the quality of credit markets are important determinants of firm investment. A firm can be considered as financially unconstrained if it has no difficulties to finance the desired investment level, neither through internal nor external funds. The investment literature uses different strategies to identify and to measure financial constraints. One approach is to identify financial constraints by including a firm's cash flow into the investment equation as a measure of internal liquidity. The first study that worked with cash flow as an indicator for financial constraints was written by Fazzari et al. (1988). The resulting regression coefficient, the 'investment-cash flow sensitivity', represents the potential sensitivity of investment to fluctuations in available internal finance. A significant cash flow coefficient can be interpreted as evidence of financing constraints. The intuition behind is that if investment activity reacts strongly to a good internal financial situation (higher cash flow), then external funds must be to expensive for the firm or to difficult to acquire.

However, due to interpretation ambiguities and the absence of theoretical justifications, the use of cash flow as measure for financial constraints is highly controversial. Kaplan and Zingales (1997) argue that there is no strong theoretical reason to expect a monotonic relationship between investment-cash flow sensitivity and the degree of financial constraints. Their empirical results show that a higher investment-cash flow sensitivity cannot be interpreted as evidence that a firm is more financially constrained, therefore investment-cash flow sensitivities are questionable indicators for

[5] Bond and Van Reenen (2007, p. 4443) point out that these type of models 'represent just an empirical approximation to some more complex underlying process that has generated the data'.

financing constraints. Another part of the Kaplan and Zingales critique refers to problems that arise within regressions of the Q-model, mainly caused by measurement error on the ratio of market to book value of a firm's assets. These doubts however should not cause problems in our analysis as we do not employ the Q-model. Yet another point of criticism that matters for our analysis is that the interpretation of cash flow is ambiguous because it may contain information about expected future profits. A good cash flow situation may lead to positive expectations about future profits. Without controlling for sales or profit expectations, the finding of a significant coefficient on cash flow cannot directly be interpreted as evidence of financing constraints, as the cash flow variable could pick up expectations. These expectations on future profits again are relevant for the investment decision, too (Bond et al. 2003). Since we are able to control for expectations about future sales, this concern is probably not relevant for our analysis.

In light of these considerations the use of cash flow is appropriate within our estimation framework. Furthermore, we are interested in gender-specific differences in the reactions to an increase in cash flow rather than in the effect and interpretation of cash flow itself. For this purpose, we create a new variable by interacting demeaned cash flow with the dummy variable for female ownership, as the magnitude of the impact of cash flow on investment may be different for female-owned firms. The interaction term approach has the main advantage that we can explicitly test differences in the investment-cash flow sensitivity of male and female firm owners.

3.4.3 Gender as proxy for personals traits

As we have stated before, if previous findings on gender differences in risk-aversion, overconfidence and lifestyle preferences hold to some extent for entrepreneurs, too, we expect female business owners to invest less. We have no information on risk aversion, overconfidence and preferences in our data, but we can assume that under the assumption of no gender discrimination the pure gender effect on investment is zero or at least negligible once we could control for these personal traits. However, estimating an investment model without in some way accounting for these factors would result in an omitted variable bias. The inclusion of the binary gender variable can be considered as a proxy variable to catch these features. Wooldridge (2009, p. 307) calls this the 'plug-in solution to the omitted variables problem'.

The true model to be estimated would be

$$E(I_i) = \alpha_i + \beta_1 X_i + \beta_2 D_i + \beta_3 Z_i + u_i$$

where X denotes a vector of firm-specific characteristics, D is a vector of observed owner-specific characteristics (age and education of the firm owner) and Z is a vector of unobserved personal traits that influence investment behavior positively, such as risk-propensity, over-confidence and work-centered or growth-oriented preferences. Being female is negatively correlated with risk-propensity, over-confidence and work-centered as well as growth-oriented preferences, but there are no theoretical reasons to believe that gender itself has an impact on investment behavior. We cannot observe Z, but we are interested in gender differences in investment behavior that result from gender differences in Z, therefore we estimate

$$E(I_i) = \alpha_i + \beta_1 X_i + \beta_2 D_i + \beta_3 f_i + u_i$$

where f denotes a dummy variable for female ownership.

3.4.4 Investment at the extensive margin: probability of investing

What is the probability that a female-owned firm invests, compared to a male-owned firm, and how does this probability change when we control for other influencing variables? In order to answer this question, we estimate a linear probability model (LPM) by virtue of its easy and straightforward interpretation. The regression coefficients should be interpreted as changes in the predicted probability of investing if the respective independent variable increases by one unit. Our estimation equation with the binary investment decision (invested=1, not invested=0) as dependent variable takes the form

$$E(I_i) = P(I_i = 1) = \alpha_i + \beta_1 X_i + \beta_2 D_i + \beta_3 f_i + u_i$$

where f denotes a dummy variable for female ownership, X is a vector of firm-specific characteristics (size in terms of sales and employees, cash flow, firm age, team size, sales expectations, innovation activity and sales growth) and D is a vector of further owner-specific characteristics (age of the firm owner and graduate status). One of the shortcomings of the LPM are heteroskedastic error terms, therefore we employ a cluster-robust form for the variance-covariance matrix of the estimator (VCE) as suggested by Cameron and Trivedi (2009) by clustering on firm-level.

Table 3.4 displays the results from five different regressions. In specification (1) we see that the raw probability difference between investing male and female firm owners amounts to 0.108. The probability that a female-owned firm invests is 10.8 percentage points lower than for a male-owned firm. Including industry dummies in specification (2) does not alter this difference substantially. This is in line with Fairlie and Robb (2009) who find that industry distributions are not a major explanation for gender gaps in business outcomes. In contrast, the additional inclusion of firm size in specification (3) leads to a substantial reduction of the gender difference in the probability of investing of about six percentage points to 0.049. Controlling for additional firm- and owner-specific variables does not reduce this difference considerably. Specification (5) shows that even after considering further firm- and owner-specific characteristics there still remains a significant gender difference of 3.3 percentage points in the likelihood to invest.

We conclude that size in terms of full time equivalent employees seems to account for the largest bulk of the gender difference in the probability to invest. Furthermore, firm size has the largest explanatory power in the model as with the inclusion of firm size the R^2 increases from 0.032 to 0.125. In order to check whether the gender effect on investment is constant over different firm size categories, we re-estimate specification (5) with interaction terms of female ownership with size categories. We repeat this procedure with firm age instead of size. We plot the interaction effects against the constant effect from a regression without interactions in Figures 3.2 and 3.3.[6] We find that women's lower probability of investing does not vary systematically with increasing size or firm age.

[6] see Appendix Tables 3.10 and 3.11 for the regression results.

Table 3.4: Linear probability random effects panel GLS model of investment

Dependent variable: investment (0/1)	(1)	(2)	(3)	(4)	(5)
Female owner (d)	-0.108***	-0.097***	-0.049***	-0.048***	-0.033***
	(0.013)	(0.014)	(0.013)	(0.012)	(0.012)
Lagged FTE (log)			0.109***	0.064***	0.046***
			(0.003)	(0.006)	(0.006)
Lagged sales (log)				0.044***	0.061***
				(0.005)	(0.005)
Firm age 5-10 years (d)				-0.054***	-0.038***
				(0.012)	(0.012)
Firm age 11-20 years (d)				-0.071***	-0.049***
				(0.012)	(0.012)
Firm age >20 years (d)				-0.065***	-0.040***
				(0.012)	(0.012)
2 managers/owners (d)				0.035***	0.027***
				(0.009)	(0.009)
3 or more managers/owners (d)				0.027**	0.017
				(0.012)	(0.012)
Sales expect. positive (d)				0.051***	0.039***
				(0.007)	(0.007)
Graduate (d)				0.024***	0.012
				(0.008)	(0.008)
Age firm owner				-0.002***	-0.002***
				(0.0004)	(0.0004)
Innovation activities (d)					0.112***
					(0.007)
Sales growth					0.170***
					(0.011)
Cash flow/lagged sales					0.032***
					(0.008)
Demeaned cash flow*female					0.010
					(0.008)
Constant	0.617***	0.686***	0.348***	-0.055	-0.356***
	(0.009)	(0.011)	(0.014)	(0.062)	(0.063)
Industry dummies	no	yes	yes	yes	yes
Legal form dummies	no	no	no	yes	yes
R-squared	0.019	0.032	0.125	0.140	0.174
Observations	20,254	20,254	20,254	20,254	20,254
Female observations	2,361	2,361	2,361	2,361	2,361
Firms	9,949	9,949	9,949	9,949	9,949
Avg. obs. per firm	2.0	2.0	2.0	2.0	2.0

Notes: This table presents the results of a random effects panel GLS regression for the years 2003-2009 with firm-level cluster-robust standard errors. The regression includes time, industry and legal form dummies as well as the stratification variables. The reference category are manufacturing firms in sole proprietorship that are younger than 5 years and have one owner-manager.*,** and *** indicate significance at the 10%, 5% and 1% levels, respectively.

Figure 3.2: Constant effect of female ownership vs. interaction with size categories

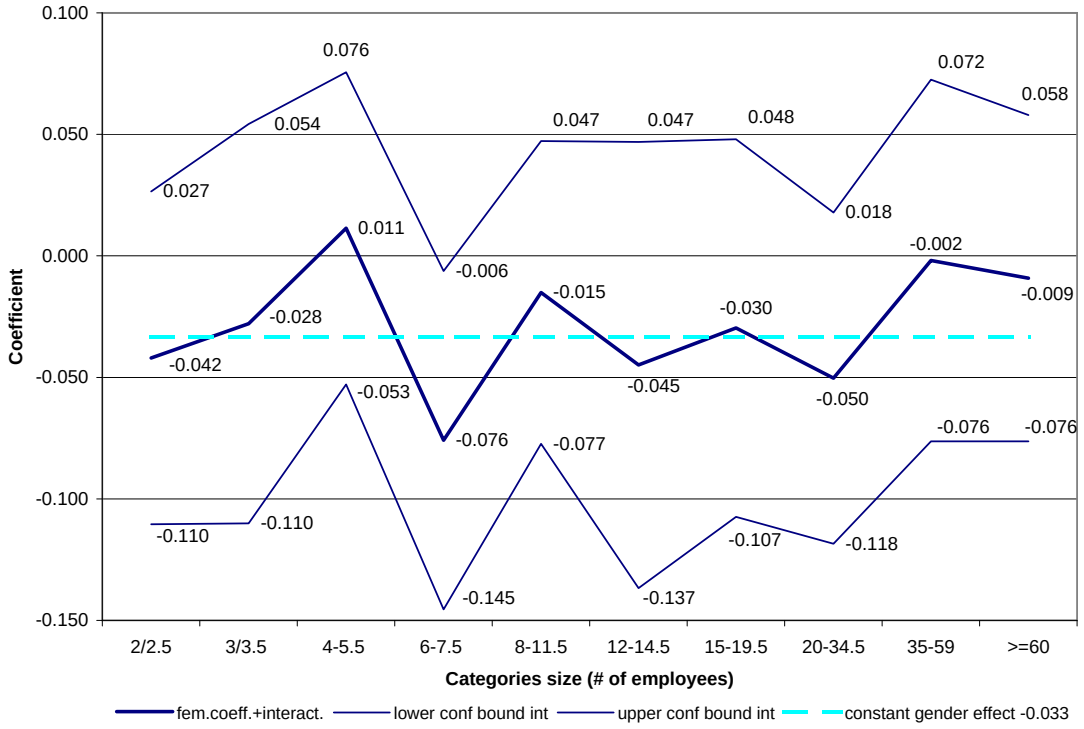
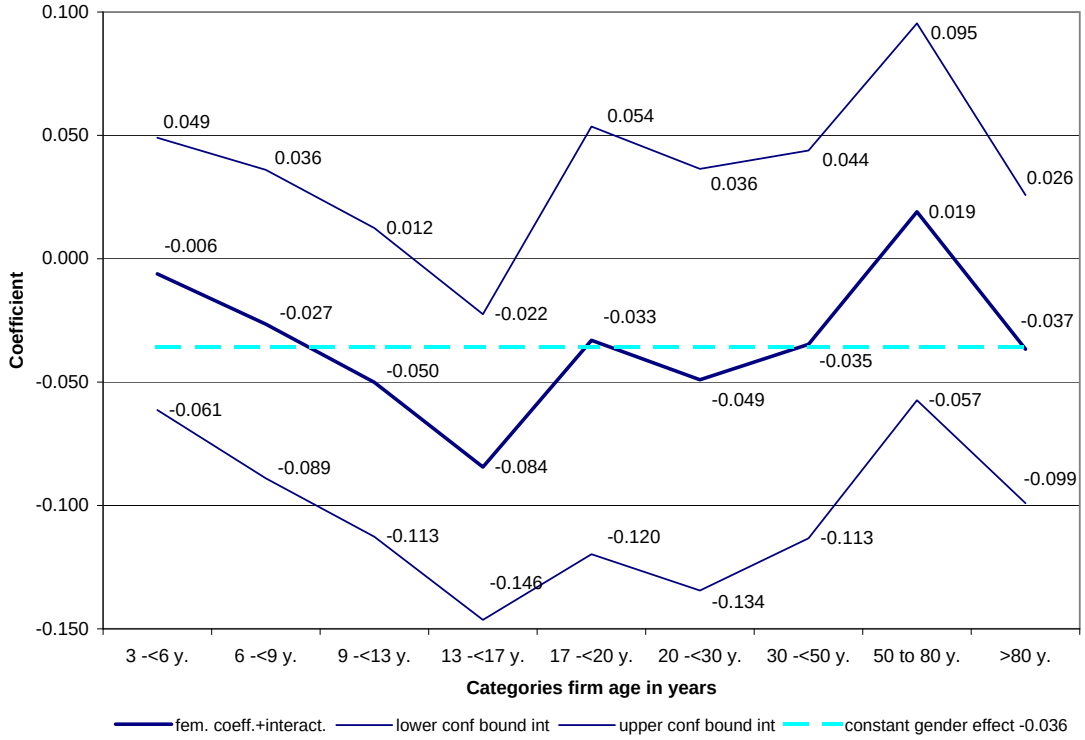


Figure 3.3: Constant effect of female ownership vs. interaction with age categories



3.4.5 Investment at the intensive margin: investment rates

From an econometric point of view, the process of firm investment with its autoregressive distributed lags would be most appropriately estimated within the dynamic econometric framework of a system GMM estimator as proposed by Arellano and Bover (1995) and Blundell and Bond (1998). Yet, the estimation of a dynamic specification is not very promising when considering that the time dimension of our panel is very short with only seven years' data and moreover, only very few firms are present during the whole time period.

Due to these data limitations we are confined to estimate a simple OLS regression of a reduced form model with time-averaged data. In doing so, we follow Addison et al. (2007) who analyze the impact of works councils on investment. We adopt their approach to examine gender differences in investment. The basic estimation equation can be written as:

$$\frac{I_{i,2008}+I_{i,2009}}{2} = \alpha + \beta_1 f_i + \beta_2 \frac{CF_{i,2008}+CF_{i,2009}}{2} + \beta_3 DemCF_i * f_i + \gamma X_i + u$$

where I in the dependent variable denotes the investment rate, the amount invested divided by lagged sales. We average the investment rate over two years in order to ensure that there are no investment spikes in the data and that investment is smoothed over the years. f is a dummy variable for female ownership. We average cash flow (CF) over the years 2008 and 2009, too. $DemCF * f$ stands for demeaned cash flow interacted with the dummy variable for female ownership. X represents a vector of the standard control variables in investment functions and includes also the lagged investment rate that serves as a rough depiction of the dynamic adjustment process of investment. Furthermore, we include sales growth as an explanatory variable, since fluctuations in sales or output motivate changes in investment spending. Sales or output growth has a positive impact on firm investment and vice versa. Increasing sales imply that a firm expects rising profits and cash flow as well as a higher degree of existing capacity utilization. This usually implies that profit expectations rise and this again encourages firms to invest more e.g. in buildings or machinery (accelerator effect). According to investment theory firms take into account expectations of the future when they decide about their investment strategy. Firms invest when the expected return on investment (ROI) exceeds their costs of investing. Positive expectations of future sales boosts investment whereas negative expectations may constrain investment. To incorporate the role of expectations aside from the growth rate of sales we include two dummy variables for positive expectations for the years 2009 and 2010. The firms were asked whether they expect their sales situation to improve, to deteriorate or to stay

unchanged next year. Aspiring investment intentions may not necessarily be reflected in current growth rate or in sales expectations. Therefore we also include a dummy variable for ambitious investment goals that takes the value 1 if the firm has stated implementation of new products, innovation/R&D or sales increases as an objective for its investment (see Section 3.4.6 for more details). We control for firm size and industry. There should exist a positive relationship between a firm's size and its investment as larger firms have easier access to finance and more ability to bear higher risks (Fazzari et al. 1988). Investment patterns also vary between different industries. Usually manufacturing firms are more capital intensive than services and some industries may experience sector-specific business cycles.

Table 3.5: OLS regression of the average investment rate in 2008/2009

Dependent var: Investment rate (Investment/lagged sales, averaged over 2008/2009)	(1)	(1A)	(2)	(2A)	(3)	(3A)	(4)	(5)
Female owner (d)	**-0.013****	**-0.014*****	**-0.012****	**-0.014*****	**-0.009***	**-0.011****	**-0.010***	**-0.010***
	(0.006)	**(0.005)**	**(0.006)**	**(0.005)**	**(0.005)**	**(0.005)**	**(0.005)**	**(0.005)**
Investment/sales 2006/2007	0.232***	0.219***	0.200***	0.188***	0.193***	0.181***	0.190***	0.175***
	(0.049)	(0.043)	(0.048)	(0.042)	(0.048)	(0.042)	(0.047)	(0.044)
Growth rate sales 2008/2009	0.079***	0.074***	0.054***	0.049***	0.054***	0.049***	0.056***	0.045**
	(0.020)	(0.018)	(0.019)	(0.017)	(0.019)	(0.017)	(0.021)	(0.020)
FTE (log) 2007	-0.003	-0.003	0.002	0.003	0.002	0.003*	0.002	-0.003
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Cash flow/lagged sales 2008/2009			0.167***	0.163***	0.198***	0.197***	0.194***	0.171***
			(0.036)	(0.032)	(0.042)	(0.038)	(0.042)	(0.039)
Cash flow*female					-0.148***	-0.157***	-0.149***	-0.138***
					(0.050)	(0.045)	(0.049)	(0.045)
Sales expectation for 2010 pos. (d)							0.017***	0.013**
							(0.006)	(0.006)
Sales expectation for 2009 pos. (d)							0.005	0.004
							(0.008)	(0.007)
Ambitious investment goals (d)								0.044***
								(0.005)
Constant	0.052***	0.051***	0.015	0.014	0.010	0.009	0.006	0.001
	(0.013)	(0.011)	(0.011)	(0.010)	(0.012)	(0.011)	(0.012)	(0.011)
Observations	1,389	1,598	1,389	1,598	1,389	1,598	1,389	1,389
Female observations	155	183	155	183	155	183	155	155
R-squared	0.146	0.144	0.184	0.182	0.191	0.191	0.199	0.248

Notes: This table presents the results of an OLS regression with robust standard errors and time-averaged data for the years 2006-2009. Each regression includes industry and legal form dummies as well as the stratification variables. Regressions (1A)-(1C) are repetitions of regressions (1)-(3) with a larger sample that due to missing entries in expectations and investment goals could not be used for (4) and (5). The reference category are manufacturing firms in sole proprietorship. Robust standard errors in parentheses. *,** and *** indicate significance at the 10%, 5% and 1% levels, respectively.

Table 3.5 reports the results from five OLS regressions of the reduced form investment equation. We use a sub-sample of firms that are observed in each single year from 2006-2009. We include only firms that have invested at least once in those years. Table 3.9 in the Appendix contains the summary statistics for this reduced sample. Investing firms are larger and are more likely to be organized as a corporation than non-investing

firms. Moreover, the share of firm owners that hold a graduate degree is higher.

Again, we start with a basic specification in (1) that does not include cash flow, the interaction term and the dummy variables for positive expectations and ambitious investment goals. We gradually include these variables in specifications (2)-(5). As the number of observations is quite small, we re-estimate the smaller specifications (1)-(3) with all available observations (1A)-(3A). All control variables enter the regressions with the expected signs. Lagged investment and sales growth are positively correlated with investment and so are expectations and ambitious goals. The coefficient for cash flow is significant and shows the expected sign, firms with higher internal funds are more inclined to invest higher amounts. Interestingly, the negative coefficient of the interaction term suggests that cash flow has a greater impact on the investment rate of male-owned firms than of female-owned firms.

The dummy variable for female ownership has a negative sign and is significant in all specifications, suggesting a higher degree of investment reluctance for women. The significance decreases from the 1% level in (1) and (2) to merely 10% in (4) and (5) and the size of the coefficient reduces from 0.014 to 0.010 as we include more explanatory variables. However, the gender difference is economically not trivial. Using the coefficients from specification (5), we calculate an exemplary investment rate of 0.081 for a male-owned firm and 0.07 for a female-owned firm with the same characteristics.[7] With 1 mio. Euro annual sales, a male-owned firm would invest 81,000 Euro and a female-owned firm only 70,000 Euro which makes a non-trivial difference of about 15%.

This result is open to multiple interpretations and cannot completely be explained within the regression framework. We might reason that female-owned firms are apparently less financially constrained because they react less to an increase in cash flow. However, the results confirm our expectation that gender differences in risk-aversion, over-confidence and attitudes towards entrepreneurship may result in lower investment activity. Yet, all these assertions are pure speculation as they cannot be tested directly within the investment function. A further analysis of the investment goals in the next section reveals that there are gender differences in the stated reasons for investing. These differences may also serve as a valid explanation for women's lower investment activity.

[7] We use the following values for this calculation: investment rate in 2006/2007: 0.05, growth rate sales 2008/2009; 0.01, 18.5 FTEs, cash flow/sales: 0.11, positive expectations for 2009 and 2010 and ambitious investment goals.

3.4.6 Investment goals

Investing firms stated their motivations for the previous year's investment by choosing between eight pre-formulated non mutually exclusive investment goals: environment protection, rationalization (cost cutting), implementation of new products, technical replacements, innovation/R&D, governmental requirements, sales increases and other goals. We identify three goals as growth-oriented and/or risky investment goals: implementation of new products, innovation/R&D and sales increases. The other reasons (environment protection, cost cutting, technical replacements and governmental requirements) can be viewed as entrepreneurial necessities which can take place without the intention for growing or expanding.

Table 3.6: Summary statistics investment goals

	Male owner		Female owner		t-test
Investment goals	Mean	St.dev.	Mean	St.dev.	p-value
Environment protection	0.105	0.306	0.076	0.265	0.015**
Rationalization	0.527	0.5	0.471	0.5	0.004***
Implementation new products	0.309	0.462	0.252	0.434	0.001***
Technical replacements	0.599	0.49	0.613	0.487	0.475
Innovation / R&D	0.116	0.32	0.052	0.223	0.000***
Governmental requirements	0.061	0.239	0.089	0.286	0.003***
Sales increase	0.492	0.5	0.424	0.494	0.001***
Other goals	0.073	0.26	0.105	0.306	0.002***
Average number of stated goals	2.282	1.109	2.083	1.045	0.000***

Notes: The variables take the value 1 if the firm has indicated the respective goal, 0 else. Comparison of means with two-sample t-test of equality of means unser the assumption of equal variances. *,** and *** indicate significance at the 10%, 5% and 1% levels, respectively.

Table 3.7: Correlation table investment goals

	Environm. protection	Rational- ization	Implement. new prod.	Technical replacem.	Innovation/ R&D	Governm. requirem.	Sales increase
Environment protection	1						
Rationalization	0.102*	1					
Implementation new products	-0.011	-0.061*	1				
Technical replacements	0.075*	0.038*	-0.119*	1			
Innovation / R&D	0.065*	0.011	0.176*	-0.006	1		
Governmental requirements	0.123*	0.008	-0.024	0.038*	-0.008	1	
Sales increase	-0.003	0.029	0.184*	-0.171*	0.142*	-0.014	1
Other goals	-0.055*	-0.180*	-0.121*	-0.183*	-0.069*	-0.026	-0.119*

Notes: *,** and *** indicate significance at the 10%, 5% and 1% levels, respectively.

Table 3.6 and 3.7 show summary statistics and a correlation table of investment goals. The growth oriented goals are significantly correlated to each other and are more often stated by male firm owners than by female owners. We estimate a linear probability random effects GLS model for each investment goal separately (Table 3.8).

Table 3.8: Linear probability model of investment goals

Dependent variable: Investment goal (0/1)	Environm. protection	Rational- ization	Implement. new prod.	Technical replacem.	Innovation/ R&D	Governm. requirem.	Sales increase	Other goals
Female owner (d)	**-0.018**	**-0.009**	**-0.049****	**0.015**	**-0.040*****	**0.018**	**-0.054****	**0.019**
	(0.012)	**(0.022)**	**(0.020)**	**(0.021)**	**(0.012)**	**(0.012)**	**(0.023)**	**(0.013)**
Lagged FTE (log)	0.002	0.070***	-0.005	-0.001	0.004	-0.001	0.039***	-0.009
	(0.008)	(0.012)	(0.010)	(0.012)	(0.007)	(0.007)	(0.012)	(0.006)
Lagged sales (log)	0.012*	-0.009	0.004	0.014	0.008	0.005	0.001	-0.002
	(0.007)	(0.010)	(0.009)	(0.010)	(0.006)	(0.006)	(0.010)	(0.005)
Firm age 5-10 years (d)	0.002	0.045*	-0.008	0.004	-0.001	0.013	-0.027	-0.007
	(0.013)	(0.024)	(0.024)	(0.025)	(0.015)	(0.014)	(0.024)	(0.014)
Firm age 11-20 years (d)	0.004	0.010	-0.030	0.062***	-0.027*	-0.002	-0.058**	-0.014
	(0.013)	(0.023)	(0.023)	(0.024)	(0.015)	(0.012)	(0.024)	(0.013)
Firm age >20 years (d)	0.020	0.033	-0.054**	0.077***	-0.055***	0.013	-0.106***	-0.016
	(0.014)	(0.024)	(0.023)	(0.024)	(0.015)	(0.013)	(0.024)	(0.014)
Sales expect. positive (d)	-0.016**	-0.002	0.047***	-0.046***	0.031***	-0.001	0.150***	-0.002
	(0.008)	(0.013)	(0.012)	(0.013)	(0.008)	(0.007)	(0.013)	(0.007)
Graduate owner (d)	-0.032***	0.004	-0.031**	5.45e-06	0.029***	-0.012*	-0.052***	0.008
	(0.009)	(0.015)	(0.014)	(0.015)	(0.009)	(0.007)	(0.015)	(0.008)
Age firm owner	-0.0004	-0.0005	0.0001	-0.002***	0.001**	-0.0007*	-0.001	0.0001
	(0.0004)	(0.001)	(0.001)	(0.001)	(0.001)	(0.0004)	(0.001)	(0.0004)
2 owners/managers (d)	0.005	-0.008	0.002	0.003	0.006	0.0002	0.016	-0.003
	(0.009)	(0.015)	(0.014)	(0.015)	(0.010)	(0.008)	(0.015)	(0.008)
3 or more owners/managers (d)	-0.012	0.017	-0.031	5.37e-05	0.003	-0.009	0.002	0.017
	(0.013)	(0.021)	(0.019)	(0.021)	(0.014)	(0.010)	(0.021)	(0.011)
Sales growth	0.023*	0.033	-0.022	-0.014	0.007	-0.003	0.165***	-0.035***
	(0.014)	(0.025)	(0.023)	(0.024)	(0.015)	(0.012)	(0.023)	(0.013)
Cash flow in t/sales t-1	-0.0001	0.001***	0.0001	-0.002***	-0.0003	0.0003	0.0002	-0.0004*
	(0.0002)	(0.0004)	(0.001)	(0.001)	(0.0002)	(0.001)	(0.001)	(0.0002)
Constant	-0.002	0.525***	0.331***	0.468***	-0.021	0.065	0.403***	0.120*
	(0.085)	(0.127)	(0.111)	(0.126)	(0.079)	(0.071)	(0.124)	(0.064)
R-squared overall	0.030	0.060	0.038	0.027	0.075	0.016	0.028	0.097
Observations	7,194	7,194	7,194	7,194	7,194	7,194	7,194	7,194
Female observations	726	726	726	726	726	726	726	726
Firms	3,999	3,999	3,999	3,999	3,999	3,999	3,999	3,999
Avg. obs. per firm	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8

Notes: This table presents the results of a linear probability random effects panel regression with robust standard errors for the years 2005-2009. Only investing firms considered. The definitions and constructions of the variables can be found in Table 1. Each regression includes industry dummies as well as a dummy for region and participation in a promotional loan program. Robust standard errors in parentheses. *,** and *** indicate significance at the 10%, 5% and 1% levels, respectively.

The explanatory variables are the same as in the estimation of the binary investment decision. The only regressions where the dummy variable for female ownership is significant with a negative sign are those for the growth-oriented and risky investment goals. Hence, the probability that a female business owner indicates that she strives for these investment goals is significantly lower. For women the probability of pursuing these investment goals is about 0.05 lower for sales increases and implementation of new products and 0.04 lower for innovation/R&D. For the other investment goals there is no statistically significant gender difference. This result contributes to a better understanding of the puzzling outcome that women react less to an increase in cash

flow. We can infer that female-owned firms are on average less eager to expand and to invest in more risky business areas. This may also be an explanation for the fact that - even with higher cash flow - female firm owners invest less and are less inclined to increase their investments. One caveat of the regression may be the relatively low explanatory power of the estimated model with an R^2 between 0.027 and 0.097.

3.4.7 Robustness checks

In order to validate our findings we employ several robustness checks for each regression. These robustness checks essentially confirm our findings from the main regressions, as the signs and the significances do not differ substantially.

1. Check: other model specification, panel probit instead of LPM.
Typically, binary dependent variables are estimated with non-linear regression models. We therefore re-run the regressions of the binary investment decision (Section 3.4.4) and the investment goals (Section 3.4.6) with a panel probit model (Appendix Tables 3.12 and 3.13).

2. Check: other model specification, tobit instead of OLS.
The investment rate in our data is a censored variable. We have a significant proportion of zero outcomes for investment and we do not know which part of these zeros are latent non-zero observations. In other words, we do not know if the zero observations for investment are 'true' zeros because the firm owner did not want to invest or if the zeros are in fact negative observations, firms that could not invest. We have tried to overcome this problem by time-averaging the data in the estimation of an investment function in Section 3.4.5. However, the standard approach for this type of analysis is the use of censored regression models. In using a censored regression model it would be appropriate to estimate a two part (or Heckman) model to overcome the strong assumption of one part models that the same probability mechanism generates both the zeros and the positives values. These models, however, need at least one exclusion variable that has a substantial impact on the probability of selection but not on the positive outcome variable for robust identification. Unfortunately we are not able to justify any of the available variables as exogenous for the investment rate but substantial for the selection into investing. We therefore re-run the OLS regression of the investment rate with a tobit maximum likelihood estimator (MLE). However, the tobit approach is based on strong assumptions about the conditional data distribution and functional form. These strong assumptions are likely to be violated and this makes the tobit MLE a non-robust estimator (Cameron and Trivedi 2009). Using the tobit

model we are able to estimate the regressions with a larger sample compared to the small sample size of the OLS regression, as we do not need to time-average the data (Appendix Table 3.14).

3. Check: considering only firms with one owner.
We only have information about the gender of the primary firm owner and not about all members of the management team. In order to make sure that the decision maker in the firm is indeed female, we repeat all regressions considering only firms with one owner-manager (Appendix Tables 3.15, 3.16, 3.17).

3.5 Conclusion

This paper addresses the question of whether female-owned firms differ in their investment activity from male-owned firms. Our results offer valuable insights to gender differences in investment behavior and enhance the understanding of the causes of smaller firm size for firms owned by women. Even after controlling for other owner and firm characteristics we find that women invest significantly less than men, at the extensive as well as at the intensive margin. Furthermore, women react less to a marginal increase in cash flow, suggesting that even in the presence of the same internal funds women invest less. This difference in the impact of cash flow on investment rate is probably the most astonishing result in the paper. Of course we cannot infer any statements about causality, the observed differences are mere correlations. However, previous findings suggest that women are more risk and competition averse, less overconfident and have different preferences in life. These personal traits are correlated with gender and are likely to have a negative influence on investment behavior. Our estimation results confirm our hypothesis that women invest less if these findings do not only hold for the average women but for female entrepreneurs, too. Therefore, the significant gender effect from the regressions on the extensive and intensive margin of investment possibly contains these unobserved features that are best able to explain the differences in investment. An additional regression on investment goals reveals that women are less likely to invest for reasons that indicate an ambition to expand their businesses. This result points to the fact that women's lower investment is attributable rather to differences in preferences than to discrimination. However, size and growth are not the only criteria for business success, pursuing lower-pace growth may also be beneficial for a firm. Further research is needed in order to shed light on gender differences in business outcomes after investment.

3.6 Appendix

Table 3.9: Summary statistics regression sample intensive margin

Gender variable	Mean	St.dev.							
Female owner (d)	0.115	0.318							
	Male owner				Female owner				t-test
	Mean	St.dev.	Min.	Max.	Mean	St.dev.	Min.	Max.	p-value
Dependent variable									
Inv./lagged sales, 2008/2009	0.049	0.094	0	1.063	0.035	0.060	0	0.413	0.079*
Independent variables									
Inv./lagged sales, 2006/2007	0.065	0.116	0	1.232	0.056	0.111	0	1.028	0.371
Av. growth rate sales 2008/2009	0.001	0.149	-0.605	0.974	-0.008	0.126	-0.412	0.366	0.461
FTE (log)	37.4	54.5	0.5	822	23.2	30.5	1	162	0.001***
Cash flow/lagged sales 2008/2009	0.114	0.129	-0.198	1.184	0.142	0.177	-0.110	0.823	0.015**
Interaction cash flow*female					0.026	0.014	-0.226	0.707	
Sales expectation for 2010 pos. (d)	0.322	0.467	0	1	0.316	0.466	0	1	0.872
Sales expectation for 2009 pos. (d)	0.144	0.351	0	1	0.142	0.350	0	1	0.938
Ambitious investment goals (d)	0.567	0.496	0	1	0.484	0.501	0	1	0.049**
Stratification variables and industry dummies									
KfW support (d)	0.784	0.412	0	1	0.761	0.428	0	1	0.526
Region (d)	0.414	0.493	0	1	0.419	0.495	0	1	0.900
Manufacturing+other (d)	0.341	0.474	0	1	0.206	0.406	0	1	0.001***
Construction (d)	0.185	0.388	0	1	0.090	0.287	0	1	0.003***
Retail and wholesale (d)	0.260	0.439	0	1	0.303	0.461	0	1	0.252
Services (d)	0.214	0.410	0	1	0.400	0.491	0	1	0.000***
Legal form dummies									
Sole proprietorship (d)	0.271	0.444	0	1	0.393	0.490	0	1	0.001***
Private limited (d)	0.070	0.256	0	1	0.103	0.305	0	1	0.143
Limited liability (d)	0.118	0.323	0	1	0.071	0.258	0	1	0.079*
Corporation (d)	0.532	0.499	0	1	0.419	0.495	0	1	0.008***
Other legal form (d)	0.008	0.090	0	1	0.013	0.113	0	1	0.543

Notes: this table provides summary statistics for the reduced sample used in the estimation of a OLS model of investment in Table 3.5. N=1,389. Only firms that are observable from 2006-2009 and firms that have invested at least once in those years are included. Comparison of means with two-sample t-test of equality of means under the assumption of equal variances. *,** and *** indicate significance at the 10%, 5% and 1% levels, respectively.

Table 3.10: Linear probability RE panel GLS model with interactions (size)

	(1)	(2)
Dependent variable: investment (0/1)	with size cat	with size cat & size interact
Female owner (d)	-0.033***	-0.120***
	(0.012)	(0.039)
2/2.5 empl	0.041*	0.025
	(0.022)	(0.025)
3/3.5 empl	0.047**	0.028
	(0.024)	(0.026)
4-5.5 empl	0.099***	0.075***
	(0.023)	(0.025)
6-7.5 empl	0.106***	0.095***
	(0.024)	(0.026)
8-11.5 empl	0.167***	0.147***
	(0.024)	(0.026)
12-14.5 empl	0.183***	0.167***
	(0.027)	(0.029)
15-19.5 empl	0.247***	0.229***
	(0.027)	(0.028)
20-34.5 empl	0.248***	0.232***
	(0.028)	(0.029)
35-59 empl	0.262***	0.243***
	(0.030)	(0.031)
>60 empl	0.297***	0.278***
	(0.032)	(0.033)
fem*2/2.5 empl		0.078
		(0.051)
fem*3/3.5 empl		0.092
		(0.058)
fem*4-5.5 empl		0.131***
		(0.051)
fem*6-7.5 empl		0.044
		(0.053)
fem*8-11.5 empl		0.105**
		(0.050)
fem*12-14.5 empl		0.075
		(0.061)
fem*15-19.5 empl		0.090
		(0.056)
fem*20-34.5 empl		0.070
		(0.052)
fem*35-59 empl		0.118**
		(0.054)
fem*>60 empl		0.111**
		(0.052)
Firm age	-0.0002	-0.0002
	(0.0001)	(0.0001)
Lagged sales (log)	0.036***	0.035***
	(0.005)	(0.005)
2 managers/owners (d)	0.024***	0.024***
	(0.008)	(0.008)
3 or more managers	0.018	0.018
/owners (d)	(0.012)	(0.012)
Graduate (d)	0.017**	0.017**
	(0.008)	(0.008)
Age firm owner	-0.002***	-0.002***
	(0.0004)	(0.0004)
Sales expect. positive (d)	0.037***	0.036***
	(0.007)	(0.007)
Innovation activities (d)	0.108***	0.108***
	(0.007)	(0.007)
Sales growth	0.160***	0.160***
	(0.011)	(0.011)
Cash flow	2.82e-08***	2.83e-08***
	(4.85e-09)	(4.86e-09)
Constant	-0.070	-0.050
	(0.066)	(0.067)
R-squared	0.169	0.176
Observations	20,254	20,254
Female observations	2,361	2,361
Firms	9,949	9,949
Avg. obs. per firm	2.0	2.0

Notes: This table presents the results of a random effects panel GLS regression for the years 2003-2009 with firm-level cluster-robust standard errors. The regression includes time dummies and the stratification variables. The reference category are manufacturing firms in sole proprietorship that are younger than 5 years and have one owner-manager. *,** and *** indicate significance at the 10%, 5% and 1% levels, respectively.

Table 3.11: Linear probability RE panel GLS model with interactions (age)

	(1)	(2)
Dependent variable: investment (0/1)	with age cat	with age cat & age interact
Female owner (d)	-0.036***	-0.055
	-0.012	(0.038)
3 -<6 y.	-0.042**	-0.051**
	(0.018)	(0.020)
6 -<9 y.	-0.070***	-0.075***
	(0.019)	(0.020)
9 -<13 y.	-0.055***	-0.056***
	(0.018)	(0.020)
13 -<17 y.	-0.084***	-0.082***
	(0.018)	(0.020)
17 -<20 y.	-0.081***	-0.085***
	(0.020)	(0.021)
20 -<30 y.	-0.067***	-0.069***
	(0.020)	(0.022)
30 -<50 y.	-0.057***	-0.060***
	(0.019)	(0.021)
50 to 80 y.	-0.071***	-0.079***
	(0.020)	(0.021)
>80 y.	-0.077***	-0.080***
	(0.020)	(0.021)
fem*3 -<6 y.		0.048
		(0.046)
fem*6 -<9 y.		0.028
		(0.050)
fem*9 -<13 y.		0.004
		(0.049)
fem*13 -<17 y.		-0.030
		(0.049)
fem*17 -<20 y.		0.021
		(0.058)
fem*20 -<30 y.		0.005
		(0.057)
fem*30 -<50 y.		0.020
		(0.055)
fem*50-80 y.		0.074
		(0.054)
fem*>80 y.		0.018
		(0.049)
Firm size	0.069***	0.069***
(number of FTE)	(0.006)	(0.006)
Lagged sales (log)	0.039***	0.039***
	(0.005)	(0.005)
2 managers/owners (d)	0.025***	0.025***
	(0.008)	(0.008)
3 or more managers	0.015	0.015
/owners (d)	(0.012)	(0.012)
Graduate (d)	0.016*	0.016**
	(0.008)	(0.008)
Age firm owner	-0.002***	-0.002***
	(0.0004)	(0.0004)
Sales expect. positive (d)	0.034***	0.034***
	(0.007)	(0.007)
Innovation activities (d)	0.109***	0.109***
	(0.007)	(0.007)
Sales growth	0.156***	0.155***
	(0.011)	(0.011)
Cash flow	1.42e-08***	1.43e-08***
	(4.85e-09)	(4.86e-09)
Constant	-0.079	-0.077
	(0.066)	(0.066)
R-squared	0.170	0.175
Observations	20,254	20,254
Female observations	2,361	2,361
Firms	9,949	9,949
Avg. obs. per firm	2.0	2.0

Notes: This table presents the results of a random effects panel GLS regression for the years 2003-2009 with firm-level cluster-robust standard errors. The regression includes time dummies and the stratification variables. The reference category are manufacturing firms in sole proprietorship that are younger than 5 years and have one owner-manager. *,** and *** indicate significance at the 10%, 5% and 1% levels, respectively.

Table 3.12: Panel random effects probit model of investment

Dependent variable: investment (0/1)	(1)	(2)	(3)	(4)	(5)
Female owner (d)	-0.446***	-0.398***	-0.188***	-0.181***	-0.123**
	(0.054)	(0.055)	(0.049)	(0.049)	(0.049)
Lagged FTE (log)			0.450***	0.268***	0.198***
			(0.014)	(0.025)	(0.025)
Lagged sales (log)				0.179***	0.252***
				(0.021)	(0.022)
Firm age 5-10 years (d)				-0.222***	-0.156***
				(0.046)	(0.046)
Firm age 11-20 years (d)				-0.295***	-0.208***
				(0.048)	(0.048)
Firm age >20 years (d)				-0.268***	-0.168***
				(0.048)	(0.048)
2 owners/managers (d)				0.141***	0.110***
				(0.037)	(0.037)
3 or more managers/owners (d)				0.135**	0.090*
				(0.054)	(0.053)
Sales expect. positive (d)				0.225***	0.172***
				(0.030)	(0.030)
Graduate (d)				0.103***	0.051
				(0.034)	(0.033)
Age firm owner				-0.007***	-0.006***
				(0.002)	(0.002)
Innovation activities (d)					0.465***
					(0.028)
Sales growth					0.690***
					(0.046)
Cash flow/lagged sales					0.342***
					(0.065)
Demeaned cash flow*female					0.285
					(0.183)
Constant	0.463***	0.755***	-0.658***	-2.345***	-3.583***
	(0.0390)	(0.0496)	(0.0580)	(0.252)	(0.262)
Industry dummies	no	yes	yes	yes	yes
Legal form dummies	no	no	no	yes	yes
Prob > chi2	0,000	0,000	0,000	0,000	0,000
Observations	20,254	20,254	20,254	20,254	20,254
Female Observations	2,361	2,361	2,361	2,361	2,361
Firms	9,949	9,949	9,949	9,949	9,949
Avg. obs. per firm	2.0	2.0	2.0	2.0	2.0

Notes: This table presents the results of a random effects panel probit regression for the years 2003-2009 with firm-level cluster-robust standard errors. All regressions include time and legal form dummies as well as the stratification variables. The reference category are manufacturing firms in sole proprietorship that are younger than 5 years and have one owner-manager. *,** and *** indicate significance at the 10%, 5% and 1% levels, respectively.

Table 3.13: Panel probit regression of investment goals

Dependent variable: Investment goal (0/1)	Environm. protection	Rational-ization	Implement. new prod.	Technical replacem.	Innovation/ R&D	Governm. requirem.	Sales increase	Other goals
Female owner (d)	**-0.153**	**-0.036**	**-0.193****	**0.049**	**-0.535*****	**0.151**	**-0.205****	**0.158**
	(0.129)	**(0.082)**	**(0.079)**	**(0.072)**	**(0.178)**	**(0.122)**	**(0.084)**	**(0.099)**
Lagged FTE (log)	0.026	0.255***	-0.016	-0.008	0.032	-0.0148	0.146***	-0.096*
	(0.063)	(0.043)	(0.041)	(0.038)	(0.080)	(0.067)	(0.044)	(0.057)
Lagged sales (log)	0.104*	-0.035	0.012	0.047	0.087	0.059	0.004	-0.011
	(0.055)	(0.037)	(0.036)	(0.033)	(0.070)	(0.058)	(0.0380)	(0.049)
Firm age 5-10 years (d)	-0.015	0.162*	-0.029	0.014	-0.002	0.158	-0.100	-0.056
	(0.143)	(0.088)	(0.084)	(0.079)	(0.157)	(0.140)	(0.090)	(0.116)
Firm age 11-20 years (d)	0.052	0.038	-0.109	0.209***	-0.240	-0.045	-0.219**	-0.096
	(0.132)	(0.085)	(0.081)	(0.076)	(0.155)	(0.139)	(0.087)	(0.112)
Firm age >20 years (d)	0.163	0.123	-0.201**	0.257***	-0.505***	0.154	-0.397***	-0.117
	(0.131)	(0.086)	(0.082)	(0.077)	(0.161)	(0.136)	(0.088)	(0.113)
Sales expect. positive (d)	-0.153**	-0.010	0.179***	-0.156***	0.302***	-0.011	0.553***	-0.016
	(0.071)	(0.047)	(0.045)	(0.043)	(0.080)	(0.077)	(0.047)	(0.065)
Graduate owner (d)	-0.309***	0.014	-0.117**	0.002	0.340***	-0.174**	-0.196***	0.059
	(0.081)	(0.054)	(0.051)	(0.048)	(0.105)	(0.086)	(0.055)	(0.070)
Age firm owner	-0.005	-0.002	0.0002	-0.007***	0.008	-0.009**	-0.003	-0.0007
	(0.004)	(0.003)	(0.003)	(0.002)	(0.005)	(0.004)	(0.003)	(0.003)
2 owners/managers (d)	0.058	-0.028	0.014	0.015	0.070	0.013	0.063	-0.041
	(0.082)	(0.056)	(0.053)	(0.050)	(0.097)	(0.089)	(0.057)	(0.077)
3 or more owners/managers (d)	-0.081	0.061	-0.123*	0.009	0.041	-0.131	-0.004	0.154
	(0.114)	(0.077)	(0.074)	(0.069)	(0.132)	(0.129)	(0.078)	(0.102)
Sales growth	0.216	0.113	-0.091	-0.046	0.094	-0.049	0.631***	-0.305**
	(0.134)	(0.086)	(0.085)	(0.080)	(0.149)	(0.146)	(0.091)	(0.123)
Cash flow in t/Sales t-1	-0.027	0.007	0.0003	-0.010	-0.004	0.004	0.002	-0.054
	(0.050)	(0.008)	(0.005)	(0.009)	(0.015)	(0.008)	(0.006)	(0.067)
Constant	-2.780***	0.092	-0.535	-0.123	-3.841***	-2.142***	-0.345	-1.530***
	(0.671)	(0.450)	(0.433)	(0.400)	(0.866)	(0.707)	(0.460)	(0.594)
Observations	7,194	7,194	7,194	7,194	7,194	7,194	7,194	7,194
Female observations	726	726	726	726	726	726	726	726
Firms	3,999	3,999	3,999	3,999	3,999	3,999	3,999	3,999
Avg. obs. per firm	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8

Notes: This table presents the results of a panel probit regression with robust standard errors for the years 2005-2009. Only investing firms considered. Each regression includes industry dummies as well as a dummy for region and participation in a promotional loan program. Robust standard errors in parentheses. *,** and *** indicate significance at the 10%, 5% and 1% levels, respectively.

Table 3.14: Random effects panel tobit regression of investment

Dependent Variable: Investment rate (investment/sales)	(1)	(2)	(3)	(4)	(5)
Female owner (d)	-0.021***	-0.021***	-0.018***	-0.018***	-0.012***
	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)
Investment/sales t-1	0.003***	0.003***	0.003***	0.003***	0.003***
	(0.0005)	(0.0005)	(0.0005)	(0.0005)	(0.0005)
Sales growth	0.101***	0.085***	0.085***	0.084***	0.060***
	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)
Lagged FTE (log)	0.011***	0.015***	0.016***	0.015***	0.003**
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Cash flow in t/sales t-1		0.096***	0.110***	0.111***	0.105***
		(0.007)	(0.007)	(0.007)	(0.007)
Interaction cash flow*female			-0.085***	-0.085***	-0.075***
			(0.016)	(0.016)	(0.015)
Sales expect. pos. (d)				0.031***	0.012***
				(0.002)	(0.002)
Ambitious investment goals (d)					0.145***
					(0.002)
Constant	-0.006	-0.028***	-0.031***	-0.036***	-0.070***
	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)
Observations	23,130	23,130	23,130	23,130	23,130
left-censored	8,515	8,515	8,515	8,515	8,515
uncensored	14,615	14,615	14,615	14,615	14,615
Female obs.	2673	2673	2673	2673	2673
Firms	10,966	10,966	10,966	10,966	10,966
Avg. obs. per firm	2.1	2.1	2.1	2.1	2.1

Notes: This table presents the results of a random effects panel tobit regression for the years 2003-2009. Each regression includes industry and time dummies as well as the stratification variables. The reference category are manufacturing firms that are younger than 5 years. *,** and *** indicate significance at the 10%, 5% and 1% levels, respectively.

Table 3.15: Linear probability random effects panel GLS model of investment (only firms with 1 owner-manager)

Dependent variable: investment (0/1)	(1)	(2)	(3)	(4)	(5)
Female owner (d)	-0.129***	-0.119***	-0.068***	-0.065***	-0.045***
	(0.017)	(0.017)	(0.016)	(0.016)	(0.016)
Lagged FTE (log)			0.107***	0.057***	0.039***
			(0.004)	(0.008)	(0.008)
Lagged sales (log)				0.051***	0.070***
				(0.007)	(0.007)
Firm age 5-10 years (d)				-0.051***	-0.035**
				(0.015)	(0.015)
Firm age 11-20 years (d)				-0.059***	-0.039***
				(0.015)	(0.015)
Firm age >20 years (d)				-0.056***	-0.031**
				(0.015)	(0.015)
Sales expect. positive (d)				0.062***	0.048***
				(0.009)	(0.009)
Graduate (d)				0.026**	0.010
				(0.011)	(0.011)
Age firm owner				-0.003***	-0.002***
				(0.0006)	(0.0006)
Innovation activities (d)					0.124***
					(0.009)
Sales growth					0.165***
					(0.015)
Cash flow/lagged sales					0.110***
					(0.030)
Demeaned cash flow*female					0.056
					(0.054)
Constant	0.575***	0.647***	0.352***	-0.0930	-0.419***
	(0.012)	(0.015)	(0.018)	(0.082)	(0.082)
Industry dummies	no	yes	yes	yes	yes
Legal form dummies	no	no	no	yes	yes
R-squared	0.023	0.035	0.116	0.133	0.17
Observations	11,918	11,918	11,918	11,918	11,918
Female observations	1,427	1,427	1,427	1,427	1,427
Firms	6,244	6,244	6,244	6,244	6,244
Avg. obs. per firm	1.9	1.9	1.9	1.9	1.9

Notes: This table presents the results of a random effects panel GLS regression for the years 2003-2009 with firm-level cluster-robust standard errors. The regression includes time dummies and the stratification variables. The reference category are manufacturing firms in sole proprietorship that are younger than 5 years.*,** and *** indicate significance at the 10%, 5% and 1% levels, respectively.

Table 3.16: Random effects panel tobit regression of investment (only firms with 1 owner-manager)

Dependent variable: Investment/sales	(1)	(2)	(3)	(4)	(5)
Female owner (d)	-0.029***	-0.029***	-0.027***	-0.026***	-0.020***
	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)
Investment/sales t-1	0.003***	0.003***	0.003***	0.003***	0.002***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Sales growth	0.106***	0.090***	0.090***	0.089***	0.062***
	(0.006)	(0.006)	(0.006)	(0.006)	(0.005)
Lagged FTE (log)	0.014***	0.019***	0.019***	0.017***	0.003**
	(0.002)	(0.002)	(0.002)	(0.002)	(0.001)
Cash flow in t/sales t-1		0.090***	0.094***	0.097***	0.090***
		(0.009)	(0.009)	(0.009)	(0.009)
Interaction cash flow*female			-0.040	-0.041*	-0.034
			(0.025)	(0.025)	(0.023)
Sales expect. pos. (d)				0.036***	0.012***
				(0.004)	(0.003)
Ambitious Inv. goals (d)					0.166***
					(0.003)
Constant	-0.016*	-0.038***	-0.039***	-0.044***	-0.080***
	(0.009)	(0.009)	(0.009)	(0.009)	(0.008)
Observations	13,551	13,551	13,551	13,551	13,551
left-censored	5,642	5,642	5,642	5,642	5,642
uncensored	7,909	7,909	7,909	7,909	7,909
Female observations	1,580	1,580	1,580	1,580	1,580
Firms	6,852	6,852	6,852	6,852	6,852
Avg. obs. per firm	2.0	2.0	2.0	2.0	2.0

Notes: This table presents the results of a random effects panel tobit regression for the years 2003-2009. Each regression includes industry and time dummies as well as the stratification variables. The reference category are manufacturing firms that are younger than 5 years. *,** and *** indicate significance at the 10%, 5% and 1% levels, respectively.

Table 3.17: Linear probability model of investment goals (only firms with 1 owner-manager)

Dependent variable: Investment goal (0/1)	Environm. protection	Rational-ization	Implement. new prod.	Technical replacem.	Innovation/ R&D	Governm. requirem.	Sales increase	Other goals
Female owner (d)	**-0.036****	**-0.047**	**-0.011**	**-0.015**	**-0.050*****	**0.014**	**-0.065****	**0.004**
	(0.015)	**(0.030)**	**(0.029)**	**(0.030)**	**(0.015)**	**(0.017)**	**(0.031)**	**(0.018)**
Lagged FTE (log)	0.010	0.063***	-0.011	0.005	0.007	0.005	0.045***	-0.011
	(0.010)	(0.016)	(0.014)	(0.015)	(0.008)	(0.008)	(0.015)	(0.008)
Lagged sales (log)	0.0005	-0.009	0.011	0.006	0.004	0.003	0.002	0.002
	(0.009)	(0.014)	(0.012)	(0.014)	(0.008)	(0.007)	(0.014)	(0.007)
Firm age 5-10 years (d)	0.011	0.037	0.011	0.013	0.010	0.004	-0.035	-0.008
	(0.016)	(0.031)	(0.031)	(0.032)	(0.017)	(0.018)	(0.030)	(0.018)
Firm age 11-20 years (d)	0.022	0.022	-0.036	0.089***	-0.024	-0.005	-0.067**	-0.018
	(0.017)	(0.030)	(0.029)	(0.030)	(0.017)	(0.016)	(0.030)	(0.018)
Firm age >20 years (d)	0.046***	0.024	-0.063**	0.104***	-0.034*	0.004	-0.110***	-0.021
	(0.017)	(0.031)	(0.030)	(0.031)	(0.017)	(0.017)	(0.031)	(0.018)
Sales expect. positive (d)	-0.020*	-0.004	0.049***	-0.023	0.025**	-0.013	0.156***	0.002
	(0.011)	(0.017)	(0.017)	(0.018)	(0.011)	(0.009)	(0.018)	(0.010)
Graduate owner (d)	-0.021*	0.001	-0.030*	-0.003	0.030**	-0.020**	-0.072***	0.011
	(0.012)	(0.020)	(0.018)	(0.020)	(0.012)	(0.010)	(0.019)	(0.011)
Age firm owner	-0.001*	-0.001	-0.0004	-0.003***	0.001	-0.001**	4.56e-05	0.001
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Sales growth	0.040**	0.025	-0.003	-0.003	0.005	0.023	0.167***	-0.060***
	(0.020)	(0.032)	(0.031)	(0.033)	(0.020)	(0.017)	(0.032)	(0.018)
Cash flow in t/Sales t-1	-5.93e-05	0.001***	0.0003	-0.002***	-0.0004**	0.0003	0.0003	-0.0003**
	(0.0001)	(0.0004)	(0.001)	(0.001)	(0.0002)	(0.0005)	(0.0005)	(0.0001)
Constant	0.157	0.591***	0.261*	0.601***	0.026	0.132	0.366**	0.036
	(0.108)	(0.169)	(0.148)	(0.166)	(0.101)	(0.089)	(0.163)	(0.085)
R-squared overall	0.031	0.052	0.036	0.030	0.071	0.022	0.033	0.090
Observations	3,949	3,949	3,949	3,949	3,949	3,949	3,949	3,949
Female observations	369	369	369	369	369	369	369	369
Firms	2,336	2,336	2,336	2,336	2,336	2,336	2,336	2,336
Avg. obs. per firm	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8

Notes: This table presents the results of an random effects panel regression with robust standard errors for the years 2005-2009. Only investing firms with one owner-manager considered. The definitions and constructions of the variables can be found in Table 1. Each regression includes industry dummies as well as a dummy for region and participation in a promotional loan program. Robust standard errors in parentheses. *,** and *** indicate significance at the 10%, 5% and 1% levels, respectively.

3.7 References

Addison, T., Schank, T., Schnabel, C. and J. Wagner (2007). Do works councils inhibit investment?, *Industrial and Labor Relations Review* 60(2), 187-203.

Allen, E., Langowitz, N. and M. Minniti (2007). Global entrepreneurship monitor, 2006 report on women and entrepreneurship, The Center for Women's Entrepreneurship at Babson College and London Business School.

Arellano, M. and O. Bover (1995). Another look at the instrumental-variable estimation of error component models, *Journal of Econometrics* 68, 29-52.

Bartholomew, S. and A. D. Smith (2006). Improving survey response rates from chief executive officers in small firms: The importance of social networks, *Entrepreneurship Theory and Practice* 30 (1), 83-96.

Blanchflower, D. G. and A. J. Oswald (1998). What makes an entrepreneur? *Journal of Labor Economics* 16(1), 26-60.

Blundell, R. and S. Bond (1998). Initial conditions and moment restrictions in dynamic panel data models. *Journal of Econometrics* 87, 115-143.

Bond, S., Elston, J. A., Mairesse, J. and B. Mulkay (2003). Financial factors and investment in Belgium, France, Germany, and the United Kingdom: A comparison using company panel data, *The Review of Economics and Statistics* 85(1), 153-165.

Bond, S. and J. Van Reenen (2007). Microeconometric models of investment and employment. In: Heckman, J. and E. Leamer (eds.), *Handbook of Econometrics*. North Holland, London, UK, 4417-4498.

Caliendo, M., Fossen, F.M. and A.S. Kritikos (2009). Risk attitudes of nascent entrepreneurs - new evidence from an experimentally validated survey, *Small Business Economics* 32(2), 153-167.

Cameron, C. and P. Trivedi (2009). *Microeconometrics Using Stata*, Stata Press, College Station, Texas.

Cliff, J. (1998). Does one size fit all? Exploring the relationship between attitudes towards growth, gender, and business size, *Journal of Business Venturing* 13, 523-542.

Cole, R. and H. Mehran (2009). Gender and the availability of credit to privately held firms: evidence from the surveys of small business finances. *Federal Reserve Bank of New York Staff Report* 383.

Croson, R. and U. Gneezy (2009). Gender differences in preferences, *Journal of Economic Literature* 47(2), 448-474.

Dohmen, T. and A. Falk (2011). Performance pay and multi-dimensional sorting - productivity, preferences and gender, *The American Economic Review* 101(2), 556-590.

Du Rietz, A. and M. Henrekson (2000). Testing the female underperformance hypothesis, *Small Business Economics* 14, 1-10.

Dwyer, P., Gilkeson J. and J. List (2002). Gender differences in revealed risk taking: evidence from mutual fund investors, *Economics Letters* 76, 151-158.

Fairlie, R. and A. Robb (2009). Gender differences in business performance: evidence from the characteristics of business owners survey, *Small Business Economics* 33(4), 375-395.

Fazzari, S., Hubbard, R. and B. Petersen (1988). Financing constraints and corporate investment, *Brookings Papers on Economic Policy* 1988(1), 141-195.

Gneezy, U., Niederle, M. and A. Rustichini (2003). Performance in competitive environments: Gender differences, *The Quarterly Journal of Economics* 118(3), 1049-1074.

Gottschalk, S. and M. Niefert (2011). Gender differences in business success of German start-up firms. *ZEW Discussion Paper* 11-019.

Hakim, C. (2002). Lifestyle preferences as determinants of women's differentiated labor market careers, *Work and Occupations* 29(4), 428-459.

Johnson, J. and P. Powell (1994). Decision making, risk and gender: Are managers different?, *British Journal of Management* 5, 123-138.

Kaplan, S. and L. Zingales (1997). Do investment - cash flow sensitivies provide useful measures of financing constraints?, *The Quarterly Journal of Economics* 112(1), 169-216.

Niederle, M. and L. Vesterlund (2007). Do women shy away from competition? Do men compete too much? *The Quarterly Journal of Economics* 122(3), 1067-1101.

Odean, T. and B. Barber (2001). Boys will be boys: gender, overconfidence and common stock investment, *The Quarterly Journal of Economics* 116(1), 261-292.

Orobia, L., Sserwanga, A. and G. Rooks (2011). Risk taking and start-up capital: Exploring gender differences in Uganda, through an international comparison, *Journal of Economics and Behavioral Studies* 3(2), 83-93.

Reize, F. (2010). KfW-Mittelstandspanel 2010. Mittelstand: Stabil in der Krise - auch in Zukunft leistungsstark durch Innovation, KfW Bankengruppe, Frankfurt am Main.

Robb, A. and J. Watson (2010). Comparing the performance of female- and male-controlled SMEs: evidence from the United States and Australia, *Frontiers of Entrepreneurship Research* 30(8), 1-12.

Schubert, R., Brown, M., Gysler, M. and H. W. Brachinger (1999). Financial decision-making: Are women really more risk-averse?, *American Economic Association Papers and Proceedings* 89(2), 381-385.

Sexton, D. L. and N. Bowman-Upton (1990). Female and male entrepreneurs: Psychological characteristics and their role in gender-related discrimination, *Journal of Business Venturing* 5(1), 29-36.

Sunden, A. and B. Surette (1998). Gender differences in the allocation of assets in retirement savings plans, *American Economic Association Papers and Proceedings* 88(2), 207-11.

Tobin, J. and W. Brainard (1977). Asset markets and the cost of capital, In: Nelson, R. and B. Balassa (eds.):*Economic progress, private values and public policy: Essays in honor of William Fellner*, North Holland, Amsterdam, 235-62.

Tonoyan, V. and R. Strohmeyer (2005). Employment growth and firm innovativeness: An empirical investigation of women- and men-owned small ventures in Germany, In: Achleitner, A.-K., H. Klandt, L. T. Koch & K.-I. Vogt (eds.): *Jahrbuch Entrepreneurship 2005/2006, Gründungsforschung und Gründungsmanagement.* Springer-Verlag Berlin, Heidelberg, New York, 323-353.

Wooldridge, J. (2009). *Introductory Econometrics: A Modern Approach.* Fourth Edition. South Western.

Chapter 4

Gender, investment financing and credit constraints

4.1 Introduction

In the previous chapter we have found that female-owned firms invest less than male-owned firms. This holds for the probability of investing, the extensive margin of investment, as well as for the investment rate, the intensive margin. Furthermore, women's investments seem to react less to a marginal increase in cash flow, which can be interpreted as women being effected less by financial constraints. An analysis of stated investment goals reveals that women less often indicate growth oriented goals for their investment. Hence, women's lower propensity to invest is rather driven by preferences than by financial constraints. Certainly, proxying financial constraints by cash flow has its limits in providing insights on a firm's financial possibilities. Restricted access to financial resources is one of the main obstacles for investing, therefore it is highly relevant to gain direct evidence on firms' financing behavior. In this chapter we revisit the issue of financial constraints and take a closer look at gender differences in investment financing, credit application and denial.

To the best of our knowledge we are the first to empirically analyze gender differences in the composition of firm investment financing, the credit application behavior and application outcome of German firm owners. As in the previous chapter, we use the KfW Mittelstandspanel, a data set on German SMEs for the years 2003-2009.[1] We analyze both the supply side and demand side of access to bank loans and we are able to control for various firm and owner characteristics.

[1]See Chapter 3 for a detailed description of the data set.

Most of the few previous studies have not found that female firm owners are affected more by financial constraints than male owners (e.g. Cavalluzzo et al. 2002). However, women seem to have different financing patterns. Already at start-up stage female-owned firms use less external debt and rely more on personal sources (Carter et al. 2007). Also women are less likely to seek external finance for follow-up investments (Coleman and Robb 2009, Sena et al. 2010). Muravyev et al. (2009) find that on average female firm owners have a higher proportion of retained earnings and a smaller share of bank financing. Robb and Robinson (2010) reveal that the average female-owned firm holds about 5% less debt than a comparable male-owned business.

Our analysis on gender differences in financing structure confirms previous evidence on financing patterns. We examine the respective shares of equity capital, external capital, business development capital and other funds in investment financing. We find that in financing their investments female firm owners rely more on internal capital and less on external funds than male firm owners, irrespective of the relative size of the investment. This difference in firm financing could be either a result of individual preferences on getting into debt or of gender discrimination on the capital market. In our empirical analysis we address both approaches. We analyze the demand side and the supply side on the credit market. More precisely, we examine the impact of the firm owner's gender on the probability of applying for credit and the probability of a non-successful outcome. We consider only investing firms. Our analysis of credit application behavior reveals that female firm owners who invest are significantly less likely to apply for credit than investing male firm owners. After splitting the sample according to positive and non-positive sales expectations we find that the gender difference in the probability of applying for credit is only evident among firm owners that have non-positive sales expectations. Female-owned firms with neutral or negative sales expectations are less likely to apply for credit when they invest compared to their male counterparts. For firms with positive expectations the probability of applying does not significantly differ between men and women.

An analysis of application denial rates shows that female-owned firms are not more likely to be denied credit. This result however suffers from sample selection bias, as it is likely that the female-owned firms that apply for credit represent a positive subsample of all applying firms. Potentially successful female applicants may be more reluctant to apply for credit because they fear and misconceive a rejection (Sena et al. 2010).

Our results suggest that differences in investment financing are not attributable to discrimination against women on the credit market. Despite this finding, women might still be more credit constrained because they are more likely to be discouraged from applying and therefore self-constrain themselves. This result is probably attributable

to certain personal traits that are associated typically with being female. Previous studies have found that women are more risk-averse, less self-confident and report more intense nervousness and fear than men in anticipation of negative outcomes (Croson and Gneezy 2009). In anticipation of non-positive sales development, these traits may prevent women more from securing external funds or even from applying for credit. Several robustness checks underpin our results.

4.2 Investment financing

4.2.1 Theoretical and empirical background

Several theories have tried to explain the complex issue of firm financing and capital structure. The starting point was the model of Modigliani and Miller (1958) who state that under the assumption of perfect and frictionless capital markets a firm's financial decisions do not affect the firm's market value and the cost of capital. In contrast, later theories on capital structure account for the fact that in an imperfect world financial decisions may be influenced by taxes, information asymmetries and agency costs.

The most prominent two competing theories are the pecking order theory and the trade-off theory. The pecking order theory focuses on information asymmetries between managers and external investors. Managers and firm owners have better information about their firms and prefer to keep control over the firm. This leads to a hierarchical order of financial resources in a firm's policy according to the involved level of information costs and risk. The preferred source of financing are internal funds as they involve no information costs, low risk and highest control. The second most preferred source is debt, and the last alternative is new equity capital, which is associated with the highest information costs and risks (Myers 1984, Myers and Majluf 1984).

The trade-off theory in contrast refers to an optimal capital structure resulting from a profit-maximizing balance of tax advantages and bankruptcy costs of debt. The implications of this theory are, particularly for Germany, not that straightforward as governmental subsidies for firm investment are very complex and generate different firm-specific financing incentives. Yet, there is empirical work supporting both theories (Shyam-Sunder and Myers 1999, Cole 2011).

Traditional capital theories as well as most empirical studies focus on large, publicly traded firms and do not consider the influence of owner-characteristics on firm financing. However, there is evidence that both firm size and owner characteristics can have an influence on financing behavior.

López-Gracia and Sogorb-Mira (2008) show how small and medium sized enterprises (SMEs) differ from large firms in regards to financing. SMEs are affected more by information asymmetries and are usually not listed on the stock market. Therefore SMEs depend more on internal funds and their financing structure is less diversified. Female-owned firms are on average smaller than male-owned firms, therefore gender differences in capital structure could possibly also be attributed to size. Regarding owner-characteristics, Ang et al. (2010) demonstrate that individual socioeconomic and demographic factors of the firm owner (e.g. age, gender, education, wealth, experience etc.) can add to a better understanding of capital structure decisions. Individual preferences and risk tolerance of the owner have an important impact on the firm's capital structure if the personal financial situation is directly affected by the firm's outcome. Owners of small firms that are individually liable may opt for different financial decisions than owners of larger firms with limited liability. Typically, the smaller the firm the more financing decisions depend on the firm owner and his or her personal features.

Myers (2001, p. 99) points out that 'the theories (on capital structure) are not designed to be general' and that the understanding of firms' financing structures is still limited. There exists no universal theory as the topic of firm financing is too complex and diverse. Every firm has individual objectives and needs. Accordingly, we do not perform a hypothesis test of a particular capital structure theory in our empirical analysis, as we do not expect any of the traditional theories to provide useful predictions. Instead, we opt for an explorative approach where we try to reveal the determinants of the composition of investment financing and particularly the correlation with gender. A firm's financing strategy is not self-determined but subject to external and internal constraints. In light of the findings discussed above we expect investment in female-owned firms to be financed by a higher share of internal funds than in male-owned firms.

4.2.2 Gender differences in financing patterns

Table 4.1 reports descriptive statistics on the composition of investment financing averaged over the years 2004-2009 for female and male-owned firms.[2] Investment financing consists of the sum of internal capital, external capital, business development capital and other funds that are used to finance the investment. All together the shares of these financing resources sum up to 100 percent. The category external capital contains

[2]Table 4.4 in the Appendix contains descriptive statistics of all variables included in the regression on investment financing.

all types of capital that are raised outside the firm, namely venture capital, mezzanine capital, bank loans and capital from external shareholders. Business development capital refers to subsidy loans provided by promotional institutions like e.g. the KfW Bankengruppe.

Table 4.1: Summary statistics investment financing

	Male owner		Female owner		t-test
Percentage of	Mean	St.dev.	Mean	St.dev.	p-value
~ internal capital	54.7	41.1	58.5	42.3	0.000***
~ external capital	30.2	37.3	26.8	37.1	0.000***
~ business development capital	8.0	20.3	7.6	21.1	0.348
~ other funds	7.1	21.3	7.1	21.7	0.963
total	100		100		

Notes: N=24,302. The category external capital consists of venture capital, mezzanine capital, bank loans and external shareholder capital. Business development capital refers to subsidy loans provided by promotional institutions. Comparison of means with two-sample t-test of equality of means under the assumption of equal variances. *** indicates significance at the 10% levels.

A two-sample t-test of equality of means reveals significant differences in the shares of external and internal capital used for investment financing. The share of internal capital is by 58.5% to 54.7% significantly higher for female-owned firms, while the share of external capital is lower (26.8% vs. 30.2%). For the share of business development capital and other funds there are no significant differences. However, this difference in the shares of internal vs. external capital is not necessarily a gender effect, it may be attributable to differences in firm characteristics such as size, industry etc.

In order to separate the impact of gender from other owner- and firm-specific characteristics we estimate a random effects panel tobit model for the share of each financing resource separately. The model has the following specification:

$$y_{it}^{*} = \alpha_i + \gamma f_i + \beta x_{it}^{'} + v_i + u_{it} \tag{4.1}$$

$$y_{it} = \begin{cases} 0 & \text{if } y_{it}^{*} \leq 0 \\ y_{it} & \text{if } 0 < y_{it}^{*} < 100 \\ 100 & \text{if } y_{it}^{*} \geq 100 \end{cases} \tag{4.2}$$

with y_{it} denoting the share of internal, external, business development or other capital with left-censoring at the lower bound of 0 percent and right-censoring at the upper

bound of 100 percent. f_i is a dummy variable for female ownership, v_i stands for time-invariant individual effects, and u_{it} is the remaining disturbance. x_{it} is a vector including firm- and owner-specific variables, i.e. firm size, firm age, age of the firm owner, graduation status of the owner, size of the management team, sales growth as a performance indicator, and cash flow as indicator for financial constraints. As a further control variable we add the investment rate to depict the relative size of the investment.

The regression results in Table 4.2 confirm the descriptive pattern. The share of internal capital in investment financing is higher in female-owned firms than in male-owned firms while the share of external capital is lower. For business development capital and other funds we observe no significant difference. These gender differences in the use of external vs. internal capital in investment financing could be either a result of gender differences in firm owner's willingness to get into debt or of differences in credit availability. In the following section we will address both approaches, differences in preferences and discrimination.

Table 4.2: Random effects panel tobit model of investment financing

	(1)	(2)	(3)	(4)
Dependent variable: investment financing, share of ~	internal capital	external capital	business development capital	other funds
Female owner (d)	5.030**	-5.842**	-4.298	1.582
	(2.458)	(2.557)	(2.864)	(4.167)
Lagged FTE (log)	-9.546***	7.701***	3.697***	13.94***
	(1.143)	(1.195)	(1.357)	(2.035)
Lagged sales (log)	0.713	2.423**	0.140	-6.169***
	(1.030)	(1.079)	(1.227)	(1.815)
Investment rate (inv./sales)	-10.74***	6.680***	9.766***	4.775***
	(0.794)	(0.802)	(0.751)	(1.154)
Cash flow	1.06e-05***	-9.72e-06***	1.92e-06*	-9.61e-06***
	(1.03e-06)	(1.09e-06)	(1.13e-06)	(1.90e-06)
Sales growth	0.380	-2.549	8.705***	7.163*
	(1.972)	(2.110)	(2.534)	(3.773)
Firm age 5-10 years (d)	-1.631	6.916***	-8.274***	-3.413
	(2.224)	(2.369)	(2.749)	(4.111)
Firm age 11-20 years (d)	-4.323**	9.834***	-4.906*	-6.781*
	(2.173)	(2.290)	(2.576)	(3.849)
Firm age >20 years (d)	-4.938**	10.88***	-7.531***	-9.248**
	(2.218)	(2.325)	(2.609)	(3.884)
2 managers/owners (d)	-2.406	1.318	2.054	4.495*
	(1.523)	(1.597)	(1.830)	(2.698)
3 or more managers/owners (d)	-0.102	-1.974	1.669	4.862
	(2.187)	(2.295)	(2.609)	(3.840)
Graduate (d)	12.69***	-13.93***	-2.033	0.263
	(1.524)	(1.577)	(1.756)	(2.579)
Age firm owner	0.186**	-0.255***	-0.162*	-0.173
	(0.076)	(0.079)	(0.088)	(0.129)
Constant	84.59***	-51.03***	-66.15***	-78.41***
	(12.21)	(12.81)	(14.51)	(21.45)
Observations	24,302	24,302	24,302	24,302
Female observations	2,347	2,347	2,347	2,347
left-censored	4,294	12,632	19,869	20,928
uncensored	10,578	9,165	4,197	2,894
right-censored	9,430	2,505	236	480
Number of firms	13,057	13,057	13,057	13,057
Avg. Obs. per firm	1.9	1.9	1.9	1.9

Notes: This table presents the results of a random effects panel tobit regression of investment financing for the years 2004-2009. Each regression includes industry, legal form and time dummies as well as the stratification variables. The reference category are manufacturing firms in sole proprietorship that are younger than 5 years. *,** and *** indicate significance at the 10%, 5% and 1% levels, respectively.

4.3 Credit application and application outcome

Credit constraints can be driven by demand-side or supply-side factors (Coleman and Robb 2009, Bellucci et al. 2010, Verheul and Thurik 2001). On the demand-side, different preferences, higher risk and debt aversion as well as lower financial literacy may, ceteris paribus, prevent women more from applying for credit. On the supply-side, discrimination on the financial market may result in lower credit approval rates or worse credit conditions for women. In this chapter we examine both sides of the credit application process of investing firms.

4.3.1 Previous evidence

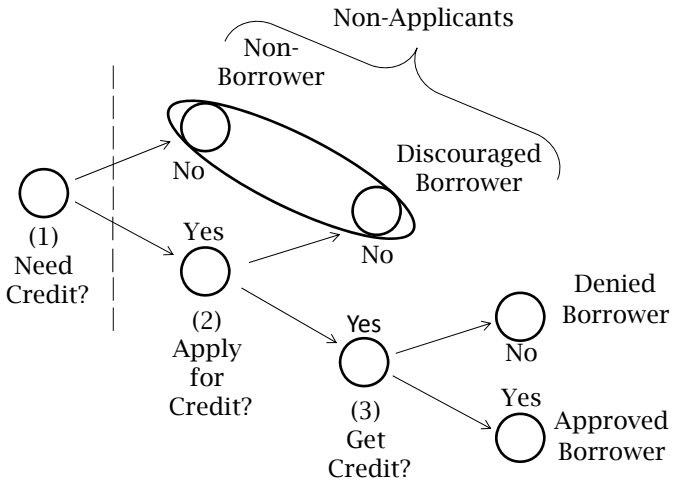
Previous empirical studies have focused mainly on the US economy and have not found strong evidence that female-owned firms have greater difficulties in funding their investments. Most authors use the same data base for their analysis, namely the Federal Reserve's Surveys of Small Business Financing (SSBFs). Cavalluzzo et al. (2002) find that denial rates of female owners increase to some extent with lender concentration but they find no evidence for discrimination in terms of interest rates. Blanchflower et al. (2003) and Blanchard et al. (2008) confirm that gender differences in denial rates are negligible. For Italy in contrast, Bellucci et al. (2010) reveal that female owned firms do not pay higher interest rates but are disadvantaged in terms of collateral requirements and credit availability. Muravyev et al. (2009) analyze gender differences in credit constraints with the World Bank's Business Environment and Enterprise Performance Survey (BEEPS) which contains data for 34 countries. They find that female entrepreneurs are more likely to be denied credit and pay higher interest rates, but that these differences vanish with increasing level of a financial development. Yet, their cross-country analysis does not allow to draw country-specific conclusions.

On the demand side, none of the authors cited above find clear evidence that women have lower application rates. Cole and Mehran (2009) find only very weak evidence of higher application discouragement for women. Regarding gender specific perceptions, Roper and Scott (2009) find that women in the UK at start-up stage - independent from their real financial situation - are more likely to perceive that they have problems in accessing external funds.

4.3.2 The credit application process

Figure 4.1 describes the credit application process in three conditional stages. According to Cole (2010), firms can be classified into four categories of 'borrower types': non-borrower, discouraged borrower, denied borrower and approved borrower. Unfortunately, we cannot observe the first stage of the application process in our data, we do not know whether firms need or do not need credit. We cannot differentiate between non-borrowers and discouraged borrowers, in our data they form one group, the non-applicants. We are constrained to analyzing the application process without its first stage and dealing with the problem of selection bias. Discouraged borrowers may decide not to apply because they anticipate or fear a loan denial. Their firm specific characteristics could be similar to applying firms that were not credit approved. We know from the literature that women are less over-confident, more risk-averse and also have a greater fear of negative outcomes when the get involved in a risky decision (Croson and Gneezy 2009). Consequently, women may be more reluctant and discouraged to apply than men are. As a result, female-owned firms which do apply could be a positively selected subgroup with better performance and creditworthiness than the average male-owned firm that applies for credit. As a consequence, our results suffer from sample selection bias, therefore discrimination in the form of credit denial could be underestimated.

Figure 4.1: Credit application process



Source: Borrowed and customized from Cole (2010)

The issue of sample selection is a well known problem in econometric modeling of discrimination as well as the omitted variable bias. The problem can be tackled to some extent if the necessary information on all application stages is available. Cavalluzzo et

al. (2002) regard discouraged borrowers as potential applicants and model this self-selection into applying by estimating the two models jointly with a selection model. Then, the main equation models the application outcome while the selection equation models the decision whether to apply or not. Alternatively, successful credit applicants can be compared to all firms with unmet credit needs, the rejected and discouraged. Blanchflower et al. (2003), Blanchard et al. (2008), Cole (2010) and Cole and Mehran (2009) employ similar approaches to deal with sample selection. Muravyev et al. (2009) point to the fact that - in contrast to not considering the discouraged applicants - this approach overestimates discrimination. The results are however often similar to the single equation model employed by us.

4.3.3 Empirical analysis

We estimate the following two equations separately, each with a linear probability random effects panel GLS model.

$$Prob(Applied = 1) = \alpha + \beta_1 f_i + \gamma_1 X_{it} + \delta_1 D_{it} + u_{it} \tag{4.3}$$

$$Prob(Denied = 1) = \alpha + \beta_2 f_i + \gamma_2 X_{it} + \delta_2 D_{it} + e_{it} \text{ if } Applied = 1 \tag{4.4}$$

With the first equation we estimate the demand-side of the application process, the probability of applying for credit, and with the second equation we estimate the supply-side, the application outcome. The dependent variable is binary in both equations. In the application decision it takes the value 1 if a firm has applied for credit and 0 if the firm did not apply. For the application outcome it takes the value 1 if a firm's application was denied and 0 if the firm's application was approved. f denotes a dummy variable for female ownership, X is a vector of firm-specific characteristics (size in terms of sales and employees, cash flow, firm age, team size, sales expectations, innovation activity and sales growth) and D is a vector of further owner-specific characteristics (age of the firm owner and graduate status). For our analysis we consider only investing firms.[3] Table 4.3 shows the results of five regression for the application decision and one for the application outcome.

[3]see Appendix Table 4.5 for descriptive statistics of all variables included in the regression.

Table 4.3: Linear probability RE panel GLS model of credit application and outcome

					sample split	
Dependent Variable (1/0)	(1) applied for credit	(2) application denied	(1A) applied for credit *with expect.*	(1B) applied for credit *with exp. interact.*	(1C) applied for credit *firms with pos. exp.*	(1D) applied for credit *firms without pos. exp.*
Female owner (d)	-0.047***	0.001	-0.047***	-0.067***	-0.010	-0.068***
	(0.017)	(0.017)	(0.017)	(0.020)	(0.027)	(0.020)
Positive sales expect. (d)			0.023**	0.018*		
			(0.009)	(0.010)		
Interact fem.*pos. exp. (d)				0.055*		
				(0.030)		
Lagged FTE (log)	0.036***	0.005	0.036***	0.036***	0.051***	0.023**
	(0.008)	(0.007)	(0.008)	(0.008)	(0.013)	(0.010)
Lagged sales (log)	0.045***	-0.018**	0.044***	0.044***	0.034***	0.054***
	(0.008)	(0.007)	(0.008)	(0.008)	(0.012)	(0.010)
Planned investment rate	0.802***	0.014	0.797***	0.795***	0.734***	0.851***
	(0.031)	(0.022)	(0.031)	(0.031)	(0.046)	(0.042)
Cash flow	-4.99e-08***	-1.96e-08***	-4.97e-08***	-4.98e-08***	-4.39e-08***	-5.89e-08***
	(7.46e-09)	(4.71e-09)	(7.45e-09)	(7.44e-09)	(1.11e-08)	(9.67e-09)
Return on sales (lag)	-0.011**	-0.161***	-0.010**	-0.011**	-0.014	-0.012***
	(0.005)	(0.035)	(0.005)	(0.005)	(0.050)	(0.003)
Sales growth	0.038**	-0.044***	0.038**	0.037**	0.042	0.038*
	(0.017)	(0.016)	(0.017)	(0.017)	(0.029)	(0.021)
Firm age 5-10 years (d)	0.022	-0.032**	0.024	0.024	0.024	0.019
	(0.017)	(0.016)	(0.017)	(0.017)	(0.028)	(0.021)
Firm age 11-20 years (d)	0.028*	-0.019	0.031*	0.031*	0.045*	0.029
	(0.016)	(0.016)	(0.016)	(0.016)	(0.027)	(0.020)
Firm age >20 years (d)	0.033**	-0.037**	0.037**	0.037**	0.043	0.039*
	(0.016)	(0.015)	(0.016)	(0.016)	(0.027)	(0.020)
2 managers/owners (d)	0.031***	-0.039***	0.031***	0.031***	0.028	0.036**
	(0.011)	(0.009)	(0.011)	(0.011)	(0.018)	(0.014)
3 or more manag./own. (d)	0.032**	-0.048***	0.032**	0.032**	0.023	0.045**
	(0.015)	(0.011)	(0.015)	(0.015)	(0.024)	(0.019)
Graduate (d)	-0.090***	0.005	-0.090***	-0.090***	-0.102***	-0.087***
	(0.011)	(0.009)	(0.011)	(0.011)	(0.017)	(0.013)
Age firm owner	-0.002***	0.0004	-0.002***	-0.002***	-0.003***	-0.001**
	(0.001)	(0.0004)	(0.001)	(0.001)	(0.001)	(0.001)
Innovation activities (d)	0.031***	0.035***	0.029***	0.028***	0.017	0.031***
	(0.009)	(0.008)	(0.009)	(0.009)	(0.017)	(0.012)
Constant	-0.088	0.373***	-0.089	-0.087	0.053	-0.186*
	(0.092)	(0.086)	(0.092)	(0.092)	(0.148)	(0.113)
R-squared	0.210	0.048	0.211	0.211	0.187	0.225
Observations	10,796	5,599	10,796	10,796	3,824	6,972
Female observations	1,018	450	1,018	1,018	366	652
Firms	6,334	3,778	6,334	6,334	2,834	4,630
Avg. obs. per firm	1.7	1.5	1.7	1.7	1.3	1.5

Notes: This table presents the results of random effects panel GLS regressions for the years 2003-2009 with firm-level cluster-robust standard errors. The regression includes time, industry and legal form dummies as well as the stratification variables. The reference category are manufacturing firms in sole proprietorship that are younger than 5 years and have one owner-manager.*,** and *** indicate significance at the 10%, 5% and 1% levels, respectively. The number of firms in (1C) and (1D) does not add up to the number of firms in the full sample (N=10,796), as the firms may have differing expectations over the years and therefore may be present in both samples after the split.

Regression (1) is the basic specification of the application decision. We find that female owners are significantly less likely to apply for a credit. The probability that an investing female-owned firm applies for credit is on average 4.7 percentage points lower than for a male-owned firm with the same characteristics. Yet, the results from regression (2) show that if women apply, there is no difference in the probability of being denied credit as compared to male-owned firms. This result may be suggestive but for the above stated reasons of self selection it cannot be interpreted as absence of discrimination. Given that women apply significantly less often for credit, it is very likely that the female-owned firms that do apply represent a positive selection.

This raises the question on the underlying reasons for women's lower probability of applying for credit. Croson and Gneezy (2009) conclude that women's higher risk aversion can be traced back to different evaluations of risk, differences in the perceptibility of emotions and male overconfidence. Furthermore, women report more intense nervousness and fear than men in anticipation of negative outcomes. The application for credit involves the possibility of being rejected and borrowing money involves the risk of not to be able to bear the costs. This suggests that women may be less likely to apply for credit because they are more risk averse and would cope worse with a credit denial. We cannot test for this assumption as our data do not provide a valid measure for risk aversion. Instead, we try to better understand this fact by accounting for the sales expectations of the firm owner. The firms were asked about their sales expectations for the next year and had to answer in three categories, 'positive', 'negative' or 'neutral' expectations. These expectations may be realistic, overoptimistic or even too pessimistic. Interesting for our analysis are gender differences in credit application that go together with these expectations. If women indeed have a stronger fear in anticipation of negative outcomes, they should be more reluctant to apply for credit when they do not have positive expectations about the future.

In regression (1A) we re-estimate regression (1) with an additional explanatory dummy variable for positive sales expectations. We find that firms with positive expectations are significantly more likely to apply for a credit while the quantitative impact of our dummy variable for female ownership does not change. Next, we include an interaction term for positive sales expectations and female ownership in regression (1B). As a further sensitivity check we split the sample into firms that have positive expectations in a given year and firms with neutral or negative expectations (regressions (1C) and (1D)). The results show that female-owned firms with positive expectations do not differ significantly from male owned firms in their probability of applying for a credit. But, as expected, female-owned firms with non-positive expectations exhibit higher reluctance of applying for credit. The probability that a female-owned firm with

non-positive expectations applies for credit is 6.8 percentage points lower than for a male-owned firm with non-positive expectations. We interpret this result as evidence of higher risk aversion and higher fear of failure for female business owners that have non-positive expectations. We also observe that the model has a higher explanatory power for firms with non-positive expectations (R^2 of 0.225 vs. 0.187).

4.4 Robustness checks

We run several robustness checks for each regression in order to test for reliability of our findings. These robustness checks essentially confirm our central findings, as the signs and the significances do not differ substantially.

1. Check: other model specification, GLS instead of tobit.
The tobit approach is based on strong assumptions about the conditional data distribution and functional form. As these strong assumptions are likely to be violated, tobit is a non-robust estimator (Cameron and Trivedi 2009). We therefore re-run the regressions of the composition of investment financing with a more robust simple random effects panel GLS model (Appendix Table 4.6) which confirms the results from the tobit regression in Table 4.2.

2. Check: other model specification, probit instead of GLS.
The decision to apply as well as the application outcome are both binary dependent variables. These are usually estimated with a non-linear regression model. We therefore repeat all regressions on credit application with a random effects panel probit approach (Appendix Table 4.7).

3. Check: considering only firms with one owner.
In the main regressions the dummy variable on female ownership refers to the gender of the principal owner. To make sure that the decision maker in the firm is indeed the principal owner, we repeat the estimations on the composition of investment financing and on credit application and its outcome considering only firms with one owner-manager (Appendix Tables 4.8 and 4.9). The results do not substantially differ from our main regressions, except for the regression on investment financing where the gender variable in the regression for internal capital turns out to be not significant. However, the magnitude of the coefficients is approximately the same, the insignificance is probably driven by a higher standard error.

4.5 Conclusion

In this chapter we investigate how male-owned and female-owned firms differ in investment financing, credit application behavior and application outcome. Our analysis shows that women rely more on internal funds and finance their investment with a lower share of external capital than male-owned firms, independently of the magnitude of the investment. Female firm owners are significantly less likely to apply for credit but not more likely to be credit denied. However, the last result may underestimate discrimination on the credit market as applying female-owned firms might represent a positively selected sample. Interestingly, gender differences in credit application behavior depend on the firm owner's expectation of future sales outcomes. We find that female-owned firms with non-positive sales expectations are significantly less likely to apply for credit than male-owned firms. For firms with positive sales expectations we find no gender difference in the probability to apply for credit. This points to the fact that female risk aversion is only prominent in anticipation of decreasing or constant sales volume. With positive sales prospects female firm owners are not more hesitant than male owners to bear the risks and the costs of a credit.

Yet, with our data we cannot judge whether women's more retentive or men's more offensive behavior leads to a better outcome for the firm as we have no information on credit repayment behavior and return on investment. On one hand side, through more cautious investment behavior a firm could miss growth opportunities. On the other hand, a too optimistic investment behavior could result in financial losses or even in business failure. A further analysis of gender differences in firm performance after investment with more appropriate data could shed more light on this question. Regarding the supply side on the credit market, our results may motivate future empirical research to gain more insights into gender differences in interest rates, credit conditions and collateral requirements.

4.6 Appendix

Table 4.4: Summary statistics regression sample investment financing

Gender variable	Mean	St.dev.	Min.	Max.					
Female owner (d)	0.096	0.295	0	1					
	Male owner				Female owner				t-test
Firm characteristics	Mean	St.dev.	Min.	Max.	Mean	St.dev.	Min.	Max.	p-value
Investment financing in %									
~ internal capital	54.7	41.1	0	100	58.5	42.3	0	100	0.000***
~ external capital*	30.2	37.3	0	100	26.8	37.1	0	100	0.000***
~ development capital	8.0	20.3	0	100	7.6	21.1	0	100	0.348
~ other funds	7.1	21.3	0	100	7.1	21.7	0	100	0.963
FTE (number of employees)	42.7	64.9	0.5	1,501	29.3	44.3	0.5	462	0.000***
Sales (in million Euro)	6.808	11.700	0.010	104	4.023	8.839	0.010	102	0.000***
Investment rate (Inv./Sales)	0.125	0.713	0.1	1.497	0.120	0.191	0.1	1.125	0.243
Cashflow (in thousand Euro)	433	778	-324	8,224	273	619	-251	7,400	0.000***
Sales growth	0.089	0.284	-1.540	2.037	0.092	0.297	-1.539	1.997	0.546
Firm age	32	37	1	384	29.2	37	1	377	0.001***
Firm age <5 years (d)	0.150	0.357	0	1	0.236	0.425	0	1	0.000***
Firm age 5-10 years (d)	0.135	0.342	0	1	0.155	0.362	0	1	0.008***
Firm age 11-20 years (d)	0.302	0.459	0	1	0.242	0.428	0	1	0.000***
Firm age >20 years (d)	0.412	0.492	0	1	0.367	0.482	0	1	0.000***
1 owner-manager (d)	0.548	0.498	0	1	0.548	0.498	0	1	0.516
2 owners/managers (d)	0.303	0.459	0	1	0.317	0.466	0	1	0.146
3 or more owners/managers (d)	0.117	0.321	0	1	0.103	0.304	0	1	0.040**
Owner characteristics									
Graduate (d)	0.559	0.496	0	1	0.547	0.498	0	1	0.256
Age firm owner	48.6	10.1	20	80	45.1	9.3	23	78	0.000***

Notes: This table provides summary statistics for the sample used in the estimation of a random effects panel tobit model of investment financing in Table 4.2. N = 20,254. Comparison of means with two-sample t-test of equality of means under the assumption of equal variances. *,** and *** indicate significance at the 10%, 5% and 1% levels, respectively.

Table 4.5: Summary statistics regression sample credit application and outcome

Gender variable	Mean	St.dev.	Min.	Max.
Female owner (d)	0.094	0.292	0	1

	Male owner				Female owner				t-test
Firm characteristics	Mean	St.dev.	Min.	Max.	Mean	St.dev.	Min.	Max.	p-value
Applied for credit	0.527	0.499	0	1	0.442	0.497	0	1	0.000***
Credit denied (only applying firms)	0.082	0.275	0	1	0.096	0.295	0	1	0.320
Sales expectations positive (d)	0.354	0.478	0	1	0.359	0.480	0	1	0.709
FTE (number of employees)	44.2	64.3	0.5	1253	30.5	46.3	1	462	0.000***
Sales (in million Euro)	7,177	12,100	0,010	104	4,111	8,850	0,010	102	0.000***
Planned investment rate	0.104	0.167	0.1	1.497	0.120	0.191	0.1	1.455	0.003***
Cashflow (in thousand Euro)	457	794.7	-320	8,150	296	670.2	-251	6,800	0.000***
Return on sales	0.067	0.118	-3.523	1.522	0.099	0.167	-0.449	1.348	0.000***
Sales growth	0.065	0.269	-1.540	2.019	0.063	0.261	-1.522	1.923	0.881
Firm age	33.3	37.6	1	384	30.4	37	1	312	0.000***
Firm age <5 years (d)	0.129	0.335	0	1	0.207	0.406	0	1	0.000***
Firm age 5-10 years (d)	0.132	0.339	0	1	0.171	0.377	0	1	0.001***
Firm age 11-20 years (d)	0.313	0.464	0	1	0.256	0.437	0	1	0.000***
Firm age >20 years (d)	0.426	0.494	0	1	0.365	0.482	0	1	0.000***
1 owner-manager (d)	0.538	0.499	0	1	0.509	0.016	0	1	0.077*
2 owners/managers (d)	0.306	0.461	0	1	0.345	0.475	0	1	0.011**
3 or more owners/managers (d)	0.128	0.334	0	1	0.111	0.314	0	1	0.122
Innovation (d)	0.505	0.500	0	1	0.399	0.490	0	1	0.000***
Owner characteristics									
Graduate (d)	0.593	0.491	0	1	0.568	0.496	0	1	0.113
Age firm owner	48.8	10	20	80	45.1	9	23	78	0.000***

Table 4.6: Random effects panel GLS regressions of investment financing

	(1)	(2)	(3)	(4)
Dependent variable: investment financing, share of ~	internal capital	external capital	business development capital	other funds
Female owner (d)	2.428**	-2.302**	-0.291	0.225
	(1.083)	(0.950)	(0.543)	(0.544)
Lagged FTE (log)	-4.051***	2.377***	0.349	1.362***
	(0.524)	(0.460)	(0.272)	(0.260)
Lagged sales (log)	0.005	1.050**	-0.263	-0.775***
	(0.566)	(0.435)	(0.279)	(0.244)
Investment rate (inv./sales)	-5.789*	2.388*	2.900*	0.417
	(3.065)	(1.302)	(1.505)	(0.307)
Cash flow	4.77e-06***	-3.58e-06***	2.06e-07	-1.45e-06***
	(4.53e-07)	(3.94e-07)	(2.37e-07)	(2.09e-07)
Sales growth	0.763	-1.858**	0.942	0.254
	(1.163)	(0.862)	(0.594)	(0.539)
Firm age 5-10 years (d)	-0.592	2.296**	-1.392***	-0.438
	(0.990)	(0.900)	(0.520)	(0.538)
Firm age 11-20 years (d)	-1.785*	3.407***	-0.850*	-0.753
	(0.966)	(0.855)	(0.503)	(0.512)
Firm age >20 years (d)	-1.481	3.676***	-1.468***	-0.736
	(0.986)	(0.880)	(0.511)	(0.509)
2 managers/owners (d)	-1.213*	0.329	0.305	0.522
	(0.695)	(0.620)	(0.343)	(0.386)
3 or more managers/owners (d)	-0.315	-1.060	0.486	0.844
	(0.995)	(0.890)	(0.486)	(0.568)
Graduate (d)	5.540***	-5.231***	-0.460	0.117
	(0.676)	(0.613)	(0.328)	(0.345)
Age firm owner	0.095***	-0.077**	-0.023	0.003
	(0.034)	(0.030)	(0.016)	(0.018)
Constant	65.05***	9.927*	12.04***	12.66***
	(6.988)	(5.203)	(3.452)	(2.927)
R-squared	0.047	0.057	0.025	0.072
Observations	24,302	24,302	24,302	24,302
Female observations	2,347	2,347	2,347	2,347
Firms	13,057	13,057	13,057	13,057
Avg. obs. per firm	1.9	1.9	1.9	1.9

Notes: This table presents the results of a random effects GLS regression of investment financing for the years 2004-2009. Each regression includes industry, legal form and time dummies as well as the stratification variables. The reference category are manufacturing firms in sole proprietorship that are younger than 5 years. *,** and *** indicate significance at the 10%, 5% and 1% levels, respectively.

Table 4.7: Random effects panel probit regressions of credit application and outcome

					sample split	
Dependent Variable (1/0)	(1) applied for credit	(2) application denied	(1A) applied for credit *with expect.*	(1B) applied for credit *with exp. interact.*	(1C) applied for credit *firms with pos. exp.*	(1D) applied for credit *firms without pos. exp.*
Female owner (d)	-0.196***	0.019	-0.197***	-0.290***	-0.042	-0.303***
	(0.074)	(0.182)	(0.074)	(0.089)	(0.116)	(0.092)
Positive sales expectat. (d)			0.068*	0.045		
			(0.041)	(0.043)		
Interact female*pos. exp. (d)				0.258*		
				(0.136)		
Lagged FTE (log)	0.143***	0.059	0.141***	0.141***	0.201***	0.091**
	(0.037)	(0.087)	(0.037)	(0.037)	(0.056)	(0.046)
Lagged sales (log)	0.221***	-0.104	0.220***	0.220***	0.173***	0.262***
	(0.034)	(0.082)	(0.034)	(0.034)	(0.052)	(0.043)
Planned investment rate	4.263***	0.219	4.237***	4.228***	3.747***	4.679***
	(0.180)	(0.247)	(0.181)	(0.181)	(0.274)	(0.256)
Cash flow	-2.29e-07***	-8.71e-07***	-2.28e-07***	-2.29e-07***	-2.00e-07***	-2.67e-07***
	(3.22e-08)	(1.74e-07)	(3.22e-08)	(3.22e-08)	(4.76e-08)	(4.37e-08)
Return on sales (lag)	-0.051	-2.042***	-0.048	-0.049	0.021	-0.348
	(0.076)	(0.435)	(0.073)	(0.074)	(0.130)	(0.230)
Sales growth	0.141**	-0.471***	0.140*	0.138*	0.178	0.125
	(0.072)	(0.176)	(0.072)	(0.072)	(0.117)	(0.094)
Firm age 5-10 years (d)	0.103	-0.319*	0.108	0.110	0.100	0.099
	(0.077)	(0.183)	(0.077)	(0.077)	(0.119)	(0.099)
Firm age 11-20 years (d)	0.129*	-0.161	0.137*	0.137*	0.168	0.146
	(0.071)	(0.166)	(0.071)	(0.071)	(0.112)	(0.090)
Firm age >20 years (d)	0.150**	-0.390**	0.162**	0.161**	0.188*	0.170*
	(0.071)	(0.174)	(0.072)	(0.071)	(0.112)	(0.090)
2 managers/owners (d)	0.140***	-0.441***	0.140***	0.140***	0.129*	0.161***
	(0.049)	(0.123)	(0.049)	(0.049)	(0.076)	(0.061)
3 or more manag./own. (d)	0.144**	-0.675***	0.144**	0.143**	0.106	0.198**
	(0.067)	(0.187)	(0.067)	(0.067)	(0.103)	(0.085)
Graduate (d)	-0.398***	0.0303	-0.400***	-0.400***	-0.449***	-0.396***
	(0.048)	(0.111)	(0.048)	(0.048)	(0.077)	(0.059)
Age firm owner	-0.008***	0.006	-0.008***	-0.008***	-0.012***	-0.006**
	(0.002)	(0.006)	(0.002)	(0.002)	(0.004)	(0.003)
Innovation activities (d)	0.135***	0.457***	0.128***	0.128***	0.083	0.136***
	(0.041)	(0.105)	(0.041)	(0.041)	(0.070)	(0.051)
Constant	-3.012***	-0.551	-3.008***	-3.002***	-2.362***	-3.392***
	(0.409)	(0.981)	(0.408)	(0.408)	(0.627)	(0.525)
Prob > chi2	0.000	0.000	0.000	0.000	0.000	0.000
Observations	10,796	5,599	10,796	10,796	3,824	6,972
Female observations	1,018	450	1,018	1,018	366	652
Firms	6,334	3,778	6,334	6,334	2,834	4,630
Avg. obs. per firm	1.7	1.5	1.7	1.7	1.3	1.5

Notes: This table presents the results of random effects panel probit regressions for the years 2003-2009 with firm-level cluster-robust standard errors. The regression includes time, industry and legal form dummies as well as the stratification variables. The reference category are manufacturing firms in sole proprietorship that are younger than 5 years and have one owner-manager.*,** and *** indicate significance at the 10%, 5% and 1% levels, respectively. The number of firms in (1C) and (1D) does not add up to the number of firms in the full sample (N=10,796), as the firms may have differing expectations over the years and therefore may be present in both samples after the split.

Table 4.8: Random effects panel tobit regressions of investment financing (only firms with 1 owner-manager)

	(1)	(2)	(3)	(4)
Dependent variable: investment financing, share of ~	internal capital	external capital	business development capital	other funds
Female owner (d)	5.405	-7.795**	-0.849	1.911
	(3.340)	(3.524)	(3.978)	(5.968)
Lagged FTE (log)	-10.41***	6.969***	5.424***	17.31***
	(1.564)	(1.647)	(1.888)	(2.898)
Lagged sales (log)	-0.637	3.940***	1.316	-8.143***
	(1.399)	(1.477)	(1.703)	(2.557)
Investment rate (inv./sales)	-20.72***	12.21***	18.24***	9.453***
	(1.416)	(1.396)	(1.351)	(2.076)
Cash flow	1.34e-05***	-1.07e-05***	8.13e-07	-8.79e-06***
	(1.69e-06)	(1.78e-06)	(1.91e-06)	(3.12e-06)
Sales growth	3.850	-4.058	6.991**	1.377
	(2.702)	(2.906)	(3.535)	(5.277)
Firm age 5-10 years (d)	-3.947	11.33***	-12.57***	-2.524
	(2.927)	(3.142)	(3.728)	(5.564)
Firm age 11-20 years (d)	-4.818*	11.05***	-6.717*	-8.950*
	(2.863)	(3.048)	(3.468)	(5.257)
Firm age >20 years (d)	-6.548**	14.23***	-7.772**	-11.63**
	(2.942)	(3.112)	(3.522)	(5.356)
Graduate (d)	14.34***	-15.13***	-3.101	-1.183
	(2.079)	(2.175)	(2.465)	(3.700)
Age firm owner	0.310***	-0.339***	-0.264**	-0.323*
	(0.109)	(0.115)	(0.131)	(0.195)
Constant	107.0***	-76.92***	-85.45***	-54.17*
	(16.63)	(17.59)	(20.24)	(30.14)
Observations	13,294	13,294	13,294	13,294
Female observations	1,269	1,269	1,269	1,269
left-censored	2,425	7,023	10,981	11,576
uncensored	5,567	4,820	2,170	1,453
right-censored	5,302	1,451	143	265
Number of firms	7,847	7,847	7,847	7,847
Avg. Obs. per firm	1.7	1.7	1.7	1.7

Notes: This table presents the results of a random effects panel tobit regression of investment financing for the years 2004-2009. Only firms with one owner/manager included. Each regression includes industry, legal form and time dummies as well as the stratification variables. The reference category are manufacturing firms in sole proprietorship that are younger than 5 years. *,** and *** indicate significance at the 10%, 5% and 1% levels, respectively.

Table 4.9: Random effects panel GLS regressions of credit application and outcome (only firms with 1 owner-manager)

					sample split	
Dependent Variable (1/0)	(1) applied for credit	(2) application denied	(1A) applied for credit *with expect.*	(1B) applied for credit *with exp. interact.*	(1C) applied for credit *firms with pos. exp.*	(1D) applied for credit *firms without pos. exp.*
Female owner (d)	-0.044*	-0.017	-0.044*	-0.053**	-0.014	-0.056**
	(0.023)	(0.025)	(0.023)	(0.026)	(0.038)	(0.027)
Positive sales expectat. (d)			0.027**	0.025*		
			(0.013)	(0.013)		
Interact female*pos. exp. (d)				0.026		
				(0.042)		
Lagged FTE (log)	0.030***	0.016	0.029***	0.028***	0.064***	0.013
	(0.011)	(0.010)	(0.011)	(0.011)	(0.018)	(0.013)
Lagged sales (log)	0.053***	-0.023**	0.053***	0.053***	0.031*	0.065***
	(0.010)	(0.010)	(0.010)	(0.010)	(0.016)	(0.013)
Planned investment rate	0.778***	0.044	0.772***	0.771***	0.747***	0.791***
	(0.040)	(0.030)	(0.040)	(0.040)	(0.065)	(0.051)
Cash flow	-4.87e-08***	-3.45e-08***	-4.85e-08***	-4.85e-08***	-4.40e-08**	-5.94e-08***
	(1.29e-08)	(8.31e-09)	(1.28e-08)	(1.28e-08)	(1.82e-08)	(1.74e-08)
Return on sales (lag)	-0.010**	-0.185***	-0.010**	-0.010**	0.021	-0.014***
	(0.005)	(0.054)	(0.005)	(0.005)	(0.052)	(0.004)
Sales growth	0.025	-0.073***	0.025	0.025	-0.014	0.042
	(0.022)	(0.024)	(0.022)	(0.022)	(0.040)	(0.028)
Firm age 5-10 years (d)	-0.0007	-0.054**	0.002	0.002	0.004	-0.005
	(0.022)	(0.022)	(0.022)	(0.021)	(0.035)	(0.027)
Firm age 11-20 years (d)	0.007	-0.027	0.011	0.011	-0.034	0.036
	(0.021)	(0.023)	(0.021)	(0.021)	(0.035)	(0.025)
Firm age >20 years (d)	0.018	-0.061***	0.023	0.023	0.007	0.033
	(0.021)	(0.022)	(0.021)	(0.021)	(0.035)	(0.026)
Graduate (d)	-0.104***	0.009	-0.104***	-0.104***	-0.110***	-0.103***
	(0.014)	(0.014)	(0.014)	(0.014)	(0.023)	(0.017)
Age firm owner	-0.001	0.001	-0.001	-0.001	-4.42e-05	-0.001
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Innovation activities (d)	0.033***	0.049***	0.031**	0.030**	0.007	0.041***
	(0.013)	(0.011)	(0.013)	(0.013)	(0.023)	(0.015)
Constant	-0.175	0.413***	-0.178	-0.179	0.008	-0.270*
	(0.121)	(0.119)	(0.121)	(0.121)	(0.197)	(0.148)
R-squared	0.231	0.060	0.232	0.232	0.212	0.243
Observations	5,777	2,875	10,796	10,796	1,964	3,813
Female observations	518	210	1,018	1,018	174	344
Firms	3,635	2,046	6,334	6,334	1,527	2,652
Avg. obs. per firm	1.6	1.4	1.7	1.7	1.3	1.5

Notes: This table presents the results of random effects panel GLS regressions for the years 2003-2009 with firm-level cluster-robust standard errors. Only firms with one owner-manager included. The regression includes time, industry and legal form dummies as well as the stratification variables. The reference category are manufacturing firms in sole proprietorship that are younger than 5 years and have one owner-manager.*,** and *** indicate significance at the 10%, 5% and 1% levels, respectively. The number of firms in (1C) and (1D) does not add up to the number of firms in the full sample (N=10,796), as the firms may have differing expectations over the years and therefore may be present in both samples after the split.

4.7 References

Ang, J., Cole, R. A. and D. T. Lawson (2010). The role of owner in capital structure decisions: An analysis of single-owner corporations, *Journal of Entrepreneurial Finance*, 14(3), 1-36.

Blanchard, L., Zhao. B. and J. Yinger (2008). Do lenders discriminate against minority and woman entrepreneurs? *Journal of Urban Economics*, 63(2), 467-497.

Blanchflower, D., Levine, P. B. and D. J. Zimmerman (2003). Discrimination in the small-business credit market, *The Review of Economics and Statistics*, MIT Press, 85(4), 930-943.

Bellucci, A., Borisov, A. and A. Zazzaro (2010). Does gender matter in bank-firm relationships? Evidence from small business lending, *Journal of Banking & Finance*, 34(12), 2968-2984.

Cameron, C. and P. Trivedi (2009). *Microeconometrics Using Stata*, Stata Press, College Station, Texas.

Carter, S., Shaw, E., Lam, W. and F. Wilson (2007). Gender, entrepreneurship, and bank lending: The criteria and processes used by bank loan officers in assessing applications, *Entrepreneurship Theory and Practice*, 31(3), 427-444.

Cavalluzzo, K. S., Cavalluzzo, L. and J. D. Wolken (2002). Competition, small business financing, and discrimination: evidence from a new survey, *The Journal of Business*, 75(4), 641-679.

Cole, R. A. and H. Mehran (2009). Gender and the availability of credit to privately held firms. Evidence from the surveys of small business finances, Federal Reserve Bank of New York, Staff Report No. 383.

Cole, R. (2010). Who needs credit and who gets credit?, Working Paper, Social Science Research Network.

Cole, R. (2011). What do we know about the capital structure of privately held U.S. firms? Evidence from the surveys of small business finance, Working Paper, Social Science Research Network.

Coleman, S. and A. Robb (2009). A comparison of new firm financing by gender: evidence from the Kauffman Firm Survey data, *Small Business Economics*, 33(4), 397-411.

Croson, R. and U. Gneezy (2009). Gender differences in preferences, *Journal of Economic Literature* 47(2), 448-474.

López-Gracia, J. and F. Sogorb-Mira (2008). Testing trade-off and pecking order theories financing SMEs, *Small Business Economics*, 31(2), 117-136.

Modigliani, F. and Miller, M. H. (1958). The cost of capital, corporate finance and the theory of investment. *American Economic Review*, 48(4), 261-97.

Muravyev A., Talavera, O. and D. Schäfer (2009). Entrepreneurs' gender and financial constraints: Evidence from international data, *Journal of Comparative Economics*, 37(2), 270-286.

Myers, S. C. (1984). The capital structure puzzle, *Journal of Finance*, 39, 575-92.

Myers, S. C. (2001). Capital structure, *Journal of Economic Perspectives*, 15(2), 81-102.

Myers, S. C. and N. S. Majluf (1984). Corporate financing and investment decisions when firms have information that investors do not have, *Journal of Financial Economics*, 13, 187-221.

Robb, A. M. and D. T. Robinson (2010). The capital structure decisions of new firms, NBER Working Paper 16272.

Roper, S. and J. M. Scott (2009). Perceived financial barriers and the start-up decision. An econometric analysis of gender differences using GEM data. *International Small Business Journal*, 27(2), 149-171.

Sena, V., Scott, J. and S. Roper (2010). Gender, borrowing patterns and self-employment: Some evidence for England. *Small Business Economics*, epub 13 March.

Shyam-Sunder, L. and S. C. Myers (1999). Testing static tradeoff against pecking order models of capital structure. *Journal of Financial Economics*, 51(2), 219-44.

Verheul, I. and R. Thurik (2001). Start-up capital: 'Does gender matter?' *Small Business Economics*, 16, 329-345.

List of Tables

List of Figures

Curriculum Vitae

Seit März 2007	Wissenschaftliche Mitarbeiterin Department für Volkswirtschaftslehre Ludwig-Maximilians-Universität, München
Oktober 2006 - Februar 2007	Wissenschaftliche Mitarbeiterin Lehrstuhl für Wirtschaftsgeschichte Eberhard-Karls-Universität, Tübingen
Oktober 2002 - August 2003	Auslandsstudium an der Universidade Federal Fluminense Niterói, Rio de Janeiro, Brasilien
April 2001 - August 2006	Studium der Internationalen Volkswirtschaftslehre Eberhard-Karls-Universität, Tübingen
Oktober 2000 - März 2001	Studium der Politikwissenschaft und Romanistik Eberhard-Karls-Universität, Tübingen
Juni 1999	Abitur Heinrich-Heine-Gymnasium, Ostfildern
Juni 1980	Geboren in Kronstadt, Rumänien