# Empirical Analyses of Financial Markets and Population Aging

Inauguraldissertation
zur Erlangung des akademischen Grades
eines Doktors der Wirtschaftswissenschaften
der Universität Mannheim

vorgelegt von
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im Sommersemester 2006

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| Tag der mündlichen Prüfung: | 9. November 2006 |

# Acknowledgements

First and foremost, I would like to thank my supervisor Axel Börsch-Supan for his encouragement and support. I have gained valuable insights on how to undertake empirical economic research from his comments and discussions. Axel Börsch-Supan has co-authored two of the papers in this dissertation. I would also like to thank Michael Haliassos for being the second reviewer of this dissertation. He has provided me with many helpful comments at early stages of my work on international capital flows.

I am indebted to my other co-authors, Alexander Ludwig and Joachim Winter. They provided me with valuable insights on macroeconomic theory and econometrics. I benefited from discussions with David Wise and Mike Hurd about the modeling of retirement entry decisions. With many detailed discussions, comments or suggestions Florian Heiss, Stefan Hoderlein, Dirk Krüger, Melanie Lührmann, Anette Reil-Held, Daniel Schunk and Matthias Weiss helped improve my work on different chapters of this dissertation.

Many thanks also go to all current and former colleagues at the Mannheim Research Institute for the Economics of Aging (MEA) and especially to Isabella Nohe, Petra Worms-Lickteig and Brunhild Griesbach who all contributed to a stimulating atmosphere that made me enjoy my work a lot.

I gratefully acknowledge financial support from the Land Baden-Württemberg, the Gesamtverband der Deutschen Versicherungswirtschaft (GDV), the Volkswagen-Stiftung and the Heidelberger Büro für Familienfragen und soziale Sicherheit.

Last but not least, I would like to thank my family and my husband Sebastian for their encouragement and support during the years of my dissertation.

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# Chapter 1

# Introduction

Population aging has become a major challenge to a growing number of countries around the world. It describes a shift in a country's age distribution towards the elderly. Two main developments are responsible for this phenomenon: a decrease in fertility rates and an increase in life expectancy. The demographic shift towards aging societies has started in more developed countries and by now also affects developing countries. It will remain an important challenge throughout the 21st century in many countries, though the level, intensity and timing will differ. This dissertation consists of a set of empirical papers that address this important topic from different angles.

The shift in a country's demographic age structure has profound and far-reaching consequences on economic conditions within and between countries. Most obviously, it strains the financial situation of social security systems, as a rising number of pensioners has to be supported by a shrinking workforce. Compared to the effects of population aging on social security systems, the effects on the economy as a whole are less widely discussed: markets for goods and services as well as labor and capital markets are also affected.

The demand for goods and services varies over the life cycle. A shift in the age structure, therefore, results in changing patterns of demand and consumption (Lührmann 2005). At the macroeconomic level these changes are likely to trigger sector shifts in production and, thus, labor markets (Börsch-Supan 2003b). The size and structure of the effects on domestic production and labor markets depend on a country's international trading activities and the sectoral mobility of employees.

Production and labor markets are also affected by demographic change through labor productivity. In an aging economy the productivity of older workers gains in importance: In Germany, for example, the share of workers older than 55 years will double from 12 percent today to almost a quarter of the total workforce in 2035. However, the age profile of productivity at an aggregate level is not yet very well understood (Börsch-Supan, Düzgün and Weiss 2005). For projections of the effects of population aging on macroeconomic measures such as economic growth

this is a key issue. Chapter 2 underlines the importance of labor productivity and human capital when simulating future economic growth depending on stagnating or increasing fertility rates using an Overlapping Generations (OLG) model.

In an aging economy, the labor force not only becomes older but also smaller. As a consequence, capital is abundant relative to labor. Cross-country differences in the timing and level of the aging process induce international capital flows (Lührmann 2003), because younger countries have lower capital-labor ratios and higher asset returns. A phenomenon that is widely discussed in this context and that has attracted much attention in the popular and academic press is the so-called "asset-meltdown". Several voices have pushed forward the argument that high savings of the baby-boom cohorts not only contributed to the rise in stock prices in the 1990s but might in the future also be responsible for a large decline in asset values when selling financial assets for their retirement consumption: an "asset-meltdown" (Siegel 1998). When the baby-boomers reach retirement within thirty years from now, they will start to withdraw their financial assets in order to finance consumption. This puts pressure on asset prices as subsequent cohorts, the baby busters, are much smaller and their demand of financial assets is correspondingly lower. The question of whether this causes a substantial "asset-meltdown" has led to divergent answers in the academic literature (Brooks (2002), Poterba (2001) and (2004)). Using an Overlapping Generations (OLG) model, Börsch-Supan, Ludwig and Winter (2007) show that well functioning capital markets channel capital from aging into younger countries such that a decline in asset returns is dampened. The extent of capital mobility is a decisive factor for the amount of such demographically induced capital flows. For a better understanding it is, therefore, necessary to further empirically explore various institutional factors that impede perfect capital mobility. In this dissertation, I investigate the relevance of institutional capital market frictions for cross-border investments and the historical experiment of the formation of the European Economic and Monetary Union (EMU) as an example of increased financial market integration and capital mobility (Chapters 3 and 4).

As mentioned above, the most obvious and most widely discussed effect of demographic change is on the social security system. In many developed countries pension systems are of the pay-as-you-go (PAYG) type. PAYG systems are characterized by contributors in the current labor force paying for the current retired generations. In aging populations the number of contributors in the workforce substantially decreases relative to the number of pensioners. This already tense financial situation is often aggravated by governments offering generous early retirement and preretirement pathways (Gruber and Wise 1999, 2004a and 2004b).

These developments have prompted many countries to reform their pension systems in two main respects. First, a shift towards (partially) funded pension systems is undertaken which allows for lower replacement rates, i.e., the average net public pension income relative to average net labor income. As a consequence, people have to substitute private and company pension plans for public old-age provisions.

Second, the PAYG system itself is modified by reducing incentives to retire early and by increasing the statutory retirement entry age. This dampens the decrease in the number of contributors relative to beneficiaries depending on how responsive people are towards new pension rules. Such reforms do not only have positive effects on the financial situation of the pension system but, as discussed above, also have important consequences for labor and capital markets by changing the relative size of the workforce. Chapter 5 examines the long-term implications of various reform options on retirement entry decisions and the actual retirement age of older workers in Germany. In particular, the effects of an increased statutory retirement age and of the introduction of adjustment costs for early retirement are examined.

The above mentioned issues are not exhaustive but present an overview of the most important economic effects of population aging. The present dissertation consists of empirical research papers that touch some of these issues. Selective questions of the causes and consequences as well as potential policy responses to population aging are analyzed. Each of the Chapters 2 to 4 is a self-contained paper with its own introduction and appendix. Chapter 5 contains two papers that are closely related to one another. However, each of them can be read independently. This implies that a few of the arguments and little parts of the literature reviews are repeated.

Chapter 2 is based on a paper by Berkel, Börsch-Supan, Ludwig and Winter (2004) and undertakes a thought experiment concerning the roots of population aging, namely demographics itself. The paper poses the intuitive question of whether an increase in a country's fertility rate could dampen the consequences of population aging. While the popular notion - "if we have too many elderly we need more children in order to compensate for this" - seems plausible at first, the results of economic theory are ambiguous. On the one hand, a higher fertility rate can have the effect of reducing the tax and social security burden imposed by the aging process. Additional positive effects arise if a higher fertility rate increases a society's human capital. On the other hand, children entail costs, in particular for their education. It is impossible to quantify the complex interaction between birth rates and economic growth ex-post empirically, because the aging process is historically unique and there is no example of a complete aging process yet. Therefore, an OLG model for Germany is employed that structurally maps the complex interactions between the aging process and macroeconomic variables such as per capita economic growth over a period of more than a generation. The results are differentiated: Higher fertility rates only result in higher per capita gross national income if the additional children born are also better educated and trained. Consequently, the formation of human capital and not a higher fertility rate itself is decisive for long-term growth. Moreover, it takes a very long transitional period until a higher fertility rate results in a larger and better-educated labor force that contributes to social security. Therefore, reforms of the social security system still have the highest priority because this is the only way to solve the problems of an aging baby-boomer

generation in the short and medium term - meaning the time until the baby-boomers retire.

While Chapter 2 maps the interactive consequences of population aging on relevant macroeconomic measures in a general equilibrium simulation model, the remaining chapters are based on empirical methods. They elaborate in more detail on single issues that are directly or indirectly related to population aging: On the one hand, capital market frictions and the extent of capital mobility are explored. On the other hand, effects of social security reforms on the distribution of actual retirement entry age are investigated.

Chapter 3 is based on Berkel (2004) and examines which institutional capital market frictions impede perfect capital mobility. Despite large potential gains, international equity investment is less diversified across countries than predicted by the international version of the traditional capital asset pricing model (ICAPM). According to the ICAPM, individuals should hold equities from around the world in accordance to the countries' world market capitalizations. However, empirical facts reveal that international portfolios are largely home biased. Using data on bilateral equity portfolio holdings for 38 countries, the paper compares the theoretically predicted share of foreign assets at the country level as predicted by the ICAPM under perfect capital mobility to the actual shares observed in the data. The difference between these two values is then taken to investigate the relevance of different capital market frictions: financial market development, information asymmetries and direct barriers such as capital controls. Two important findings are reported: First, besides a home bias in equities for most country pairs, a 'friendship bias' can be observed for some country pairs, which are mostly located in the EU. This result already suggests that information and familiarity links between countries play an important role. Second, indirect barriers such as the degree of financial market development and especially information asymmetries have strong explanatory power. In contrast, direct barriers such as capital flow restrictions have no significant impact, which might be due to low data quality, though. Based on this work, identified capital market frictions can be incorporated in OLG models in order to simulate demographically induced capital flows. Corresponding approaches on how to implement capital market frictions are also shortly sketched in this chapter.

Whereas Chapter 3 gives a broad overview on various capital market frictions, Chapter 4 investigates the importance of a single event, namely the formation of a currency union. The paper analyzes the effect of European financial integration, especially of the EMU, on gross portfolio flows between Germany and 47 countries from 1987 to 2002. A gravity model of bilateral asset trade is estimated. The results reveal that there is substantially more portfolio trade between Germany and countries also participating in the EMU. This effect evolves smoothly over time. In particular in 2002, cross-border portfolio flows between Germany and EMU countries are significantly larger compared to flows between Germany and Denmark, the UK, and Sweden which are part of the EU-15 but not of the Euro area. Moreover,

the paper investigates whether economic changes intertwined with the formation of the EMU can explain part of its effect on portfolio investment. Changes in exchange rate volatility, financial market development and increased real economic integration among EMU countries have significant effects on German gross portfolio flows, but they can not account for the positive effect on German gross portfolio flows due to the formation of the EMU. Finally, heterogeneous country responses to this event are revealed. The EMU effect on gross portfolio flows is larger for countries with more developed banking and equity markets and for country pairs with more correlated business cycles. The analyses in Chapters 3 and 4 show that the assumption of perfect capital mobility is less problematic within EMU countries compared to within and between other regions.

Chapter 5 is motivated by the question of how different pension reform options affect retirement entry decisions of older workers. The first part of the chapter is based on Berkel and Börsch-Supan (2004) and focuses on the changes in pension legislation since 1992 and the reform options discussed by the German Social Security Reform Commission installed in 2002 ("Rürup Kommission"). Theses options include shifts in the adjustment factors of early retirement and an increase in the statutory retirement age from age 65 to 67. The aim of the paper is to provide an econometric estimate of the long-term impact of these reform options on retirement entry decisions in Germany. In a first step, a structural model is estimated which relates the actual retirement decisions of older workers in the data to the relevant pension rules. In a second step, pension reform rules are changed and future retirement decisions are simulated based on the estimated coefficients of the model. The simulations show that the early retirement adjustment factors introduced by the 1992 pension reform will raise the average effective retirement age for men by almost two years. The two-year increase in all relevant age limits proposed by the "Rürup Kommission" would raise the retirement age of men by another eight months. The results show that these reform options offer major potential for postponing the effective age of retirement and for regaining financial sustainability of the German PAYG public pension system. The analysis employs survey-based data of the German Socio-Economic Panel (GSOEP) and relies on the individual retirement entry age as self-defined by the interview respondents.

The second part of Chapter 5 discusses the identification of preretirement and its characteristics in administrative data of individuals' retirement entries in 2003 published by the German Pension Insurance ("Deutsche Rentenversicherung"). Administrative data is very valuable because large samples and detailed information on pension claims and labor-market status before retirement are provided. In this data - in contrast to the GSOEP data mentioned above - retirement entry age is defined as the age when receiving old-age pension payments for the first time. This classification does not cover preretirement, which refers to retirement entries before early retirement, i.e., before age 60 or 63. Identifying and characterizing preretirement is an important exercise in this context since preretirement cases are in the center

of interest in recent German pension and labor-market reform initiatives. The data underlines that preretirement is frequently used in Germany: 40 percent of all men and women in the sample preretire. On average they stay 2.4 years in preretirement before taking one of the regular retirement plans. Furthermore, differences between individual determinants of the retirement age for those choosing preretirement programs as opposed to regular public pension plans are discussed. Once sufficiently long time series data will be available in the future, deeper analyses of the effects of pension and labor-market reforms on retirement entries, especially preretirement, can be undertaken based on the insights gained in this paper.

To summarize, this dissertation elaborates on different topics relevant for a better understanding of the economic consequences of population aging. It investigates the impact of demographic change on economic growth, the determinants of international investment - relevant inter alia for predicting future demographically induced capital flows - and evaluates potential reforms of the German pension system.

# Chapter 2

# Births, Economic Growth and Population Aging

## 2.1 Introduction[1]

The gradually accelerating demographic change is one of the key factors shaping the future development of our society. In an aging population a shrinking working age population is accompanied by a rising number of pensioners. In the future this means that the financial burden of supporting ever more pensioners will fall on ever fewer shoulders and will exercise increasing pressure on social security systems and on the economy as a whole.

To date discussion has focused primarily on the consequences of aging, and on the financing and design of the public pension system. However, it would also make sense to investigate the causes of the aging phenomenon, focusing in particular on the continuing decrease of the fertility rate. The obvious question to ask is whether the aging problem can be solved by raising the fertility rate?

Economic theory is unable to provide an unambiguous answer to this question. Neo-classical growth theory postulates a negative long-term relationship between the rate of growth of a homogeneous population and per capita production as the per capita output of one additional worker falls when a country's labor force grows (Solow 1956). However, this comparative static model does not do justice to the complex relationships pertaining between the population structure and overall economic development. In the short and medium term - and particularly during a period of demographic change - the connection between fertility rate and economic growth is not clear cut at all. Whether changes in population growth hinder, promote, or have no impact at all on economic growth has long been debated between

[1]This is a joint paper with Axel Börsch-Supan, Alexander Ludwig and Joachim Winter. A German version has been published in *Perspektiven der Wirtschaftspolitik* (2004), 5(1), pp. 71-90.

economists and demographers without reaching any conclusive answer.[2]

The key aspects of economic theory which need to be included in any consideration of this issue can be outlined very briefly. A higher fertility rate can have the effect of reducing the tax and social security contribution burden imposed by the aging process. A higher fertility rate may also increase a society's human capital which in turn has a positive impact on growth (Lucas (1988), Romer (1986)). On the other hand, children also entail short-term costs (particularly for their education) which must be paid for by society (Cutler et al. (1990), Weil (1999)). However, in reality the detailed workings of these mechanisms are highly complex.

All in all, these opposing effects make it very difficult to arrive at a theory which adequately explains the impact of higher birth rates on economic growth in an aging society and a quantitative analysis is therefore required. It seems appropriate to perform an empirical ex-post analysis in order to determine the influence of a higher fertility rate on economic growth. However, for a number of reasons this approach would not generate satisfactory results:

(1) The aging process is historically unique. The aging society is a late 20th century phenomenon. History can provide no examples of any society or economy which has completed an aging process of this nature.

(2) The observable time frame for the current aging process is not long enough to be able to analyze past developments to demonstrate the impact of changed fertility rates on economic growth in Germany. The aging process is the outcome of the lower fertility rates prevalent since the beginning of the 1970s and therefore only stretches back one generation. What is more, as children first need to be raised, educated and trained before they can join the labor force and contribute to gross national income (GNI), it takes 20 to 25 years before the impact of changes in the fertility rate becomes apparent in terms of overall economic output.

(3) The interactions between the fertility rate and economic growth are extremely complex and for this reason it is unlikely that they will be adequately explained by drawing on developments in the relatively recent past alone.

For these reasons the interaction of fertility rates and economic growth can be more effectively studied using a macroeconomic simulation model. It is capable of structurally mapping the complex interactions between the aging process and macroeconomic variables such as per capita economic growth over a period of more than one generation. The model can simulate various fertility rates and calculate their impact on economic growth in the period 2000 to 2100. This long period of time is necessary in order to encompass both short-term and extremely long-term developments. In order to register the full impact of a change in the fertility rate it

[2] A review can be found in Bloom, Canning and Sevilla (2001).

must be monitored for a period equivalent to at least the entire lifespan of a single individual.[3]

The simulation model used in this study[4] consists of three related components: a demographic projection, a workforce projection and a macroeconomic model based on these two forecasts. In order to analyze the overall economic impact of a change in the fertility rate, the demographic projection entail three fertility scenarios. The initial scenario is based on the assumption that the current fertility rate in Germany of around 1.36 children per woman remains unchanged. This initial scenario is then contrasted with an increase in the fertility rate to 1.8 children per woman. A fertility rate of this magnitude currently applies in France (1.8), in some Scandinavian countries (Denmark 1.65, Norway 1.70) and the United States (1.93). Also a potential further fall in the fertility rate to 1.1 children per woman is examined. This is roughly the rate to be found in some Southern European countries (Spain 1.13 or Italy 1.20) and many Eastern European countries (e.g. Bulgaria 1.10, the Czech Republic 1.16). The workforce projection is based on the demographic projection and on assumptions regarding the future age and gender-specific composition of the workforce. The demographic and workforce projections - which are presented in Section 2.2 - provide the exogenous data for the macroeconomic simulation model.

The description of the macroeconomic simulation model - a multi-country model with overlapping generations - is presented in Section 2.3 and provides the relevant macroeconomic variables such as German GNI and growth rates. The results are discussed in Section 2.4.

## 2.2 Demographic and Workforce Projections

The starting point of the simulations are demographic projections that differ with respect to various forecast rates of birth that feed back into the workforce projections and the macroeconomic model. The demographic model for Germany is the product of an extrapolation differentiated according to age and sex. Although this study only investigates variations in fertility rates, our model is actually capable of combining various fertility, mortality and migration scenarios.

In the reference scenario the fertility rate of 1.4 children per woman,[5] which has remained more or less unchanged over the last two decades, is extrapolated to the

[3]Guest and McDonald (2002) also use a simulation model to study a similar issue and consider the influence of a falling fertility rate on the standard of living in Australia.

[4]A comprehensive and detailed explanation of the method adopted can be found in the study undertaken for the Heidelberg Office of Family Affairs and Social Security ("Heidelberger Büro für Familienfragen und soziale Sicherheit") (Börsch-Supan, Berkel, Ludwig and Winter 2002).

[5]The fertility rate refers to the total fertility rate (TFR). TFR is defined as the average number of children that would be born to a woman by the time she ended childbearing if she were to pass through all her childbearing years conforming to the age-specific fertility rates (ASFR) of a given year. Both TFR and ASFR are employed in our demographic projections.

future for Western Germany (Table 2.1). It is also assumed that the fertility rate of 1.15 per woman in Eastern Germany will continue to adjust to the rate in Western Germany until 2015. The scenario of a constant fertility rate is then compared with the alternative scenarios in other European countries referred to briefly in the introduction. On the one hand it is assumed that the fertility rate will increase from 1.4 to 1.8 children per woman by 2015. In the other scenario the fertility rate drops roughly symmetrically to 1.1 children per woman. Both scenarios help to illustrate the range of effects of variations in the fertility rate on economic growth.[6]

Table 2.1: Fertility rate projections

| | decreasing | | constant | | increasing | |
|---|---|---|---|---|---|---|
| | West | East | West | East | West | East |
| 1999 | 1.4 | 1.14 | 1.4 | 1.14 | 1.4 | 1.14 |
| 2015 | 1.1 | 1.1 | 1.4 | 1.4 | 1.8 | 1.8 |
| 2100 | 1.1 | 1.1 | 1.4 | 1.4 | 1.8 | 1.8 |

*Source:* Statistisches Bundesamt (2001) for the year 1999. The values for 2015 and 2100 are based upon our fertility scenarios.

The assumptions regarding life expectancy and labor force projections in Germany are based on the medium forecast scenario of Birg and Börsch-Supan (1999). These variables initially differ in Western and Eastern Germany but subsequently converge over time. The demographic projections diverge from the forecasts by Birg and Börsch-Supan (1999) with regard to the migration figures. In the present paper the ratio of immigrants to the overall German population established in 1999 is extrapolated. Demographic changes can consequently be unambiguously assigned to differences in fertility scenarios.

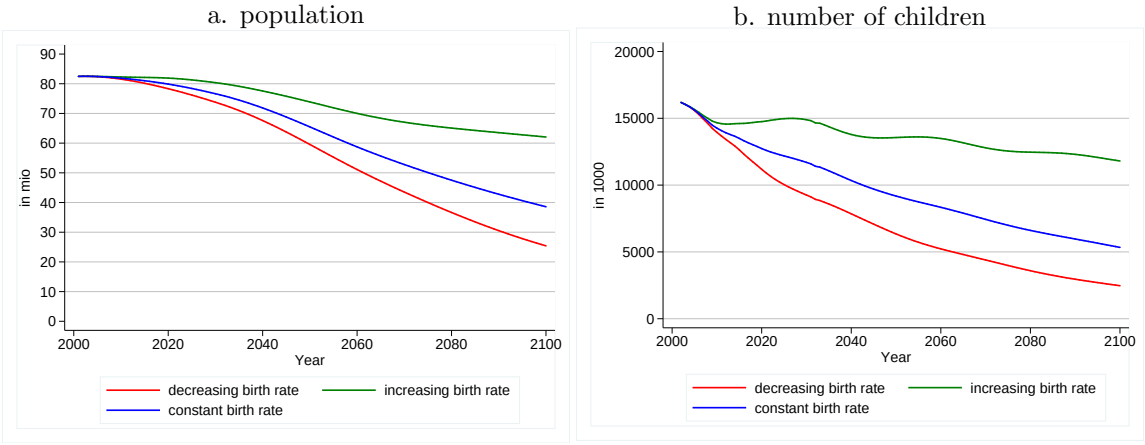
As international capital flows are allowed for in the macroeconomic simulation model and therefore other countries are modeled as well, demographic and labor force projections are also needed for those other countries, namely EU countries. They are taken from the United Nations projections (UN 2000) and the OECD Labor Force Statistics (OECD 1999).

At a constant fertility rate of 1.4 children per woman Germany's current population of around 82 million would be almost halved in 100 years (Figure 2.1 a). A 30 per cent higher fertility rate of 1.8 children per woman would significantly slow down the contraction of the population but would not be enough to stabilize it as

[6]In addition to these scenarios of rapidly increasing or falling fertility rates in the period up to 2015, also more gradual changes in the period up to 2030 have been studied. The differences between these two alternatives and the variants presented here are negligible in the medium term; cf. Börsch-Supan, Berkel, Ludwig and Winter (2002).

this value is still below the replacement rate of 2.1 children per woman. Projections of the number of children - here defined as all those under 20 years of age - reflect overall demographic projections (Figure 2.1 b).

Figure 2.1: Projections of population and number of children




During the first 10 year period the number of children does not differ significantly from one scenario to the next as the fertility rate must first settle at the new level. In the long term, all the scenarios predict a decline in the total German population and number of children. Both the population and number of children will decrease considerably faster if the fertility rate drops than if it were to increase.

The additional children who would be born if the fertility rate were to increase will (on average) join the labor force at the age of 20. Only then will they enlarge the supply of labor. As a result, a change in the fertility rate between 2002 and 2015 will therefore only affect the size of the working age population from 2035 onwards (Figure 2.2 a). Likewise the number of pensioners will only change around 60 years later (Figure 2.2 b).

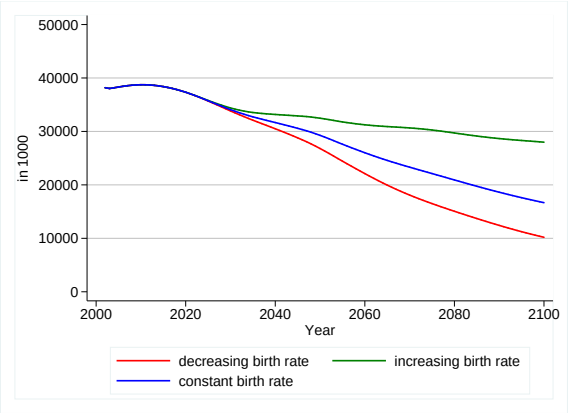
These figures clearly illustrate the problem of an aging Germany: The number of pensioners will rise up to the year 2035 both absolutely and relative to the workforce as the old-age dependency ratio (Figure 2.3) clearly shows.[7] This dramatic increase will take place when the 1960s baby-boomers reach retirement age from 2020 onwards. If the birth rate were to increase, the old-age dependency ratio would fall again from 2035 onwards; at a constant fertility rate, the ratio would remain unchanged. If the fertility rate were to drop even further, the old-age dependency ratio would continue to increase even after 2040.

Figures 2.1 to 2.3 have important things to tell: Even if the fertility rate was to rapidly increase, the aging problem would still be inescapable in the period up to 2035. In fact such an increase would exacerbate the overall dependency ratio even

[7]The old-age dependency ratio is defined as the ratio of employed persons to pensioners.

Figure 2.2: Working age population and number of pensioners

a. working age population




b. number of pensioners

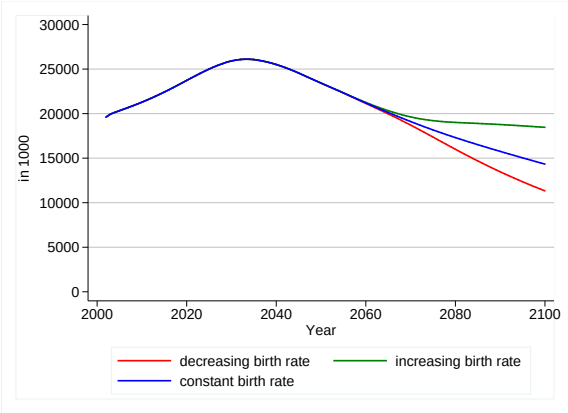
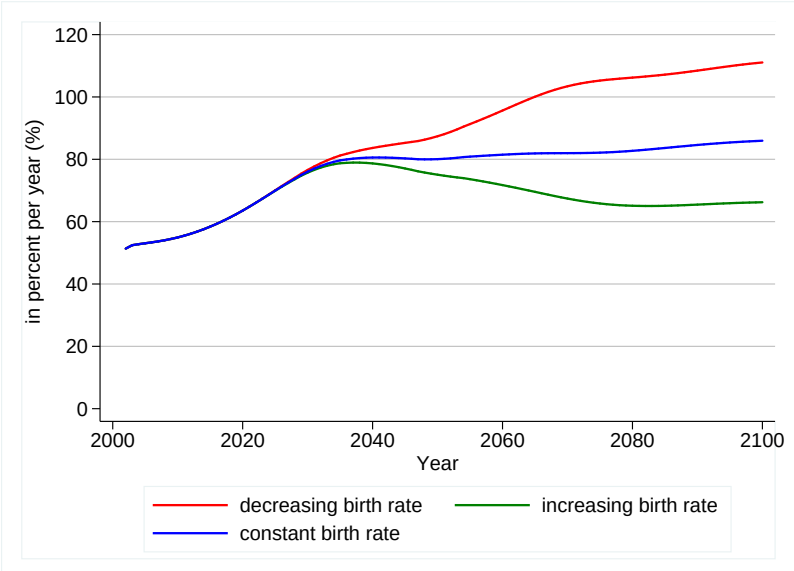



Figure 2.3: Old-age dependency ratio



further in the short term as the increased number of children would also have to be supported by the working age population. This means that in the long term positive effects on the economy as a whole can only be expected after an initial aging summit is reached around 2035.

## 2.3 A Model of the German Economy

Within the focus of this study the effects of demographic change on the economy as a whole are of outstanding importance. Therefore the demographic scenarios outlined in Section 2.2 are embedded in a model of the German economy. The workforce projections of the previous section provide the labor supply of the future. In the model this variable is a central determinant of the object of our study: per capita GNI and its growth.

An Overlapping Generations (OLG) model is employed which is particularly suitable for examining demographic changes. The concept of an OLG model was originally devised by Samuelson (1958) and Diamond (1965). The variant presented in the following expands the model proposed by Auerbach and Kotlikoff (1987)[8] to include several countries and thus accounts for the impact of international capital markets and goods on national economies (Börsch-Supan, Ludwig and Winter (2003b); Ludwig (2002)).[9]

It is assumed that perfect capital markets exist between the countries considered and that capital can flow freely over national borders. As the following observations examine the economic development of Germany in the context of its interactions with economic developments in other EU countries, the assumption of perfect capital mobility approximates to reality fairly well, especially since the introduction of the euro has finally eliminated exchange rate risks in the eurozone.[10] The more regions which are considered, the less realistic is the assumption of perfect capital markets, however.[11]

[8] Cf. Chapter 3 in Auerbach and Kotlikoff (1987).

[9] Models of overlapping generations are a favorite method of studying the impact of population aging on the economy; refer to Kotlikoff, Smetters and Walliser (1999, 2001), De Nardi, Imrohoroglu and Sargent (1999) and Altig et al. (2001) for the USA; Miles and Iben (2000) for the United Kingdom and Fehr (2000) and Hirte (2002) for Germany.

[10] Chapter 3 indicates that the degree of international diversification in the eurozone and within the EU-15 countries is relatively advanced compared to other regions. As Chapter 4 shows, the degree of capital flows with Germany has increased in light of the European Economic and Monetary Union (EMU).

[11] In contrast to the flows of capital and goods that are determined endogenously in the model, migration is determined exogenously by the demographic model.

### 2.3.1 The Model Structure

In the model the economy has three sectors: the household sector, the production sector and the (rudimentary) state sector. The most interesting aspect of the state sector is in the context of the present paper the pay-as-you-go (PAYG) retirement insurance system.

In the household sector, households maximize their consumption and have perfect foresight regarding the utility they derive from their consumption over their lifetime. The key notion in this model is consumption smoothing: Households distribute their consumption as evenly as possible over their lifetime. As older family members no longer receive earnings from paid work and the public PAYG pension is lower than the pensioner's final wage income, households build up savings during working life to avoid a dramatic reduction in consumption after retirement. Due to population aging the public PAYG pension will be much more modest in the future and will consequently reinforce the need to make private provision for old-age. This effect is mapped in the model by corresponding forecasts of contribution and replacement rates for the public pension system (see also the discussion of the state sector below).[12]

In order to accommodate the long-term demographic development of the population structure, two characteristic stages in individual's lives are distinguished: working life and retirement. The proportion of the working age population and the retirement entry age at a specific point in time are defined along sex and cohort lines in the labor force projection. The number of people currently working or in retirement varies according to the demographic projections on the basis of various fertility rates.[13] The model is therefore capable of mapping in detail the influence of demographic changes on the labor supply, the demand for goods and consequently on the production sector.

Children do not yet receive earnings from paid work, nor are they recipients of state transfers on a scale comparable with public pensions. On the contrary, their consumption, education and training are financed by their parents. Children are therefore not modeled as independent decision makers. Parents do, however, take account of the consumption of their children when making their own consumption and savings decisions. The budget restrictions of all households are extended in order to take account of the consumption of children. The statistical number of children are assigned to households according to the age-specific fertility rates of their female members. The consumption of each child is modeled as a mark-up to the consumption of each adult family member. The consumption of children, expressed in units of parental consumption, produces a scaling factor of 0.36. One

[12]Other motives for savings, such as a planned bequest or insurance against longevity risks or unforeseeable events are not taken into account in our model.

[13]Other influencing factors are the labor force participation of women and overall rates of unemployment. The figures are based on the projections of Birg and Börsch-Supan (1999).

child's consumption is thus equal to 36 per cent of the consumption of an adult.[14] In monetary terms this is equivalent to around 309 euros a month.

This may appear to be a rather pecuniary view of children. Empirically, however, quantifiable monetary parameters provide the only reliable variables to draw on. We have therefore refrained from any attempt to model the utility of children or their consumption.[15]

The production sector consists of one representative company per country. GNI as well as the wage and interest rates are determined on the basis of the specified use of production factors labor and capital as well as a specific technology. Initially it is assumed that the productivity of the factors grows exogenously at a constant rate. Alternatively, it is also examined - in stylized form - the influence of endogenous growth. It is assumed that a society's average human capital increases the younger its working population is. Human capital in turn determines the productivity which then endogenously specifies the overall growth in the model.[16] According to this hypothesis, productivity growth in an economy increases as the average age of the working population falls.[17]

We restrict our focus to this stylized model of endogenous growth, even though the structure of human capital is much more complicated in reality. It is more or less impossible to take account of all the factors that influence economic growth in such a model. Although endogenous growth can be modeled theoretically along the "learning by doing" lines suggested by Romer (1986) and implemented by Fougère and Mérette (1999), for example, or according to the "learning and doing" approach proposed by Lucas (1988), it is not possible, however, to calibrate these theoretical models reliably with quantitative parameters.

The organization of pension and all other social security systems is the function of the state sector. These tasks include collecting pension, unemployment, health and long-term care insurance contributions as well as income tax, whereby income tax is used in the model to finance state subsidies to the pension system and general state consumption. No other government spending is modeled. The replacement rate provided by the PAYG-funded public pension system is exogenous and is based on data from the Federal Ministry of Labor. The contribution rate is derived from the

[14]These calculations are based on 1993 income and consumption survey (EVS) data on the consumption of children and adults as presented for various types of households in Hertel (1998).

[15]In an otherwise very similar approach, Kotlikoff and Walliser (2001) take account of the consumption of children in the utility of their parents whereby the weighting issue remains controversial (refer also to Brooks (2002)). Barro and Becker (1988) model the "quality" of children in terms of their human capital - however, this approach is also contentious and difficult to implement in a concrete simulation model.

[16]Whether a larger and/or younger population has a positive or negative impact on the productivity of an economy is controversial. See, for example, Becker, Edward and Murphy (1999).

[17]Instead of making human capital dependent on the average age of the working population, the number of children can also be used to determine a society's future human capital. There is very little qualitative difference in the results, however.

budget equation of the public pension system and federal subsidies. The transition to a partly-funded pension system is not explicitly modeled in the following but results from the household savings behavior described above.[18]

In the model's ideal capital market, international capital flows into countries offering higher interest rates until interest rates differentials are equalized again. As capital market imperfections do not exist, both the interest rate and the net wage rate are identical in all the countries considered. The interest rate not only determines the amount of capital accumulated in the domestic market, it also determines the amount of capital invested outside of that country and consequently the amount of capital which flows between all the countries under consideration. This relationship is used to solve the model by iterating the computations until all markets in all countries are cleared.

### 2.3.2 Criticisms

Any model of reality inevitably entails a large degree of simplification. While future demographic developments are mapped in detail and account is taken of the linkages between national capital markets which are of great importance to Germany, a number of aspects which are not of key importance in this study have been excluded:[19]

(1) Variables such as the labor supply or family planning decisions are determined exogenously from demographic and workforce projections. Potential feedback effects between the decision of a woman or couple to have a child and the labor supplied by that woman or the effects on these variables by the social insurance systems are thus not taken into account.[20]

(2) The model takes no account of market frictions on the domestic labor market or any capital market imperfections, such as credit restrictions. The assumption of perfect capital markets is not very restrictive for the mapping of capital flows within the EU, though.

(3) It is assumed that households act on the basis of foresight and that the future holds no uncertainties. At the individual level such uncertainties would include the risk implicit in longevity against which individuals would build

[18] See also Börsch-Supan, Heiss, Ludwig and Winter (2003a) on the introduction of a funded pension system.

[19] See also the overview in Kotlikoff (1998).

[20] Sinn (1998), Barro and Becker (1988) as well as Cigno (1991) point to the negative effects which social insurance systems can have on decisions to have children and the formation of human capital. See also Fernandez-Villaverde (2001) for the relationship between technological progress and population growth. See Tamuara (2000) for an overview of the theoretical literature on family planning.

up precautionary savings. At the aggregate level risk on financial markets is ignored.

In our view these simplifications do not have a substantial influence on the key findings as they only have a secondary and indirect impact on the relationship between fertility rates and economic growth which is of actual interest in this study.[21]

## 2.4 The Impact of Demographic Change on the German Economy

How would the German economy develop if the fertility rate were to rise to 1.8 children per woman? Or, what would be the consequences if fertility rates were to continue to fall even lower? In order to answer these questions the analysis concentrates in particular on the impact of demographic changes on the level of per capita GNI and its growth. It is thereby initially assumed that technological progress is independent of population structure. The findings of this initial model are then compared with a scenario in which - as described in Section 2.3.1 - productivity is linked to the population structure.

### 2.4.1 Exogenous Productivity Growth

As the demographic and workforce projections in Section 2.2 show, in the first 20-year period following an increase in the fertility rate there are more children who have not yet joined the working population and who need to be supported and educated by society. This development is also reflected in economic growth. More resources are required for children and this dampens capital accumulation to some extent and in turn affects production. This means that an increase in the fertility rate will initially slow down growth. Apart from this affect, there is a fall in all per capita figures simply because GNI now needs to be distributed among a larger number of people, i.e., shared with additional children.

These initial losses in growth are only overcome once the children are educated and trained and have joined the working population at the age of 20 - at the earliest from the year 2035 onwards. However, this is also precisely the time at which the aging problem and the crisis in the public health and pension systems will peak.[22] This means that not even a dramatic increase in fertility rates to 1.8 children per woman would substantially alleviate the short-term aging problem.

After this transitional period the positive impact of increasing fertility rates become obvious: Because more children now join the labor force, the working age

[21] Estimating the scale of these effects is current ongoing work.

[22] The consequences of the aging process for the social security system in Germany is a much discussed issue. See Birg (2001), p. 170-194, and Börsch-Supan (2002).

population grows faster than the rest of the population. The age burden now falls on more shoulders. This is clearly demonstrated by the way the contribution rate[23] to the pension system changes over time (Figure 2.4). The contribution rate is identical for all scenarios until the aging problem reaches its zenith in the period 2035 to 2040. If the fertility rate increases the contribution rate will be 5 percentage points lower in the year 2060 than it would be in the initial scenario of a constant birth rate. A higher supply of labor and a lower contribution rate, both induced by a rising fertility rate, will result in temporarily significantly higher per capita GNI growth between 2035 and 2080 compared to the reference scenario (Figure 2.5).

This positive effect will lessen over the longer term, however. A larger employed labor force in the years 2035 to 2060 leads to higher growth as the size of the working age population grows faster relative to the population as a whole. What is more, the older members of the population - the baby-boom generation - will begin dying during this period. After 2075 the first wave of workers resulting from a higher fertility rate will reach retirement age. This means that, in the scenario of an increasing fertility rate, the number of pensioners will drop less rapidly (Figure 2.2 b) and the old-age dependency ratio will again increase slightly until it levels out around the year 2100 (Figure 2.3). Under these conditions the opposite effect becomes more important again whereby additional numbers of workers make a less than proportional contribution to production.[24] By the end of the present century, and assuming constant technological progress, per capita rates of growth will more or less converge again. The positive per capita growth effect of a higher fertility rate will thus die away in the long run.

The impact of a higher fertility rate on levels of per capita GNI is similar (Figure 2.6). In fact it is difficult to even visually distinguish the different scenarios in Figure 2.6. However, a closer look reveals the same qualitative impact that has already been observed for economic growth. In the case of an increasing fertility rate per capita GNI is lower than in the comparative scenario at first. However, the initial negative effect lasts longer as the initial losses in GNI growth first need to be catched up. A weakly positive effect on the level of per capita GNI will only become apparent from 2080 onwards.

### 2.4.2 Endogenous Productivity Growth as a Result of Human Capital Accumulation

The rather sobering results generated under the assumption of exogenous growth presented in Section 2.4.1 do not apply, however, if account is taken of the pos-

[23]The total contribution rate is the sum of the direct contribution rate and indirect subsidies to the public pension system financed from general taxation; cf. for example Börsch-Supan, Heiss, Ludwig and Winter (2003a).

[24]This argument goes back to Solow (1956), cf. Section 2.1 above and, for a more detailed treatment, Cutler et al. (1990).

Figure 2.4: Direct and indirect contribution rate to the public pension system

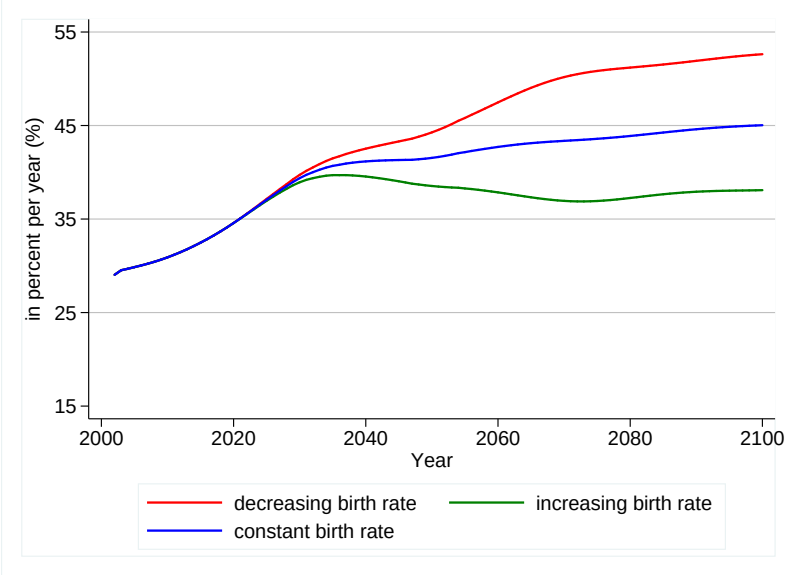
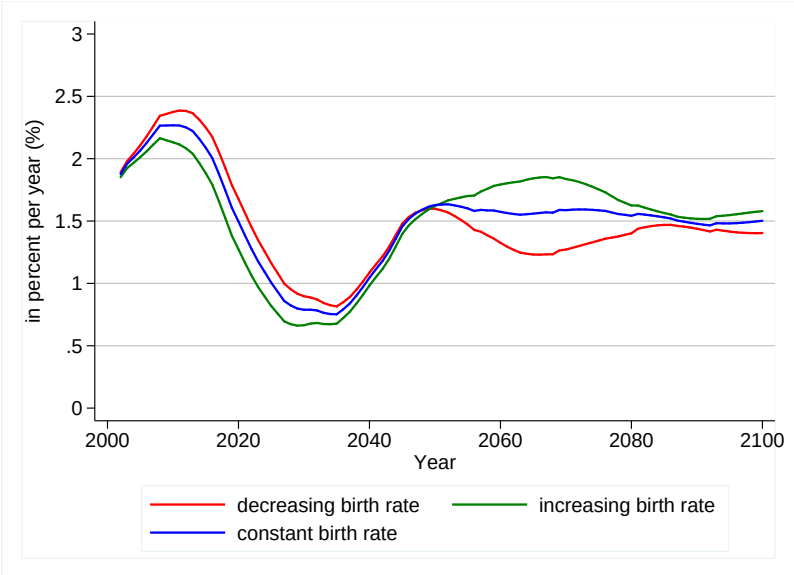
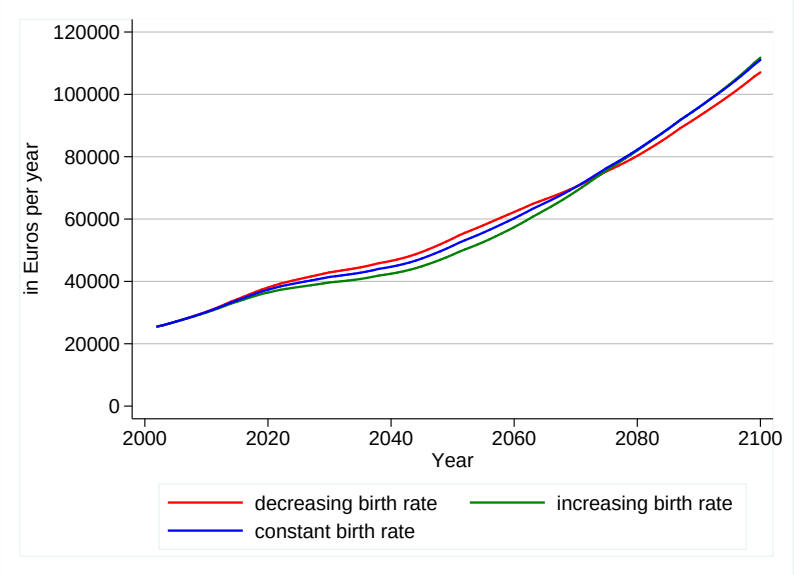



Figure 2.5: GNI per capita growth - exogenous growth




sibility that children born in the future may be better educated and trained and consequently accelerate the pace of technical progress. In order to illustrate this effect a variant of the simulation model is used in this section which allows for endogenous growth. As described in Section 2.3.1, the stylized assumption is made

Figure 2.6: GNI per capita - exogenous growth




that labor force productivity is higher if its average age is lower. At any rate this hypothesis reflects a typical view. It is not at all clear whether it can be demonstrated empirically. It would therefore be better to regard the following simulations as an expression of the effects of improved education and training.

Figures 2.7 and 2.8 show the results. If, in addition to a rising fertility rate, improved human capital leads to growing labor force productivity, outcomes under exogenous growth change in two fundamental ways. First, per capita economic growth with endogenous productivity growth and rising fertility rates is significantly above rates of economic growth and exogenous productivity growth (refer to Figure 2.7)). Second, this positive effect will also hold beyond the year 2085 as a higher fertility rate will, in the long term, lead to a younger and - according to our assumptions - more productive working population. In this case, one additional young worker will, in comparison with an older member of the labor force, make a greater than proportional contribution to production as the better educated and trained additional worker can more than compensate for decreasing marginal returns. Whereas in the case of exogenous growth young and old workers are rated identically and - owing to decreasing marginal productivity - an additional worker makes a less than proportional contribution to production (cf. Section 2.4.1).

A qualitatively and quantitatively significant positive result is also apparent with regard to per capita GNI with endogenous productivity growth (Figure 2.8): If the lower average age of the working population which results from a higher fertility rate leads to a positive human capital effect, per capita GNI from around 2055 is

Figure 2.7: GNI per capita growth rate - exogenous & endogenous growth

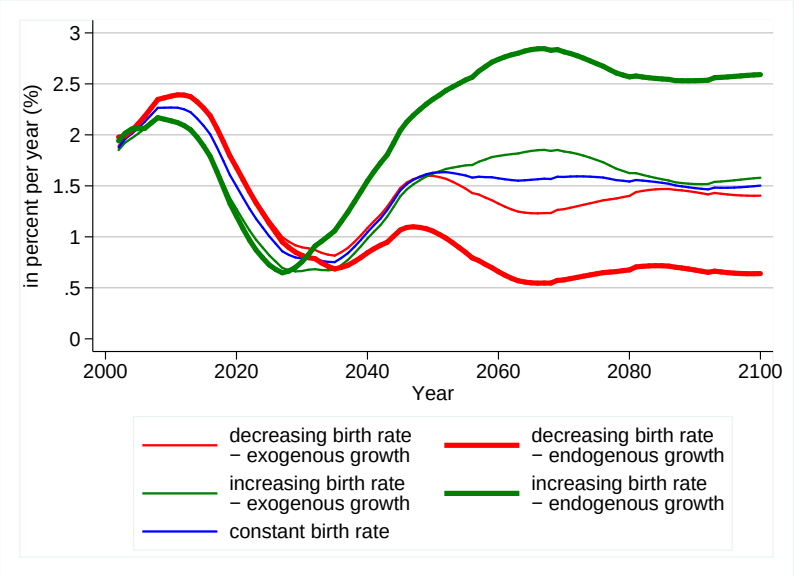
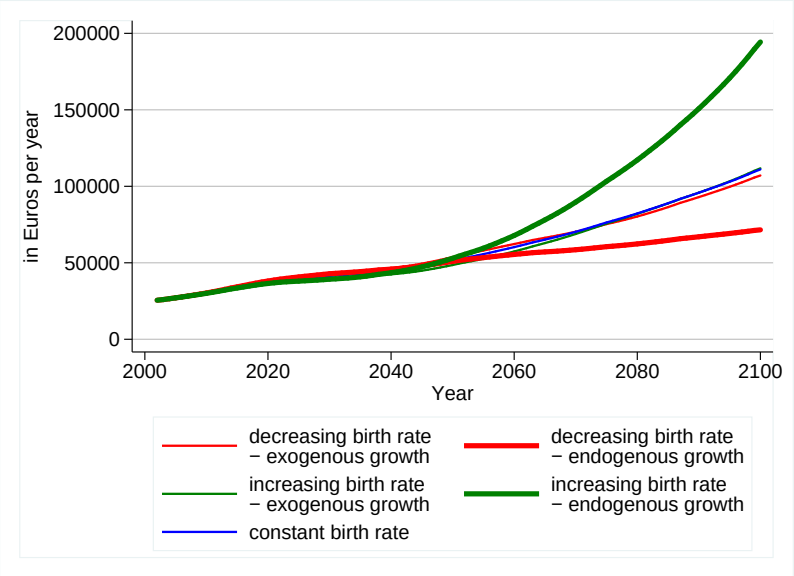



Figure 2.8: GNI per capita - exogenous & endogenous growth



substantially higher than under conditions of exogenous growth and a rising fertility rate. In this case it is also decisive that this effect persists beyond the year 2085. What is more, the positive effect is not only larger and permanent, but also occurs around five years earlier.

These results clearly demonstrate that the education and training of children and young people will play a key role in managing the process of demographic change.

## 2.5 Conclusions

Could a higher fertility rate help to dampen the effects of aging? Economic theory offers inconclusive guidance, even if the idea that "if we have too many old people, we need more children to balance the effects out", appears plausible enough. The quantitative study discussed here also comes to more differentiated conclusions: A long-term boost in per capita gross national income will only result from a higher fertility rate if the additional children born are also better educated and trained. This means that the formation of human capital and not a higher fertility rate itself is decisive for long-term growth.

The three most important economic policy conclusions consequently relate to the formation of human capital, the role of tax financed family transfers ("Familienlastenausgleich") and the priority of further reforms of our social security systems:

(1) An aging Germany needs better trained and educated - and consequently highly productive - children. Following international comparative studies - such as studies of educational standards like the "TIMMS Study" or the "PISA Study" in which Germany scored conspicuously poorly - there is a need for far-reaching reforms in Germany's vocational and continuing professional training sector. In a period of demographic change the engine of future growth - training and education in the context of the family, school, university, and continuing professional training - merits special attention and support.

(2) As the number of newborn children has very little influence on per capita GNI, there are no particularly obvious reasons on economic grounds for encouraging higher fertility rates. If higher fertility rates are desirable, the corresponding rationale will have to be obtained from other scientific disciplines. The study considered here does, however, generalize on the basis of the problems of current tax financed family transfers. It would be beyond the scope of this paper to discuss whether such transfers are adequate. However, this paper does support the conclusion that all that economists can really call for is compensation for the burdens borne by families which simultaneously represent benefits for others. The mere existence of more children does not in itself present a long-term solution to the demographic-driven problems of the future.

(3) A higher fertility rate does not represent an alternative to a reform of the social security system aimed at solving the immediate aging problem which, if no reform is forthcoming, results in a crisis in the public pension and health systems in the period between 2020 and 2040. This also applies if the impact of human capital is taken into account. The transition period after which a higher fertility rate would result in a larger and better trained labor force able to pay contributions to the pension and other social insurance systems is far too long. Further reforms of our social security systems must have top priority. Specifically, further pension reforms are needed which go well beyond the steps taken by the "Riester reform" and which tackle the problems which will arise after 2015. Furthermore, a reform of the health system, which even faces more pressing problems, is needed.

Investments in human capital and reforms of social security systems are investments in the future which initially impose painful costs. However, it would be futile to hope for a painless cure to the problems associated with demographic change. The happy circumstance that we are living longer on average at the same time involves the need to finance this longevity. The financing burden must be mainly borne by the generation which will itself enjoy a longer life. The option of postponing urgent social reforms and shifting the burden to later (and possibly larger) generations will, as this paper has demonstrated, ultimately prove to be an economic nonstarter.

# Chapter 3

# Institutional Determinants of International Equity Portfolios - A Country-Level Analysis

## 3.1 Introduction

Despite large potential gains, international equity investment is less diversified across countries than predicted by the international version of the traditional capital asset pricing model (ICAPM) based on Sharpe (1964), Lintner (1965) and Mossin (1966). According to the ICAPM, individuals should hold equities from countries around the world in proportion to their market capitalizations. However, empirical facts reveal that international portfolios are heavily biased towards domestic assets. This phenomenon − known as the 'home bias puzzle' − is one of the most striking empirical results in international economics. Table 3.1 shows that in 2001 U.S. investors hold almost 90 percent of their portfolios in domestic equity compared to a world market capitalization of U.S. equity of only 50 percent. For some countries this bias is even more pronounced, for example 67.8 percent compared to 3.9 percent for Germany and 85.9 percent compared to 1.25 percent for Spain. If one considers the European Monetary Union (EMU) as one large financial unit, the home bias phenomenon is also very noticeable: Investors hold 80.9 percent whereas market capitalization of the euro area amounts to 15.2 percent.

This phenomenon has already attracted a large body of theoretical and empirical research. Lewis (1995, 1999) and Karolyi and Stulz (2003) provide extensive reviews of the recent international economics and finance literature. However, the puzzle is not yet fully resolved. This is partly due to the lack of data on cross-border holdings, especially of large cross-country panel data and of data with a reasonably long time series dimension. Therefore, most existing studies dealing with the home bias phenomenon are limited to data on U.S. foreign equity holdings or on countries'

Table 3.1: Home bias in equities in 2001

| | % of equity assets in domestic equities | share of world market capitalization |
|---|---|---|
| US | 89.22 | 50.64 |
| Japan | 89.50 | 8.26 |
| UK | 74.73 | 8.13 |
| Germany | 67.81 | 3.93 |
| France | 79.80 | 4.31 |
| Spain | 85.94 | 1.25 |
| EMU | 80.93 | 15.19 |

*Sources:* Foreign equity investments from the IMF's CPIS, market capitalizations from WDI (2002) and FIBV, own calculations.

total foreign equity holdings not subdivided into country pairs. In contrast, this paper employs a more comprehensive data set, the *Coordinated Portfolio Investment Survey* (CPIS) of the International Monetary Fund (IMF), that allows to shed new light on bilateral equity holdings between countries for 1997 and 2001 as well as on their institutional determinants.[1]

An important assumption of the traditional version of the ICAPM is that there are no barriers to international investment. Based on the ICAPM, the theoretically predicted share of foreign assets at the country level is calculated in this paper and compared to the actual share observed in the data. The difference between these two values is then taken to investigate the relevance of different capital market frictions. This empirical approach is based on Ahearne, Griever and Warnock (2004) and Edison and Warnock (2004).

The present paper contributes to the existing literature in two aspects. First, it extends the analysis of the home bias in equities to a large cross section of 38 countries whereas Ahearne, Griever and Warnock (2004) and Edison and Warnock (2004) look at U.S. holdings of foreign equities alone.[2] The home bias phenomenon is described and characterized at the bilateral country level. An interesting finding is thereby - as far as known to the author - for the first time revealed: a phenomenon that I call bilateral 'friendship bias' for several European country pairs.

[1] As opposed to institutional explanations, individual investor behavior such as familiarity, probability judgments and social identity have also been considered in the literature to explain part of this phenomenon. The distinction between institutional and behavioral explanations was first suggested by French and Poterba (1991).

[2] Ahearne, Griever and Warnock (2004) employ country-level data for 1994 and 1997; Edison and Warnock (2004) use security-level data for U.S. firms for 1994 and 1997.

Second, Ahearne, Griever and Warnock (2004) and Edison and Warnock (2004) focus on information frictions as one important explanation of the home bias, which they proxy by firms' cross listings. In contrast, the present paper takes various institutional frictions to investment into account such as information asymmetries, financial market development and capital controls.[3] Especially the impact of financial development is investigated more closely. It is proxied by the development of the equity market and, alternatively, of the banking sector. Financial development of both the home and the foreign country are considered and differences between them examined. Moreover, the analysis accounts for closely-held shares that cannot be freely traded (Dahlquist et al. 2003).

The results provide new insights into the relevance of capital market frictions for foreign equity holdings using a large cross section of country pairs. The degree of equity market development of the country invested in plays a significant positive role, whereas the development of the banking sector in the investor's country is positively linked to portfolio shares of foreign equity investment. Information advantages measured by geographical proximity as well as by the existence of a common legal origin or, alternatively, of a common historical colonial relationship have great explanatory power. The existence of capital controls has no significant impact on the share of foreign equity investment, which, however, might be due to low data quality.

Section 3.2 describes the econometric specification and discusses the measures of capital market frictions employed in the empirical analysis. Descriptive statistics of portfolio compositions across countries and estimation results are presented in Section 3.3 and concluded in Section 3.4. Based on the insights of the present paper, Section 3.5 gives an outlook on how to implement capital market frictions into an Overlapping Generations (OLG) simulation model.

## 3.2 Empirical Approach

The empirical approach is based on the idea of comparing the portfolio share of foreign equities predicted by the International Capital Asset Pricing Model (ICAPM) to the empirical share in a world with capital market frictions. The discrepancy between these two measures is then explained by direct and indirect barriers to international investment at the country level. After explaining the economic specification in more detail, the variables of interest and the data are described. Finally, arising estimation issues are discussed.

[3]Frictions caused by non-tradable goods are not considered in this paper. Lewis (1999) tests implications of models assuming complete markets and non-tradable goods. She shows that these models are not able to explain the home bias. Baxter and Jermann (1997) show that when non-traded human capital is taken into account, the international diversification puzzle is even aggravated.

### 3.2.1 Econometric Specification

In order to set up an empirical model, two different classes of theoretical capital asset pricing models are considered: first, the traditional version of the ICAPM without capital market frictions and, second, an ICAPM with barriers to international investment.[4]

The first class of models goes back to Sharpe (1964), Lintner (1965) and Mossin (1966). The traditional version of the ICAPM is built on the assumption that investment and consumption opportunity sets do not differ across countries. Investors are the same with respect to risk-aversion and information. These models assume perfect markets. The fact that countries use different currencies has no significant implications for portfolio choice and asset pricing. There are no taxes, no tariffs, no information asymmetries, no restrictions on short-sales and no barriers to international investment. One convenient property of this traditional version of the ICAPM is that it has simple and clear implications for investors' asset holdings: Investors hold the world market portfolio share of risky assets irrespective of their country of residence $i$. It follows that the portfolio share of country $i$ invested into country $j$, $W_j^*$, can be expressed as:

$$W_{j,t}^* = \frac{MCAP_{j,t}}{MCAP_{world,t}}, \forall i,$$

where $MCAP_{j,t}$ denotes market capitalization of country $j$ in period $t$ and $MCAP_{world,t}$ world market capitalization in period $t$. This market portfolio share serves as the benchmark case of portfolio holdings to which the actual portfolio share that can be observed in the data is compared.

The second class of models by Black (1974), Stulz (1981), Merton (1987) and Cooper and Kaplanis (1994) relaxes the assumption of perfect markets.[5] These models include frictions that are typically modeled as a deadweight cost or a tax on expected returns in the foreign country. Those costs can be interpreted as costs caused by capital controls, taxes, information costs or transaction costs. These models only provide for testable implications of single model parameters, however, and do not allow to deduct an estimation equation of portfolio shares and various types of capital market frictions. Therefore, a reduced form approach is employed in the subsequent empirical analysis that combines - against the background of the above mentioned two classes of CAPM models with and without frictions - the market portfolio share, $W_{j,t}^*$, investment costs, $C_{i,t}$, $C_{j,t}$ and $C_{ij,t}$, and observed portfolio shares, $W_{ij,t}^{act}$:

[4]See Stulz (1995) for a detailed review of the capital asset pricing literature and a systematic discussion of different models.

[5]Deviations from the optimal portfolios in the case of the traditional ICAPM mentioned above can also arise due to deviations from purchasing power parity such as in the model by Adler and Dumas (1981). However, Cooper and Kaplanis (1994) show empirically that large parts of the home bias in equity puzzle cannot be explained by this model.

$$W_{ij,t}^{act} = \alpha_{0,t} + \alpha_{1,t} W_{j,t}^{*} + C_{i,t}' \beta_{1,t} + C_{j,t}' \beta_{2,t} + C_{ij,t}' \beta_{3,t} + Z_{ij,t}' \gamma_t + \epsilon_{ij,t}.$$

The optimal share of investment in the ICAPM with perfect markets, $W_{j,t}^{*}$, enters the right hand side.[6] $C_{i,t}$, $C_{j,t}$ and $C_{ij,t}$ are vectors of measures for capital market frictions referring to the country of origin $i$, the country of destination $j$ or the country pair $ij$.[7] These vectors consist of variables that take account of investment costs due to indirect or direct barriers to investment. They are in the center of interest and discussed in more detail in the following section. The vector $Z_{ij,t}$ includes additional covariates that proxy investment opportunities and diversification considerations. They are also discussed in more detail in the next section. Moreover, a constant, $\alpha_{0,t}$, and a nuisance term, $\epsilon_{ij,t}$, are included. $\epsilon_{ij,t}$ captures all the factors affecting actual portfolio shares other than measured by the above mentioned explanatory variables.

### 3.2.2 Variables of Interest

#### Information Frictions

Asymmetric information is regarded as a key factor of explaining the empirical evidence on foreign asset holdings and international capital flows. Martin and Rey (2004) construct a gravity model where transaction costs and costs caused by information asymmetries between two countries are proxied by geographical distance. The model implies that gross bilateral asset flows will be greater the smaller the distance. Di Giovanni (2005), Portes and Rey (2005) and Ghosh and Wolf (2000) use this gravity model to explain cross-border capital flows between countries.[8] In Portes and Rey (2005), information frictions are also captured by using variables measuring directly the degree of asymmetry between domestic and foreign investors such as the volume of telephone traffic and the number of bank branch subsidiaries as well as an index of insider trading. They find that for a large cross section of countries the geographical component dominates in explaining the volume and direction of international capital flows. Geographical distance does not only play an important role for investment at the cross-country level but also within countries: Using firm level data, Coval and Moskowitz (1999) and Huberman (2001) provide evidence that U.S. investors have strong preferences for geographically proximate investments.

[6] Thus, the effect of $W_{j,t}^{*}$ on $W_{ij,t}^{act}$ is left unrestricted. In a restricted version one could regress capital market frictions on $W_{ij,t}^{act} - W_{j,t}^{*}$.

[7] Country of origin denotes the investor's country of residence, whereas the country of destination is the country invested in, i.e., the issuers country of residence.

[8] Portes and Rey (2005) investigate international equity flows, Di Giovanni (2005) cross-border M&A activity and Ghosh and Wolf (2000) FDI, bank lending, portfolio debt and portfolio equity.

Information advantages do not only arise due to geographical proximity but also due to similarity of institutions and legal structures. Legal rights of investors differ very much across countries. A large part of this variation is accounted for by legal origin. This applies especially to commercial laws for the financing of firms and for investment but also to law enforcement (La Porta et al. 1997, 1998). Thus a common legal origin indicates a lower level of information asymmetries. It is distinguished between German, French and Scandinavian civil law families, the English common law, and the Socialist law family.

The similarity of institutions can also be proxied by the fact that two countries share a common colonial background. Colonialism explains the building of institutions for several, although not all, countries (Acemoglu, Johnson and Robinson 2002). The institutions are often very similar to those of the former colonizers. Thus, information advantages exist between former colonies and their colonizers.

The following variables are included to mirror information frictions:[9] the logarithm of distance between country $i$ and country $j$, $logdistance_{ij}$, and a dummy variable equal to one if a country pair has a common legal origin, $samelegor_{ij}$. Alternatively, a dummy variable equal to one if two countries share a common colonial background is used, $colony_{ij}$.[10]

**Financial Market Development**

In larger and more liquid markets prices are supposed to be more informative. One reason is that larger markets encourage arbitrage through liquidity, the existence of more and better substitutes to use as hedges for trading against mispriced securities and reduced transaction costs (Beck, Demirgük-Kunt and Levine (2001) and Wurgler (2000)).

A common proxy for financial development such as the size and depth of the domestic capital market is the amount of private credit provided by the banking sector relative to GDP which is included in the subsequent regression analysis for the home and foreign country, $logdcredit_{i,t}$ and $logdcredit_{j,t}$ respectively.[11] The banking sector plays an important role for private investment in many emerging economies as well as in continental Europe and Japan. It represents the overall development of the private banking sector - more specifically the development of its financial institutions that conduct and channel international equity investments -

[9] Section 3.2.3 and Table 3.10 in Appendix A include descriptions of all employed variables, their sources and exact calculations.

[10] In the trade literature, a dummy variable that denotes whether two countries have a common language is often employed in order to proxy information advantages. Note that in this sample all country pairs that have a common colonial background at the same time share a common language and vice versa.

[11] See for example Chinn and Ito (2006) and Di Giovanni (2005). As a comparable measure M2 to GDP is often used. However, this variable is only available for a much smaller number of countries.

and the amount of liquidity available in the economy.

In order to capture an additional angle of financial development, stock market capitalization of country $i$ and $j$ relative to GDP is considered, $logmcap_{i,t}$ and $logmcap_{j,t}$. It directly addresses the influence of growing equity markets on international investments which experienced a substantial growth in industrialized economies as well as in new markets of transitional and emerging countries in the 1990s.

Finally, a variable is employed that measures the actual liquidity in the equity market, i.e., it takes account of equity shares by large controlling shareholders that can not be freely traded. Especially in countries with poor investor protection many firms are controlled by large shareholders such that only a fraction of the shares issued by firms can be freely traded in these countries and held by foreign investors. La Porta et al. (1998) provide evidence that the size and breadth of capital markets is largely influenced by investor protection and the quality of the legal environment. Dahlquist et al. (2003) investigate the impact of equity shares held by large shareholders on U.S. foreign investment. They show that a country's share in U.S. equity portfolios is negatively related to the share of equities held by large shareholders in that country. In the subsequent regression analysis of the present paper the float portfolio share calculated by Dahlquist et al. (2003), $W_{j,t}^{float}$, is used as a proxy for investor rights and the liquidity of the market. The float portfolio share is the market capitalization of a country excluding closely-held shares by controlling shareholders.

### Direct Barriers

Direct barriers such as capital controls that have an immediate impact on net investment returns and, therefore, on the investment decision are also considered. Albeit having been reduced to a great extent throughout the 1990s, capital controls are still existent today. The crucial question is whether controls that are in place are in fact effective.[12] Although there have been attempts to determine measures of the effectiveness of capital controls, these are only available for a very small number of countries or years.[13]

Given the large cross-country data sample that is employed in the present paper, a financial openness measure is used that was for the first time provided by Grilli and Milesi-Ferretti (1995) based on the IMF's *Annual Report on Exchange Arrangements and Exchange Restrictions* (AREAER), $restrict_{i,t}$ and $restrict_{j,t}$. It does not account for the effectiveness of capital controls but only states whether restrictions on capital flows are in place or not.

[12]For a detailed description of different types of capital controls and their effectiveness see Edison et al. (2002) and Neely (1999); for different country experiences see Ariyoshi et al. (2000).

[13]See, e.g., Edison et al. (2002) for a comprehensive overview of capital control measures.

**Additional Covariates**

Two different variables are considered that mirror diversification and investment opportunities. First, a correlation variable that is equal to the monthly return correlation in the four years preceding year $t$ is added, $rcorr_{ij,t}$. If diversification motives matter for investors' investment decisions, countries hold a higher portfolio share of those foreign assets whose stock returns are only weakly correlated with domestic stock returns.

Second, GDP growth for the country of destination is included, $gdpgrowth_{j,t}$. Again this variable is averaged across the four years preceding year $t$ in order to avoid business cycle effects.[14] High GDP growth in the foreign country $j$ mirrors profitable investment opportunities that emerge in booming economies. This is an implication of standard growth theory. Emerging countries in South-east Asia in the 1990s that experienced booming economies and large capital inflows at the same time constitute a well-known example of this relationship.

### 3.2.3 Data

So far, reliable bilateral holdings data has hardly been available except for the results of some smaller surveys of residents' portfolio holdings such as for the U.S. in 1994 and 1997. The present work is based on cross-country equity holdings obtained from the *Coordinated Portfolio Investment Survey* (CPIS) of the International Monetary Fund (IMF). For the first time this data set includes comparable portfolio holdings data from as many countries around the world as possible. The survey has been undertaken in 1997 with 29 countries only. Since 2001 yearly waves are undertaken including 64 countries. Data for 1997 and 2001 is used in this study. The availability of several other variables limits the number of countries in the present sample to 38 in 2001. Table 3.2 lists all countries by regions.

The CPIS data refers to end of year numbers and includes, among other things, information on gross bilateral foreign equity holdings, securities and, for some countries, separately reported liabilities. Foreign equity holdings entail cross-border investment from all sectors: monetary authorities, general government, banks and other financial intermediaries, nonprofit organizations, and households.[15] The greatest difficulty consists in capturing cross-border investments by households. The IMF provides the definitions and concepts,[16] whereas the data is organized by domestic statistical institutions as each country should take account of its own particular financial structure and circumstances. There are some differences in reporting equity

[14] Alternatively, seven and ten year averages have been considered. However, results do not change.

[15] Note that equity investment that establishes a direct investment relationship is excluded from the CPIS. See the definition in the IMF's Balance of Payments Manual, fifth edition (BPM5) and the IMF's Coordinated Portfolio Investment Survey Guide.

[16] These have to be in conformity with the BPM5.

holdings between the 1997 and 2001 waves. In 1997 the distinction between unavailable and zero was not made. Therefore, the two years are treated separately in the estimations.

The CPIS data is used in order to calculate actual portfolio shares of country $j$'s assets held in country $i$. Note that country $i$ refers to the residence of the holder of the security and country $j$ refers to the residence of the issuer of the security. Appendix B explains in detail how $W_{ij,t}^{act}$ is calculated from the observations of bilateral cross-country portfolio holdings.

Information on countries' total market capitalizations is taken from the World Development Indicators (WDI, 2002) and the International Federation of Stock Exchanges (FIBV).[17] An alternative measure of market capitalizations, the liquidity adjusted float portfolio share, can be found in Dahlquist et al. (2003). Data on GDP growth is obtained from WDI (2002).

Table 3.2: Countries and regions

| | | |
|---|---|---|
| *South America* | *South-east Asia* | *Northern Europe* |
| Argentina | Indonesia | Denmark |
| Brazil | Malaysia | Finland |
| Chile | Philippines | Ireland |
| Colombia | Singapore | Norway |
| Venezuela | Thailand | Sweden |
| | | United Kingdom |
| *North America* | *Oceania* | *Western Europe* |
| Canada | Australia | Austria |
| United States | New Zealand | Belgium |
| | | France |
| *West Asia* | *Eastern Europe* | Germany |
| Israel | Hungary | Netherlands |
| Turkey | Poland | Switzerland |
| *East Asia* | *Southern Europe* | *Northern Africa* |
| Hong Kong | Greece | Egypt |
| Japan | Italy | |
| Korea, Rep. Of | Portugal | |
| | Spain | |

[17]The availability of stock market measures limits the amount of countries in the present sample to 38.

In order to measure information frictions, the physical distance between countries' capital cities and alternatively the fact of two countries sharing a common border is used. Moreover, a dummy variable is added that is equal to one if two countries have a common colonial background. All data are based on the CIA factbook[18] and are obtained from Frankel, Stein and Wei (1995). A dummy variable, based on La Porta et al. (1998), is included that is equal to one if both countries belong to the same legal family. The amount of domestic credit provided by the banking sector relative to GDP, obtained from WDI (2002), is used to proxy the degree of financial market development.

Capital controls are taken account of by using an updated index by Grilli and Milesi-Ferretti (1995) based on the IMF's AREAER. The capital control data refers to the home country as well as to the country of destination. Unfortunately, the data does not allow a clear separation of restrictions on inflows or outflows. Thus, the same indicator, $restrict_{i,t}$ and $restrict_{j,t}$ respectively, is included for both countries.

In 1997 as well as in 2000/01 there have been several banking crises, for example in Thailand, Malaysia and Turkey. This is taken into account by a dummy variable that is equal to one if a banking crisis as documented in Caprio and Klingebiel (2003) happened in the relevant or precedent year.

In order to calculate return correlations $rcorr_{ij,t}$, standard national stock market indices by Morgan Stanley Capital International (MSCI) are used.[19] The regional classification of the countries is shown in Table 3.2. It is based on the UN geographical region division[20] and used to construct region dummies.

For more detailed information on variable definitions and sources refer to Table 3.10 in Appendix A.

### 3.2.4 Estimation Issues

In several cases reported investments are zero. These corner solution outcomes are likely due to an investor's optimization in a world with investment barriers which results in an optimal outcome of zero foreign equity holdings. Consequently, $W_{ij,t}^{act}$ is zero. For all other observations the dependent variable is positive and continuous. Therefore, a corner solution model is estimated. In the context of this study, partial effects of $W_{j,t}^{*}$, $C_{i,t}$, $C_{j,t}$ and $C_{ij,t}$ on $E(W_{ij,t}^{act}|W_{j,t}^{*}, C_{i,t}, C_{j,t}, C_{ij,t})$ are of interest. Note that these marginal effects refer to the full sample including zero *and* positive values. They are obtained by estimating a Tobit model censored at zero and by calculating average adjustment factors for the coefficients of the Tobit regression. All tables in this paper report these marginal effects instead of estimated coefficients.[21]

[18] See www.cia.gov/cia/publications/factbook/.

[19] For all available countries the gross index including dividend payments in U.S. dollars is used.

[20] See http://unstats.un.org/unsd/methods/m49/m49region.htm.

[21] See Wooldridge (2002), Chap. 16 pp. 521-524, for the derivation of the adjustment factor.

The corner solution model can be applied to the CPIS data for 2001, but not immediately to the 1997 wave, because - as mentioned in Section 3.2.3 - in 1997 zeros refer to both true zeros and missing values. In order to provide comparability across regressions for each year and to validate a Tobit estimation approach for the 1997 data, missing values are imputed by using the information of the 2001 wave: A Probit model fitting the probability of a missing or a zero entry given the explanatory variables mentioned above is estimated for 2001. The estimation output is reported in Table 3.3. The estimated coefficients are used to estimate the probability of a zero or missing value for 1997. If the probability of a missing is larger than one half, the reported zero is changed into a missing value.

Table 3.3: Probit estimates of missing values in 2001

| | | | |
|---|---|---|---|
| $W^*_{j,t}$ | 0.02 | $rcorr_{ij,t}$ | -0.186 |
| | (0.93) | | (0.64) |
| $logdistance_{ij}$ | -0.067 | $gdpgrowth_{ij}$ | -1.405 |
| | (0.66) | | (0.20) |
| $samelegor_{ij}$ | 0.681 | $bankcrisis_i$ | -0.523 |
| | (4.10)*** | | (3.26)*** |
| $logdcredit_{i,t}$ | -0.223 | $bankcrisis_j$ | -0.095 |
| | (2.40)** | | (0.56) |
| $logdcredit_{j,t}$ | 0.043 | $constant$ | 2.049 |
| | (0.42) | | (1.78)* |
| $restrict_{i,t}$ | -0.094 | $No.\ of\ obs.$ | 433 |
| | (0.93) | $LL$ | -239.46 |
| $restrict_{j,t}$ | -0.061 | $adj.\ R^2$ | 0.08 |
| | (0.68) | | |

*Notes:* The dependent variable is equal to one if there exists a missing value and equal to zero if there is a zero value in 2001. Absolute values of $t$ statistics are reported in parentheses. All regressions include region dummies for country $i$ and $j$ in order to account for region-specific fixed effects.

## 3.3 International Equity Portfolios: Composition and Determinants

In a first step, descriptive statistics of the composition of international equity portfolios and the extent of the home bias at the aggregate country level are presented. It serves to give a first comparison of bilateral portfolio shares in the data and optimal portfolio shares as predicted by the traditional version of the ICAPM under

the assumption of perfect capital markets. In a second step, multivariate analysis are undertaken as described in Section 3.2.1. The results provide insights into the determinants of international equity portfolios.

### 3.3.1 Bilateral Friendship Bias versus Bilateral Home Bias

For all countries around the world with existing stock markets, a home bias in equities with respect to total home versus foreign investment can be observed. Table 3.1 in Section 3.1 presents an overview of this home bias for some selected countries.

In contrast to a home bias referring to total home versus foreign investment, one can also observe a home bias at the bilateral country pair level. A bilateral home bias indicates that investors hold - compared to the traditional version of the International Capital Asset Pricing Model (ICAPM) - too little of their portfolio in foreign equities of a given country. For the U.S. this bilateral home bias is existent for all country pairs and has been amply discussed in the literature (e.g. Tesar and Werner (1995), and Ahearne, Griever and Warnock (2004)). However, for certain country pairs, especially within the EMU, one can observe a bilateral 'friendship bias'. It states that the actual equity portfolio share, $W_{ij,t}^{act}$, is larger than the one predicted by the ICAPM under the assumption of perfect capital markets, $W_{j,t}^{*}$. Table 3.4 documents the predicted and the actual shares. Bold numbers refer to country pairs with a bilateral friendship bias.

In most cases within the EMU this relationship is reciprocal, i.e., it is observed for the country pair Austria-Germany and at the same time for the country pair Germany-Austria. The number of country pairs with a friendship bias has increased substantially from 1997 to 2001. Moreover, the friendship bias has been persistent over the years: for almost all country pairs with a friendship bias in 1997 one can also observe a friendship bias in 2001. The fact that most country pairs with a friendship bias in the present data sample are part of the EMU might indicate that this phenomenon is related to the large extent of enhanced financial integration and development within the EMU. Also historical and cultural linkages might be an explanation. The results of the multivariate analysis that are discussed in the following section will shed light on the actual determinants of international portfolio holdings.

### 3.3.2 Determinants of International Equity Portfolios

Main estimation results for the years 1997 and 2001 are summarized in Tables 3.5 and 3.6. In the first specification, market capitalization of country $j$, $W_{j,t}^{*}$, is the only explanatory variable entering the regression. Subsequently, the introduced proxies for capital market frictions are added one after the other.[22]

[22]Further robustness checks have been undertaken by excluding single countries from the sample in order to test whether major financial centers such as the U.K., Ireland and the U.S. drive the

Table 3.4: Equity portfolio shares invested within the EMU (in percent)

| country$_j$ | predicted shares ($W^*_{j,t}$) | actual shares invested in country $j$ by investing country $i$ ($W^{act}_{ij,t}$) | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Austria | Belgium | Finland | France | Germany | Greece | Ireland | Italy | Netherl. | Portugal | Spain |
| *2001* | | | | | | | | | | | | |
| Austria | 0.09 | | **0.12** | 0.00 | 0.01 | **0.09** | 0.00 | 0.06 | 0.05 | **0.09** | *) | 0.00 |
| Belgium | 0.06 | **0.47** | | 0.03 | **0.57** | **0.17** | 0.01 | **0.32** | **0.10** | **1.18** | **1.49** | **0.16** |
| Finland | 0.70 | **0.79** | **1.79** | | 0.47 | **1.16** | 0.01 | **0.90** | 0.48 | **0.97** | 0.19 | 0.33 |
| France | 4.31 | 2.56 | **17.33** | 1.63 | | 4.01 | 0.08 | **5.38** | 2.48 | **4.44** | 0.99 | 1.86 |
| Germany | 3.93 | **14.22** | **4.80** | 1.04 | 2.06 | | 0.07 | **5.26** | 2.00 | 3.59 | 1.00 | 1.56 |
| Greece | 0.32 | 0.11 | 0.05 | 0.01 | 0.01 | 0.01 | | 0.07 | 0.02 | 0.06 | *) | 0.01 |
| Ireland | 0.28 | **1.33** | **2.71** | **0.62** | **0.65** | **0.91** | 0.03 | | **2.20** | **0.34** | 0.15 | 0.24 |
| Italy | 1.93 | 0.48 | **2.24** | 0.32 | 0.96 | 1.10 | 0.02 | **2.56** | | 1.90 | 0.74 | 1.23 |
| Netherl. | 1.68 | **3.04** | **9.84** | 1.22 | **2.36** | **2.71** | 0.04 | **4.15** | **2.01** | | 0.56 | 0.72 |
| Portugal | 0.17 | 0.16 | 0.21 | 0.01 | 0.05 | 0.06 | 0.00 | 0.17 | 0.10 | 0.10 | | 0.22 |
| Spain | 1.72 | 0.63 | **2.71** | 0.28 | 0.99 | 1.18 | 0.02 | 1.73 | 0.63 | **1.82** | **2.26** | |
| *1997* | | | | | | | | | | | | |
| Austria | 0.15 | | 0.03 | 0.02 | 0.03 | | | 0.06 | 0.10 | 0.14 | 0.03 | 0.00 |
| Belgium | 0.59 | 0.39 | | 0.10 | 0.35 | | | 0.05 | 0.10 | 0.30 | 0.22 | 0.05 |
| Finland | 0.32 | 0.06 | 0.14 | | 0.07 | | | 0.29 | 0.04 | 0.13 | 0.00 | 0.02 |
| France | 2.90 | 0.89 | 1.74 | 0.36 | | | | 2.04 | 1.70 | 1.66 | 0.30 | 0.81 |
| Germany | 3.55 | **5.82** | 1.05 | 0.33 | 1.15 | | | 2.60 | 1.01 | 2.61 | 0.37 | 0.77 |
| Greece | 0.15 | 0.00 | 0.08 | 0.00 | 0.04 | | | 0.04 | **0.39** | 0.01 | 0.00 | 0.02 |
| Ireland | 0.21 | **0.30** | **1.17** | 0.00 | **0.23** | | | | **0.30** | 0.03 | 0.14 | 0.02 |
| Italy | 1.48 | 0.45 | 0.19 | 0.08 | 0.71 | | | 1.00 | | 0.46 | 0.09 | 0.09 |
| Netherl. | 2.02 | 1.68 | **3.54** | 0.36 | 1.55 | | | 1.91 | 0.74 | | 0.33 | 0.18 |
| Portugal | 0.17 | 0.02 | 0.03 | 0.01 | 0.07 | | | 0.16 | 0.04 | 0.03 | | 0.05 |
| Spain | 1.25 | 0.10 | 0.52 | 0.09 | 0.50 | | | 0.63 | 1.15 | 0.61 | 0.59 | |

*Notes:* Bold numbers refer to a friendship bias; *) observation $< 0$ that has been deleted from the sample; $W^*_{j,t}$ denotes country $j$'s share in world market capitalization; $W^{act}_{ij,t}$ refers to the observed equity portfolio share invested in country $j$ by country $i$; for 1997 there is no information of German or Greek equity holdings available; Own calculations based on CPIS by the IMF for 2001, WDI (2002) and FIBV.

The marginal effect of $W^*_{j,t}$ on actual portfolio shares is highly significant but very low in size, namely equal to 0.05 in 1997 and 0.09 in 2001. The size does not change in the subsequent regressions when additional variables enter. Noticeable, for a large cross section of countries the market portfolio share, $W^*_{j,t}$, which - in the traditional ICAPM under the assumption of perfect capital markets - just equals the portfolio share invested in country $j$ for each country $i$, does hardly explain the actual share of foreign investment in country $j$, $W^{act}_{ij,t}$.

### Information Asymmetries

Differences in accounting standards, disclosure requirements and regulatory environments across countries lead to information asymmetries between local and foreign investors. Foreign investors have to translate and interpret this information in light of the relevant legal conventions and business culture which leads to additional costs.

Information frictions proxied by $logdistance_{ij}$ and $samelegor_{ij}$ have highly significant and large coefficients. A one percent increase in geographical distance between two countries leads on average to a decrease in the portfolio share of equity holdings of about 0.16 percentage points in 1997 and 0.29 in 2001 (Tables 3.5 and 3.6, specification (2)). If both countries have the same legal origin, the share of foreign equity holdings is on average about 0.24 higher in 1997 and even larger in 2001, namely equal to 0.43. When $colony_{ij}$ is used instead of $samelegor_{ij}$ (specification (3)), the effect is even larger: If both countries have a common colonial background, the marginal effect amounts to 0.40 in 1997 and in 2001 to 0.62.[23] Overall, the results emphasize the importance of information frictions as determinants of international equity portfolios.

### Financial Market Development

The second group of indirect capital market frictions refers to the degree of financial market development. Two alternative measures of financial development are considered: the relative size of the banking sector and the relative size of the equity market. They proxy different angles of financial market development but are positively correlated with each other. Moreover, the float portfolio share, $W^{float}_{j,t}$, is included instead of the market portfolio share, $W^*_{j,t}$, in order to exclude non-liquid equity shares.

Financial development of the banking sector in the source country $i$ as well as in the country of destination $j$ is proxied by the corresponding ratios of private credit

results. These additional regressions are not reported in the following, because results did not change. However, they can be obtained from the author upon request.

[23] Likewise, $logdistance_{ij}$ can be interchanged with a dummy variable equal to one if two countries are part of the same region or share a common border. The results can be obtained from the authers upon request.

Table 3.5: Main regression results, 1997

| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
|---|---|---|---|---|---|---|---|---|
| $W^*_{j,t}$ | 0.049 | 0.049 | 0.049 | 0.047 | | 0.047 | 0.047 | 0.047 |
| | [14.51]*** | [15.25]*** | [15.45]*** | [14.66]*** | | [14.62]*** | [14.64]*** | [14.74]*** |
| $logdistance_{ij}$ | | -0.156 | -0.153 | -0.163 | -0.164 | -0.165 | -0.163 | -0.175 |
| | | [6.26]*** | [6.20]*** | [6.56]*** | [6.56]*** | [6.63]*** | [6.47]*** | [7.02]*** |
| $samelegor_{ij}$ | | 0.251 | | 0.235 | 0.232 | 0.237 | 0.237 | 0.223 |
| | | [5.59]*** | | [5.22]*** | [5.13]*** | [5.27]*** | [5.27]*** | [5.02]*** |
| $colony_{ij}$ | | | 0.404 | | | | | |
| | | | [6.88]*** | | | | | |
| $logdcredit_{i,t}$ | | | | 0.239 | 0.240 | 0.189 | 0.194 | 0.116 |
| | | | | [3.43]*** | [3.43]*** | [2.55]** | [2.60]*** | [1.54] |
| $logdcredit_{j,t}$ | | | | 0.072 | 0.076 | 0.071 | 0.081 | 0.07 |
| | | | | [1.09] | [1.15] | [1.08] | [1.18] | [1.04] |
| $logmcap_{i,t}$ | | | | 0.064 | 0.064 | 0.038 | 0.030 | 0.034 |
| | | | | [1.44] | [1.43] | [0.81] | [0.60] | [0.69] |
| $logmcap_{j,t}$ | | | | 0.078 | 0.077 | 0.084 | 0.074 | 0.088 |
| | | | | [2.01]** | [1.97]** | [2.07]** | [1.64] | [1.98]** |
| $W^{float}_{j,t}$ | | | | | 0.038 | | | |
| | | | | | [14.38]*** | | | |
| $restrict_{i,t}$ | | | | | | 0.106 | 0.106 | 0.091 |
| | | | | | | [1.87]* | [1.86]* | [1.62] |
| $restrict_{j,t}$ | | | | | | -0.017 | -0.019 | -0.019 |
| | | | | | | [0.50] | [0.55] | [0.55] |
| $rcorr_{ij,t}$ | | | | | | | 0.057 | -0.009 |
| | | | | | | | [0.53] | [0.08] |
| $gdpgrowth_{j,t}$ | | | | | | | | 0.066 |
| | | | | | | | | [5.50]*** |
| *No. of obs.* | 900 | 900 | 900 | 900 | 900 | 900 | 900 | 900 |
| *adjm. factor* | 0.51 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 |
| *adj.* $R^2$ | 0.17 | 0.2 | 0.21 | 0.21 | 0.21 | 0.22 | 0.22 | 0.23 |

*Notes:* Dependent variable for all specifications: $W^{act}_{ij,t}$; Tobit estimation of a corner solution model. Reported coefficients are marginal effects corrected by an adjustment factor as reported in Section 3.2.4. Absolute values of $t$ statistics are reported in parentheses. Region dummies for the country of origin and the country of destination, dummies for banking crises in the country of origin and the country of destination, as well as a constant are included but not reported.

Table 3.6: Main regression results, 2001

| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
|---|---|---|---|---|---|---|---|---|
| $W^*_{j,t}$ | 0.087 | 0.087 | 0.086 | 0.085 | | 0.085 | 0.085 | 0.084 |
| | [13.88]*** | [14.29]*** | [14.40]*** | [13.45]*** | | [13.42]*** | [13.42]*** | [13.67]*** |
| $logdistance_{ij}$ | | -0.285 | -0.271 | -0.292 | -0.292 | -0.292 | -0.277 | -0.288 |
| | | [5.45]*** | [5.26]*** | [5.61]*** | [5.59]*** | [5.61]*** | [4.64]*** | [4.98]*** |
| $samelegor_{ij}$ | | 0.432 | | 0.435 | 0.431 | 0.436 | 0.441 | 0.391 |
| | | [4.36]*** | | [4.42]*** | [4.37]*** | [4.43]*** | [4.46]*** | [4.08]*** |
| $colony_{ij}$ | | | 0.620 | | | | | |
| | | | [4.89]*** | | | | | |
| $logdcredit_{i,t}$ | | | | 0.241 | 0.240 | 0.244 | 0.248 | 0.299 |
| | | | | [1.77]* | [1.76]* | [1.78]* | [1.81]* | [2.25]** |
| $logdcredit_{j,t}$ | | | | -0.014 | 0.009 | -0.018 | -0.013 | -0.010 |
| | | | | [0.11] | [0.08] | [0.14] | [0.10] | [0.08] |
| $logmcap_{i,t}$ | | | | -0.149 | -0.149 | -0.149 | -0.156 | -0.212 |
| | | | | [2.40]** | [2.40]** | [2.39]** | [2.44]** | [3.38]*** |
| $logmcap_{j,t}$ | | | | 0.166 | 0.172 | 0.165 | 0.158 | 0.158 |
| | | | | [2.64]*** | [2.72]*** | [2.62]*** | [2.44]** | [2.52]** |
| $W^{float}_{j,t}$ | | | | | 0.069 | | | |
| | | | | | [13.24]*** | | | |
| $restrict_{i,t}$ | | | | | | 0.017 | 0.020 | -0.002 |
| | | | | | | [0.19] | [0.22] | [0.02] |
| $restrict_{j,t}$ | | | | | | -0.012 | -0.007 | -0.008 |
| | | | | | | [0.14] | [0.08] | [0.10] |
| $rcorr_{ij,t}$ | | | | | | | 0.050 | 0.046 |
| | | | | | | | [0.49] | [0.46] |
| $gdpgrowth_{j,t}$ | | | | | | | | 0.145 |
| | | | | | | | | [5.62]*** |
| *No. of obs.* | 899 | 899 | 899 | 899 | 899 | 899 | 899 | 899 |
| *adjm. factor* | 0.55 | 0.55 | 0.54 | 0.55 | 0.55 | 0.55 | 0.55 | 0.54 |
| *adj.* $R^2$ | 0.1 | 0.11 | 0.11 | 0.12 | 0.12 | 0.12 | 0.12 | 0.12 |

*Notes*: see Table 3.5.

provided by the financial sector relative to GDP, $logdcredit_{i,t}$ and $logdcredit_{j,t}$. For both years only the coefficient for country $i$ is significant and has a positive sign[24] (specification (4)). A one percent increase in private credit relative to GDP in the home country $i$ is associated with an increase in foreign portfolio shares of about 0.24 percentage points in 1997 and 2001. The positive effect indicates that more and better banking institutions and more liquidity in the banking sector at home - proxied by private credit relative to GDP in country $i$ - are associated with more investments in foreign markets.

Stock market capitalization in country $i$, $logmcap_{i,t}$, has no effect in 1997 and a negative effect in 2001.[25] The latter is in line with the consideration that more developed equity markets offer more diversification possibilities at home such that investors are less inclined to invest abroad. The negative marginal effect in 2001 amounts to 0.15. In contrast, stock market capitalization in country $j$, $logmcap_{j,t}$ has a positive and significant marginal effect on foreign portfolio shares which is equal to 0.08 in 1997 and 0.17 in 2001. Based on these results, investors seem to be more inclined to hold equity shares in such economies. The more developed equity markets in the foreign country $j$, the more informative are prices and investment opportunities.

All in all, the results suggest the following relationship between financial market development and foreign portfolio shares: Both, the relative size of the *banking sector* in the *investor's* country and the relative size of the *stock market* in the *issuer's* country are positively linked to foreign portfolio shares.

The effect of the float compared to the market portfolio share is slightly smaller in both years (specification (5)). In the full sample the float portfolio share does not seem to capture any further liquidity effects and thus does not provide any additional explanatory power compared to the market portfolio share, $W^*_{j,t}$.

### Capital Controls

If capital controls on incoming capital are in place, the share of foreign equity investment into that country should be lower. Again a negative effect is expected if capital controls on outgoing capital are in place. Unfortunately, the AREAER data does not allow to distinguish between incoming and outgoing capital controls. The results in Tables 3.5 and 3.6 show that capital controls have hardly any significant impact. Exceptions are specifications (6) and (7) in 1997. The existence of controls yields a weak positive effect that is significant at the 10 percent level only, meaning

[24] If stock market capitalization is excluded from specification (4), $logdcredit_{j,t}$ has a positive and significant effect on actual portfolio shares. Due to the fact that $logdcredit_{j,t}$ and market capitalization, $logmcap_{j,t}$, are positively correlated, the effect is attributed to $logmcap_{j,t}$ rather than $logdcredit_{j,t}$ once both variables enter the regression.

[25] Note that the negative sign is not influenced by the alternative financial market development measure $logdcredit_{i,t}$ and still present in a regression without $logdcredit_{i,t}$ and $logdcredit_{j,t}$.

that the existence of controls in the country of origin, $i$, is associated with a higher share of foreign equity. This result is mainly driven by Chile that experienced high shares of foreign equity holdings and capital controls in 1997.[26] Once Chile is excluded from the sample, the coefficient on $restrict_{i,t}$ turns negative in 1997.[27] Moreover, the effect vanishes in the full sample when GDP growth is added.

### Investment Opportunities and Diversification

In addition, variables mirroring investors' investment opportunities and diversification, i.e., GDP growth and return correlations respectively, are included in the regression analysis.

As specifications (7) and (8) (Tables 3.5 and 3.6) show, return correlations, $rcorr_{ij,t}$, have no significant impact. A negative effect would be consistent with a diversification motive. The tendency to find either a positive relationship or none at all is in line with other empirical studies, e.g., Portes and Rey (2005) and Aviat and Coeurdacier (2004). The finding might be driven by the common positive impact that financial integration has on portfolio shares and return correlations at the same time. According to this argument, return correlations measure the effect of increased financial integration instead of measuring diversification opportunities. One possible solution to this measurement problem would be to instrument current stock market correlation. Coeurdacier and Guibaud (2005) show that when using stock return correlation over the period of 1950-1975 as an instrument, a diversification motive can be identified. As such data is not present for the country sample used in this paper, this approach cannot be undertaken, however.

GDP growth is included for the country of destination. In booming economies that experience high GDP growth rates more promising investment opportunities are likely to be existent. In line with this consideration, GDP growth in country $j$ has a significantly positive impact in both years: A one percentage point increase in GDP growth leads to an increase in foreign equity holdings of about 0.07 percentage points in 1997 and 0.15 in 2001 (specification (8)).

### Market and Float Portfolio Shares in Different Geographical Regions

The results in Tables 3.5 and 3.6 show that coefficients on the market and float portfolio shares are very low. The float portfolio denotes the market portfolio share corrected for non-tradable shares held by large shareholders. – Do these two findings change when the impact of $W^*_{j,t}$ on $W^{act}_{ij,t}$ is analyzed for different regions and countries separately?

The size of the marginal effects of $W^*_{j,t}$ and $W^{float}_{j,t}$ differs significantly across

[26] See De Gregorio, Edwards and Valdès (2000) on the Chilean experience of capital controls in the 1990s.

[27] These results are not reported but can be obtained from the author upon request.

Table 3.7: The market portfolio share for different regions

| | 1997 | | 2001 | |
|---|---|---|---|---|
| | (9) | (10) | (9) | (10) |
| $W^*_{j,t}$ | 0.131 | 0.108 | 0.205 | 0.180 |
| | [3.55]*** | [9.37]*** | [3.29]*** | [7.21]*** |
| $(W^*_{j,t}) * samerica$ | 0.167 | | 0.068 | |
| | [0.63] | | [0.09] | |
| $(W^*_{j,t}) * namerica$ | -0.090 | | -0.127 | |
| | [2.42]** | | [2.03]** | |
| $(W^*_{j,t}) * easia$ | -0.051 | | -0.050 | |
| | [1.05] | | [0.49] | |
| $(W^*_{j,t}) * seasia$ | -0.147 | | -0.976 | |
| | [0.33] | | [0.86] | |
| $(W^*_{j,t}) * wasia$ | -0.503 | | 0.211 | |
| | [0.19] | | [0.01] | |
| $(W^*_{j,t}) * seurope$ | 0.048 | | -0.325 | |
| | [0.48] | | [0.23] | |
| $(W^*_{j,t}) * neurope$ | -0.014 | | -0.017 | |
| | [0.37] | | [0.26] | |
| $(W^*_{j,t}) * oceania$ | 0.074 | | 0.101 | |
| | [0.53] | | [0.38] | |
| $(W^*_{j,t}) * eeurope$ | -0.505 | | 1.801 | |
| | [0.03] | | [0.24] | |
| $(W^*_{j,t}) * U.S.$ | | -0.063 | | -0.096 |
| | | [5.61]*** | | [4.01]*** |
| $(W^*_{j,t}) * EMU$ | | 0.001 | | 0.119 |
| | | [0.01] | | [1.78]* |
| *No. of obs.* | 900 | 900 | 899 | 899 |
| *adjm. factor* | 0.49 | 0.49 | 0.54 | 0.54 |
| *adj.* $R^2$ | 0.24 | 0.24 | 0.13 | 0.13 |

Notes: see Table 3.5. In addition, the following variables are included but not reported: $logdistance_{ij}$, $samelegor_{ij}$, $logdcredit_{i,t}$, $logdcredit_{j,t}$, $logmcap_{i,t}$, $logmcap_{j,t}$, $restrict_{i,t}$, $restrict_{j,t}$, $rcorr_{ij,t}$ and $gdpgrowth_{j,t}$.

Table 3.8: The float portfolio share for different regions

| | 1997 | | 2001 | |
|---|---|---|---|---|
| | (9) | (10) | (9) | (10) |
| $W_{j,t}^{float}$ | 0.168 | 0.101 | 0.284 | 0.171 |
| | [3.46]*** | [9.38]*** | [3.27]*** | [7.27]*** |
| $W_{j,t}^{float} * samerica$ | 0.462 | | -0.039 | |
| | [0.80] | | [0.03] | |
| $W_{j,t}^{float} * namerica$ | -0.134 | | -0.220 | |
| | [2.76]*** | | [2.53]** | |
| $W_{j,t}^{float} * easia$ | -0.077 | | -0.113 | |
| | [1.22] | | [0.84] | |
| $W_{j,t}^{float} * seasia$ | 0.042 | | -1.070 | |
| | [0.06] | | [0.60] | |
| $W_{j,t}^{float} * wasia$ | 4.284 | | 1.677 | |
| | [0.14] | | [0.13] | |
| $W_{j,t}^{float} * seurope$ | 0.060 | | -0.449 | |
| | [0.49] | | [0.41] | |
| $W_{j,t}^{float} * neurope$ | -0.066 | | -0.122 | |
| | [1.37] | | [1.40] | |
| $W_{j,t}^{float} * oceania$ | 0.035 | | 0.043 | |
| | [0.26] | | [0.16] | |
| $W_{j,t}^{float} * eeurope$ | 1.443 | | 4.052 | |
| | [0.14] | | [0.18] | |
| $W_{j,t}^{float} * U.S.$ | | -0.066 | | -0.104 |
| | | [6.14]*** | | [4.52]*** |
| $W_{j,t}^{float} * EMU$ | | 0.019 | | 0.190 |
| | | [0.38] | | [2.22]** |
| *No. of obs.* | 900 | 900 | 899 | 899 |
| *adjm. factor* | 0.49 | 0.49 | 0.54 | 0.54 |
| *adj.* $R^2$ | 0.24 | 0.24 | 0.13 | 0.13 |
| *W-test* | $0.56^a$ | $0.05^b$ | $0.84^a$ | $0.17^b$ |
| *p-value* | [0.46] | [0.83] | [0.36] | [0.68] |

*Notes:* see Table 3.7, $^a$) refers to the Wald test with the null hypothesis: $W_j^* = W_{j,t}^{float}$; $^b$) refers to the Wald test with the null hypothesis: $(W_{j,t}^*) * EMU = (W_{j,t}^{float}) * EMU$.

regions. Tables 3.7 and 3.8 present regressions including region dummies or country dummies interacted with the market and the float portfolio share respectively. Compared to the reference region Western Europe, the marginal effect of the market portfolio share is significantly smaller for North America (Table 3.7, specification (9)). The same picture applies to the float portfolio (Table 3.8, specification (9)). In contrast, there is no significant difference between Western Europe and all other regions. Note that the marginal effect of $W^*_{j,t}$ - which corresponds to the reference region Western Europe - is larger compared to the full sample results in Tables 3.5 and 3.6: A one percentage point increase in the market portfolio share is associated with an increase in the portfolio share of 0.13 percentage points in 1997 and 0.21 in 2001.

The coefficient on the float portfolio is now larger than the one on the market portfolio share for Western Europe in 1997 and 2001 (specification (9), Table 3.8) and the EMU in 2001 (specification (10), Table 3.8). But as the Wald tests report, the null hypothesis of the coefficients on $W^*_{j,t}$ and $W^{float}_{j,t}$ being equal cannot be rejected, neither for Western Europe nor for the EMU (Table 3.8).[28] These results indicate that the float portfolio does not add any explanatory power, neither to the full sample nor to single regions.[29] The two proxies for financial development might already account for the liquidity effect measured by the float portfolio. In the next paragraph this interpretation is further underlined with regression results in a sample with EMU countries only.

### The EMU

As the EMU forms a relatively well integrated financial region, regressions are run separately for this group of countries in order to see whether the above mentioned determinants have different effects on portfolio shares.

Within the EMU an increase of $W^*_{j,t}$ by one percentage point leads to an increase of the portfolio share by 25 percentage points whereas a similar increase of $W^{float}_{j,t}$ leads to a portfolio share that is 33 percentage points higher in 1997 (Table 3.9, specifications (11) and (12)). For 2001 the average partial effects are 37 and 48 percentage points respectively. The results show a much larger effect on actual portfolio shares compared to the full sample or other regions. However, $W^{float}_{j,t}$ is not significantly larger than $W^*_{j,t}$ (see Wald test in specification (12), Table 3.9). If $W^{float}_{j,t}$ and the residual value of the market portfolio share, i.e., the difference between the market and the float portfolio share, $W^{diff}_{j,t}$, enter the regression at the same time, both are separately insignificant but jointly significant (specification (13)). This changes once the proxy for equity market development in country $j$,

[28] The coefficient corresponding to EMU is the sum of the coefficients of $W^*_{j,t}$ and of $(W^*_{j,t}) * EMU$.

[29] This stands in contrast to Dahlquist et al. (2003) who show that the coefficient on $W^{float}_{j,t}$ is larger than on $W^*_{j,t}$. However, they do not include any other proxies for financial market development in their regressions.

Table 3.9: Regression results for within-EMU investments

| | 1997 | | | | 2001 | | | |
|---|---|---|---|---|---|---|---|---|
| | (11) | (12) | (13) | (14) | (11) | (12) | (13) | (14) |
| $W^*_{j,t}$ | 0.250 | | | | 0.365 | | | |
| | [5.02]*** | | | | [3.38]*** | | | |
| $W^{float}_{j,t}$ | | 0.327 | 0.183 | 0.342 | | 0.484 | 0.148 | 0.875 |
| | | [4.93]*** | [1.04] | [2.38]** | | [3.31]*** | [0.34] | [2.63]** |
| $W^{diff}_{j,t}$ | | | 0.453 | 0.010 | | | 0.978 | -0.725 |
| | | | [0.89] | [0.02] | | | [0.81] | [0.72] |
| $logdistance_{ij}$ | -0.356 | -0.359 | -0.355 | -0.358 | -1.249 | -1.242 | -1.269 | -1.067 |
| | [3.67]*** | [3.69]*** | [3.66]*** | [3.63]*** | [5.32]*** | [5.26]*** | [5.34]*** | [4.65]*** |
| $samelegor_{ij}$ | 0.173 | 0.161 | 0.183 | 0.164 | 0.775 | 0.747 | 0.829 | 0.550 |
| | [1.47] | [1.36] | [1.53] | [1.35] | [2.51]** | [2.40]** | [2.54]** | [1.73]* |
| $logdcredit_{i,t}$ | 0.202 | 0.210 | 0.195 | 0.225 | -0.545 | -0.539 | -0.562 | -0.407 |
| | [0.83] | [0.85] | [0.80] | [0.91] | [1.14] | [1.12] | [1.17] | [0.82] |
| $logdcredit_{j,t}$ | 0.252 | 0.285 | 0.230 | 0.266 | -0.018 | 0.051 | -0.127 | 0.277 |
| | [1.04] | [1.18] | [0.93] | [1.07] | [0.03] | [0.09] | [0.22] | [0.47] |
| $logmcap_{i,t}$ | -0.110 | -0.122 | -0.103 | -0.183 | -0.662 | -0.667 | -0.655 | -0.762 |
| | [0.85] | [0.93] | [0.78] | [1.49] | [3.79]*** | [3.81]*** | [3.74]*** | [4.28]*** |
| $logmcap_{j,t}$ | 0.215 | 0.170 | 0.253 | | 0.458 | 0.422 | 0.529 | |
| | [1.60] | [1.25] | [1.54] | | [2.63]** | [2.34]** | [2.38]** | |
| $rcorr_{ij,t}$ | -0.629 | -0.575 | -0.670 | -0.364 | -0.622 | -0.600 | -0.652 | -0.380 |
| | [1.83]* | [1.68]* | [1.87]* | [1.21] | [1.63] | [1.57] | [1.69]* | [0.99] |
| $gdpgrowth_{j,t}$ | 0.056 | 0.055 | 0.058 | 0.052 | 0.207 | 0.207 | 0.210 | 0.191 |
| | [2.25]** | [2.17]** | [2.29]** | [2.04]** | [3.00]*** | [2.98]*** | [3.04]*** | [2.66]*** |
| *No. of obs.* | 81 | 81 | 81 | 81 | 89 | 89 | 89 | 89 |
| *adj. factor* | 0.73 | 0.73 | 0.73 | 0.73 | 0.72 | 0.72 | 0.72 | 0.73 |
| *adj.* $R^2$ | 0.30 | 0.30 | 0.30 | 0.29 | 0.18 | 0.17 | 0.18 | 0.16 |
| *W-test* | | 1.36 | $12.69^a$ | | | 0.66 | $5.85^a$ | |
| *p-value* | | 0.25 | $0.00^a$ | | | 0.42 | $0.00^a$ | |

*Notes:* see Table 5.1; the Wald test refers to the null hypothesis: $W^*_j = W^{float}_{j,t}$; $^a$) The Wald test refers to the null hypothesis: $W^{float}_{j,t} = W^{diff}_{j,t} = 0$.

$logmcap_{j,t}$, is left out of the regression (specification (14)). In this case, only the float portfolio share is significant. This shows that for the EMU sub-sample the float portfolio share indeed seems to capture some liquidity effects of total equity shares traded at stock exchanges if these effects are not accounted for separately by equity market development, namely $logmcap_{j,t}$.

Information frictions are still existent as shown by the large size of the coefficients of $logdistance_{ij}$ and $samelegor_{ij}$. However, the coefficient of $samelegor_{ij}$ is not significant in 1997. Banking sector development, measured as private credit provided by the financial sector, is not significant in any of the years whereas stock market development matters in 2001, again with a negative effect for country $i$ and a positive effect for country $j$. This result might point at the fact that banking sector developments within the EMU are fairly similar whereas differences in equity market development are still existent such that it matters for foreign portfolio shares.[30]

Diversification considerations seem to be existent in the EMU sample for both years: If returns are negatively correlated across countries, portfolio shares are higher. GDP growth opportunities in the country of destination, $j$, matters.

Overall, results for the EMU countries show that information frictions are very important. Results with respect to financial market development are mixed across years. Clearly, banking sector development does not matter in this sample as variation across EMU countries is very small. Moreover, the diversification considerations come out more clearly and the market portfolio share has a much larger impact compared to the full sample results.

## 3.4 Conclusion

This paper employs the IMF's *Coordinated Portfolio Investment Survey*, in order to investigate institutional determinants of international equity portfolios. While a bilateral home bias in equities can be observed for most country pairs including the U.S., the data reveal a bilateral 'friendship bias' for several other country pairs, mostly countries within the same geographical region, in particular within the EMU.

The empirical approach of the estimation analysis is based on the difference between actual equity portfolio shares and the ones predicted by the ICAPM under the assumption of perfect capital markets. This difference is used to investigate the relevance of institutional capital market frictions, such as information asymmetries, financial market development, and capital controls for portfolio holdings at the aggregate country level.

Financial market development is looked at from two different angles: equity market development and development of the banking sector. The results reveal that the

[30]Baele et al. (2004) and Adam et al. (2002) find that the equity market is less integrated among EMU countries than other market segments, which supports this interpretation.

degree of equity market development in the foreign country plays a significant positive role for foreign portfolio shares. At the same time, the development of the home banking sector is positively linked to foreign portfolio shares. For holding foreign portfolio shares, it is advantageous to have well developed home financial institutions that organize and channel these investments efficiently. Liquidity constraints due to controlling shareholders are taken into account by using an alternative float portfolio instead of the market portfolio share. However, the float portfolio share has no additional explanatory power given all other covariates. The impact of financial market development is substantial, but less important, i.e., less significant, across specifications compared to the impact of information advantages. The latter are proxied by geographical proximity and the existence of a common legal origin or, alternatively, by the existence of a common colonial background. In contrast, capital controls do not play any significant role in determining equity portfolios.

In addition, variables mirroring investors' investment opportunities such as return correlations and GDP growth are included in the regression analysis. As in other empirical studies, no relation between stock market return correlations and foreign portfolio shares can be revealed. Only within the EMU a weakly significant coefficient is found that is in line with portfolio diversification considerations. GDP growth in the foreign country is positively associated with foreign portfolio shares, which is in line with the observation that booming economies offer more promising investment opportunities.

The findings in this paper motivate future research that incorporates capital market frictions into models that simulate international investment and capital flows. Models that take this direction and explain (part of) the home bias can be found e.g. in Baxter and Jermann (1997), Obstfeld and Rogoff (2000), Heathcote and Perri (2004) or Coeurdacier (2005). However, these papers focus only on non-tradable goods or costs associated with goods trade whereas the degree of financial market development, information frictions or direct barriers to investment are not considered.

## 3.5 Outlook

As part of a broader research agenda of population aging, it is of interest to incorporate capital market frictions into an Overlapping Generations (OLG) model as employed in Chapter 2 in order to project demographically induced capital flows more realistically. So far, the model in Chapter 2 assumes perfect capital mobility. In the following, three different approaches of how to consider capital market frictions in an OLG model framework are sketched. They combine the insights of this paper with different modeling approaches. The first approach is a very direct and straight forward way of implementing capital market frictions by introducing exogenous mark-ups on returns to capital. In the second approach adjustment costs

of investment are modeled that depend on financial market development. The third approach introduces risk to the, so far, deterministic OLG model in Chapter 2.

**Exogenous Mark-ups on Returns to Capital**

In a first approach, an exogenous mark-up to the return on financial investment is introduced. This mark-up can be modeled as a proportional tax, $\tau_{i,t}$, on gross returns to investment that is specific to each country $i$ and year $t$. The dynamic maximization problem of the representative firm in the production sector then looks as follows:[31]

$$\max_{K_{i,t},L_{i,t},I_{i,t}} \sum_{t=0}^{T} \left( \frac{1}{1 + r_{i,t}(1 - \tau_{i,t})} \right)^t [Y_{i,t} - I_{i,t} - w_{i,t} L_{i,t}] \tag{3.1}$$

subject to

$$Y_{i,t} = F(K_{i,t}, L_{i,t}) \quad \text{and} \tag{3.2}$$

$$I_{i,t} = K_{i,t+1} - K_{i,t}(1 - \delta_i), \tag{3.3}$$

where $K_{i,t}$, $L_{i,t}$ and $I_{i,t}$ refer to the capital stock, the labor supply and investments in country $i$ in year $t$; $r_{i,t}$ and $w_{i,t}$ denote returns on financial investments and wages. The tax, $\tau_{i,t}$, is proportional to gross returns of financial investment, $r_{i,t}$, and enters the maximization problem through the discount factor, $\frac{1}{1+r_{i,t}(1-\tau_{i,t})}$, as the representative firm considers net returns when discounting all future profits.

The maximization problem results in the following first order condition with respect to capital:

$$r^n_{i,t} = r_{i,t}(1 - \tau_{i,t}) = (F_{K_{i,t}} - \delta_i), \tag{3.4}$$

where $r^n_{i,t}$ denotes net returns to financial investment and $F_{K_{i,t}}$ refers to the marginal product of capital. This first order condition describes the relationship between net returns, mark-ups, gross returns and the marginal product of capital in a straight forward way: Net returns on financial investment equal the marginal product of physical investment less depreciation and less the proportional tax. Market clearing on international capital markets and the assumption of perfect capital mobility require that in equilibrium net returns are the same across all countries: $r^n_{i,t} = r^n_t$.

The mark-up, $\tau_{i,t}$, can be calculated exogenously on the basis of observable taxes on capital as well as capital controls and plugged into the model. De Gregorio, Edwards and Valdès (2000) calculate such mark-ups for Chile. As pointed out in the present paper it is difficult to find quantitative information on capital controls

[31] One could also state this maximization problem in a static way. However, as for the second approach the dynamic maximization problem is needed, it is also used here. Note also that a constant interest rate overall periods is assumed here.

or on capital taxes including bilateral tax treaties for a large number of countries that could be used for such an undertaking.

There are further capital market frictions that have not been directly addressed in the present paper such as country or currency risks that can also be included in such an approach. Country risks emerge due to political or economic risks and may lead to country defaults. The dummy for banking crises in the present paper shows that such risks affect international investment (see Table 3.3). Moreover, exchange rate risks play a role in investors' decisions. Such risks are not existent among countries that form a currency union. The next chapter provides empirical evidence on how German cross-border portfolio investment increases with countries that are also part of the EMU. In addition to taxes, these risks can also be transformed into risk premia mark-ups of expected returns to capital. Frankel (1992) and Favero, Giavazzi and Spaventa (1997) show how interest rate differentials can be decomposed into currency and default risk premia. These premia can then be included in the mark-up $\tau_{i,t}$.

### Modeling Adjustment Costs of Investment

In a second approach that can be combined with the first one, proportional adjustment costs to investment can be introduced that depend on the degree of financial market development. Convex adjustment costs that are proportional to investment can be added to the model.[32] They change the firm's maximization problem in the following way:

$$\max_{K_{i,t},L_{i,t},I_{i,t}} \sum_{t=0}^{T} \left(\frac{1}{1+r_{i,t}}\right)^t [Y_{i,t} - I_{i,t} - C(I_{i,t}, K_{i,t}) - w_{i,t}L_{i,t}] \tag{3.5}$$

subject to

$$Y_{i,t} = F(K_{i,t}, L_{i,t}) \quad \text{and} \tag{3.6}$$

$$I_{i,t} = K_{i,t+1} - K_{i,t}(1-\delta_i) \quad \text{and} \tag{3.7}$$

$$C(I_{i,t}, K_{i,t}) = \frac{\Psi_{i,t}}{2}\frac{I_{i,t}^2}{K_{i,t}}, \tag{3.8}$$

where $\Psi_{i,t}$ is an adjustment cost function that is described in more detail below. The maximization problem yields the following first order condition with respect to capital:

[32] Börsch-Supan, Ludwig and Winter (2007) model a fixed adjustment factor to investment based on Hayashi (1982). The approach described in the following extends this idea in order to specify these adjustment costs in more detail such that they vary across countries and time.

$$r_{i,t} = \frac{F_{K_{i,t}} + (1-\delta_i)\Delta q_{i,t} + \frac{\Psi_{i,t}}{2}(\frac{I_{i,t}}{K_{i,t}})^2}{q_{i,t-1}} - \delta_i, \tag{3.9}$$

with $q_{i,t} = 1 + \Psi_{i,t}\frac{I_{i,t}}{K_{i,t}}$ as the Lagrangian factor of the net investment equation 3.8. It equals the total marginal costs of investment. The first order condition yields the arbitrage condition for the rate of return on financial and physical investment, which is now augmented by the introduction of adjustment costs on investment. The rate of return on financial investment has to be equal to the marginal cost of one unit of physical investment at price $q_{i,t-1}$ in each country.[33] If $\Psi_{i,t} = 0$, then equation 3.9 reduces to equation 3.4.

International investment depends positively on the degree of financial market development.[34] As discussed in Section 3.2.2, it can be proxied by the size of the capital market. The adjustment cost function,$\Psi_{i,t}$, can therefore be described as a function of the capital output ratio:

$$\Psi_{i,t} = \alpha\frac{K_{i,t}}{Y_{i,t}}, \tag{3.10}$$

The parameter $\alpha$ has to be calibrated such that the current account to output ratios in the data are matched. As costs should decrease with increased financial development $\alpha$ is expected to be positive.

### Implementing Risk

Instead of exogenously implementing currency and default risks as, for example, suggested in the first approach risk can be generated by using a stochastic instead of a deterministic growth model. Default risk depends on a country's debt level. In a stochastic model, this risk can be modeled as shocks to interest rates.[35] These shocks depend on the level of debt and lead to a risk premium on returns as described in Turnovsky (1999):[36]

[33]The right hand side of equation 3.9 describes the marginal product of capital plus capital gains on non-depreciated capital plus the reduction in marginal adjustment costs minus depreciation.

[34]Moreover, the present paper indicates that international investment depends positively on information advantages that can be proxied by geographical proximity or the fact that two countries have a common legal origin. However, these measures are both country pair specific and can therefore not be implemented in a multi-country OLG setting where all determinants are specific to the home country only. Country pair specific frictions can only be modeled as adjustment costs to investment in a three-country model with three different production sectors. Alternatively, the notion of a home bias can be introduced via individuals' preferences that depend on information advantages and familiarity. They can be proxied by geographical proximity or a common legal origin between two countries.

[35]See for example Backus, Kydland and Kehoe (1994) who built a stochastic growth model. As opposed to this approach, they implement shocks to aggregate productivity and government purchases of goods and services.

[36]Refer to p. 42ff. Note that Turnovsky's set-up refers to a deterministic model.

$$r_{i,t}(d_{i,t}) = r^*_{i,t} + w(d_{i,t}); \quad w' > 0 \tag{3.11}$$

where $d_{i,t}$ is a country's debt level; $w(d_{i,t})$ is the country specific risk premium in each period $t$ that increases with the stock of debt issued by that country. The risk premium makes foreign borrowing more costly and generates an upward-sloping supply curve of debt. In addition to default risk, exchange rate risk comes into play when goods or capital are traded internationally. This risk can be modeled as shocks to interest rates and goods prices. These shocks and their persistence depend on exchange rate determinants, i.e., economic fundamentals such as prices, interest rates, debt and output.

These three approaches of implementing capital market frictions can be divided into two different categories: Frictions can be further specified within the model (second and third approach) or modeled as exogenous mark-ups to interest rates as described in the first approach. The latter approach is more straight forward to implement in an already existing model. Moreover, no additional parameters have to be calibrated within the OLG model. However, this way of implementing frictions is more vulnerable to the Lucas-critique. Taxes, capital controls as well as exchange rate and country risks are very likely to change in the future, especially in light of the globalization process and the tendency to form regions that are financially integrated such as further enlargements of the EMU. Therefore, an endogenous determination of capital market frictions within an OLG model is more consistent with long run future projections of international capital flows.

## 3.6 Appendix A

Table 3.10: Variable descriptions and data sources

| Variable | Description and Source |
|---|---|
| $W_{ij,t}^{act}$ | actual portfolio share of country j's assets in country i's portfolio<br>*Sources: Coordinated Portfolio Investment Survey (CPIS), IMF; International Federation of Stock Exchanges (FIBV), WDI (2002) and own calculations (see Appendix B)* |
| $W_{j,t}^{*}$ | country j's stock market capitalization relative to total world market capitalization ("market portfolio share") as described in Section 3.2<br>*Source: International Federation of Stock Exchanges (FIBV), WDI (2002)* |
| $W_{j,t}^{float}$ | corresponds to $W_{j,t}^{*}$ excluding shares by controlling shareholders ("float portfolio share")<br>*Source: Dahlquist, Pinkowitz, Stulz and Williamson (2003) for 1997, the ratio of $W_{j,t}^{*}$ and $W_{j,t}^{float}$ in 1997 is used to impute the values for 2001* |
| $logdistance_{ij}$ | logarithm of physical distance between country $i$'s and $j$'s capitals<br>*Source: Frankel, Stein and Wei (1995) (www.nber.org/ wei/data/fsw1995/fsw1995.zip)* |
| $colony_{ij}$ | dummy equal to one if both countries share a common colonial past, otherwise it is zero<br>*Source: Frankel, Stein and Wei (1995) (www.nber.org/ wei/data/fsw1995/fsw1995.zip), updated with information by the original data source, CIA factbook (www.cia.gov/cia/publications/factbook/)* |
| $samelegor_{ij}$ | dummy equal to one if both countries share a common legal origin; it is distinguished between German, French, Scandinavian civil law families, the English common law and the Socialist law family<br>*Source: La Porta, de Silanes, Shleifer and Vishney (1998).* |
| $logdcredit_{i,t}$, $logdcredit_{j,t}$ | logarithm of domestic private credit provided by the banking sector relative to GDP<br>*Source: WDI (2002)* |
| $logmcap_{i,t}$, $logmcap_{j,t}$ | logarithm of stock market capitalization relative to GDP<br>*Sources: International Federation of Stock Exchanges (FIBV), WDI (2002)* |

Table continues on the next page.

| | |
|---|---|
| $restrict_{i,t}$, $restrict_{j,t}$ | index of capital flow restrictions which takes the values zero, one, two or three, depending on whether none, one, two or three of the following restrictions are in place: (i) multiple exchange rates, (ii) capital account restrictions, and/or (iii) current account restrictions are in place; (iii) is only added if (ii) exists[a] *Source: based on an update of Grilli and Milesi-Ferretti (1995)*[b] |
| $gdpgrowth_{j,t}$ | yearly GDP growth in country j averaged across four years preceding year $t$, i.e., referring to the averages in years 1993-1996 for 1997 and 1997-2000 for 2001 *Source: WDI (2002)* |
| $rcorr_{ij,t}$ | return correlations of country i's and country j's monthly stock market indices in the four preceding years *Source: standard national stock market indices, www.msci.com* |
| *samerica* | dummy variable equal to one if country $j$ is in South America[c] |
| *namerica* | dummy variable equal to one if country $j$ is in North America[c] |
| *easia* | dummy variable equal to one if country $j$ is in East Asia[c] |
| *seasia* | dummy variable equal to one if country $j$ is in South East Asia[c] |
| *wasia* | dummy variable equal to one if country $j$ is in West Asia[c] |
| *seurope* | dummy variable equal to one if country $j$ is in Southern Europe[c] |
| *neurope* | dummy variable equal to one if country $j$ is in Northern Europe[c] |
| *oceania* | dummy variable equal to one if country $j$ is in Oceania[c] |
| *eeurope* | dummy variable equal to one if country $j$ is in Eastern Europe[c] |
| *U.S.* | dummy variable equal to one if country $j$ is the U.S. |
| *EMU* | dummy variable equal to one if country $j$ is in the EMU |

[a]) Restrictions on current account have been included because current account transactions can be used to (partially) evade restrictions on capital transactions (if these are in place); [b]) I would like to thank Axel Dreher for sharing his update. [c]) For the subdivision of countries into regions see Table 3.2.

## 3.7 Appendix B

The actual portfolio share, $W^{act}_{ij,t}$, can be calculated as foreign equity holdings of country $i$ in country $j$, $equa_{ij}$, relative to country $j$'s total holdings of foreign as well as domestic equities, $equa^{tot}_{j,t} = \sum_{i=1}^{N} equa_{ji,t}$:

$$W^{act}_{ij,t} = \frac{equa_{ij,t}}{equa^{tot}_{j,t}} \tag{3.12}$$

As $equa^{tot}_{j,t}$ is not directly available from the CPIS data,[37] country $j$'s total equity holdings are calculated as follows:

$$equa_{j,t} = MCAP_{j,t} - \sum_{i=1, i\neq j}^{N} equl_{ji,t} + \sum_{i=1, i\neq j}^{N} equa_{ji,t} \tag{3.13}$$

where $\sum_{i=1,i\neq j}^{N} equl_{ji,t}$ denotes the sum of all equity liabilities of the rest of the world held in country $j$ and $\sum_{i=1,i\neq j}^{N} equa_{ji,t}$ all foreign assets of country $i$ held in the rest of the world.

[37] The data includes only foreign equity securities and no domestic securities, $equa_{jj,t}$.

# Chapter 4

# European Financial Integration and German Cross-Border Portfolio Transactions

## 4.1 Introduction

The formation of the European Economic and Monetary Union (EMU) has been the most important development affecting European financial markets in the last two decades. Starting in 1990, twelve participating countries committed themselves to remove all obstacles to financial integration.[1] Finally, eleven countries gave up their national currencies on January 1, 1999, Greece following in 2001, thereby eliminating any exchange rate risk among themselves. In order to analyze this process, three main questions are addressed in this paper: (1) How large is the effect of European financial integration and the EMU on German cross-border portfolio flows?[2] More specifically: Are portfolio transactions between Germany and EMU countries significantly larger over time compared to trade with Denmark, the UK and Sweden that have not introduced the Euro? (2) What kind of reforms or underlying country characteristics can explain (part of) this effect? (3) Are there heterogeneous responses to increased European financial market integration with respect to portfolio investment?

These research questions are of interest because learning more about the underlying factors and driving forces of financial integration helps to understand determinants of international asset trade. In the last two decades, the volume of capital flows has increased dramatically. In light of economic globalization, financial market integration is very likely to further increase over time and across countries. Espe-

[1] Austria, Belgium, Finland, France, Germany, Italy, Luxembourg, Netherlands in 1990; Ireland, Portugal and Spain in 1993, and Greece in 1998.

[2] Portfolio flows include equity, mutual funds, bonds and money market papers.

cially the investigation of question (3) sheds light on changes in German asset trade with European countries in the course of future enlargements of the EMU.

Several studies empirically investigate the impact of European financial integration on stock market returns using time-series methods (Baele (2005), Bartram, Taylor and Wang (2005), Fratzscher (2002)). There is also a growing literature on the effects of the EMU on the real economy, e.g., on goods trade (Rose and van Wincoop (2001) and Micco, Stein and Ordonez (2003)) and business cycles (e.g., Boewer and Guillemineau (2006)). In contrast, the present paper investigates the role of European financial integration and the EMU on German cross-border portfolio flows. The estimates are based on a gravity model of asset trade à la Martin and Rey (2004) using annual data on gross portfolio flows between Germany and 47 countries for the period of 1987 to 2002. As shown in the literature, the gravity framework has performed very well in explaining volumes of bilateral cross-border asset trade in earlier studies.[3] So far, it has not yet been employed to analyze the effects of European financial integration and the EMU.

Based on this approach and data, the present paper empirically describes the differences of German portfolio flows to and from EMU countries compared to the other trading partners. Gross flows mirror the volume of assets transacted on financial markets. If frictions are present ceteris paribus less asset trading is taking place. In this respect, gross flows may point at the degree of segmentation between markets. However, this measure does not have any implications for diversification across countries. The data set used refers to cross-border portfolio flows with Germany only. Panel data on bilateral portfolio flows within a broader set of countries is not yet publicly available. As Germany is economically the largest country within the EMU and accounted for 19 percent of total portfolio investment within the EMU in 2002,[4] it is a promising starting point to analyze the effects of European financial market integration.

Referring to the questions posed in the beginning, the following results are revealed in the present paper: First, there is substantially more portfolio trade between Germany and countries also participating in stage one and three of the EMU. Investigations over time show that trade with the Euro area has become more and more important. For 2002 cross-border portfolio flows between Germany and EMU countries are significantly larger compared to flows between Germany and Denmark, the UK, and Sweden which are part of the EU-15 but not of the Euro area.[5] Second, developments intertwined with the formation of the EMU such as changes in exchange rate volatility, financial market development and increased real economic integration among EMU countries have an impact on German portfolio flows. How-

[3]See, e.g., Buch (2005), Portes and Rey (2005), Portes, Rey and Oh (2001).

[4]This number is based on the *Coordinated Portfolio Investment Survey* (CPIS) issued by the IMF.

[5]Note that the sample employed in the present paper ends in 2002. It includes observations for the years 1987-2002.

ever, these factors are not able to explain the effect of the EMU on German portfolio transactions in the framework employed in this paper. Third, the EMU effect on gross portfolio flows is larger for countries with more developed banking and equity markets, and for countries with more correlated business cycles. Whether countries are more market-based or more bank-based or whether countries are geographically further away from Germany does ceteris paribus not lead to different country responses.

The paper is organized as follows: Section 4.2 reviews important results of the literature on financial market integration in Europe. In Section 4.3 the estimation approach based on a gravity model of bilateral asset trade and the data are described. Section 4.4 summarizes and discusses the empirical results which are concluded in Section 4.5.

## 4.2 Financial Market Integration in Europe - Related Literature

A number of recent papers give a broad overview of the degree of capital market integration in Europe by using different price and quantity measures of financial integration. Baele et al. (2004) present a comprehensive assessment of these measures and find a rising degree of equity market integration over time in Europe. A comparison of the European equity market with other market segments reveals that while the money market has almost fully converged after the introduction of the single currency, important barriers to international investment still remain in the equity market. The markets for government and corporate bonds as well as the credit market lie in between these two extremes. Despite being characterized by different levels of integration, all sectors have shown a marked increase in integration, underlining the hypothesis that monetary unions facilitate cross-border asset flows (Baele et al. (2004), Adam et al. (2002)).

A more indirect measure of financial market integration looks at investment savings correlations as pioneered by Feldstein and Horioka (1980). In a world of perfect capital markets the two macroeconomic variables should be independent of each other. Empirically, this is not the case - a phenomenon that is well know in the literature as the so called Feldstein-Horioka puzzle. Blanchard and Giavazzi (2002) show that the correlation between domestic saving and investment has declined over time, especially in the Euro area, suggesting higher integration in financial markets.

While the above mentioned studies give a broad and general overview of financial integration in the Euro area, other papers more specifically look at certain market segments. Pagano and von Thadden (2004) focus on the impact that the monetary union has on the markets for Euro area sovereign and private bonds. They find that primary and secondary bond markets have become increasingly integrated and that bond yields have converged dramatically during the formation of the EMU. Still

existing small yield differentials reflect differences in fundamental risk rather than persistent market segmentation. In this respect, the sequence of policy actions in the wake of the EMU removed most remaining obstacles in this market and, therefore, facilitated a huge improvement of bond market integration.

Baele (2005), Bartram, Taylor and Wang (2005) and Fratzscher (2002) focus on European equity markets. They investigate the degree of financial integration within Europe by analyzing stock market returns across countries using high frequency data and time-series methods. Baele (2005) investigates the effect of globalization and regional integration on the intensity by which global and regional market shocks are transmitted to local equity markets. He finds that the interdependence of 13 European equity markets with the US, and especially within European countries increased over the 1980s and 1990s. According to his findings, equity market development, trade integration and price stability enhance the extent of interdependence within European equity markets. Bartram, Taylor and Wang (2005) conjecture that the degree of dependence between equity markets of countries within the Euro area increased in late 1997 or early 1998 after the Euro membership had been determined and announced. Similarly, Fratzscher (2002) suggests that European equity markets have become more integrated since 1996. He also shows that reduced exchange rate uncertainty as well as monetary policy convergence of interest rates and inflation rates have been the central driving forces behind the financial integration process in Europe.

From a microeconomic perspective, Guiso, Haliassos and Japelli (2003) find that households' equity market participation has increased. They analyze the current state of equity ownership in several European countries. However, considerable country-specific differences remain, which they explain by different levels of participation costs in the Euro area. This finding suggests that there are still a number of barriers existent that need to be overcome before full integration of European equity markets will be realized.

As shown in the cited papers, financial market integration altogether increased substantially in Europe over the last two decades. Different levels of integration among financial market segments exist, though, in which still some institutional, legal and fiscal barriers remain. Integration of European equity markets increased especially in the late 1990s, but is still lower compared to other segments.

## 4.3 Data and Methodology

### 4.3.1 A Gravity Model of Bilateral Asset Trade - Empirical Framework

Martin and Rey (2004) propose a theory of asset trade based on a general equilibrium model from which a gravity equation emerges.[6] The resulting gravity equation and its intuition are similar to gravity equations in the literature on international trade in differentiated goods. The model is characterized by three key assumptions: (i) assets are imperfect substitutes, (ii) cross-border asset trade entails transaction and/or information costs, (iii) the supply of assets is endogenous. The model is made up of risk-averse agents that develop an optimal number of Arrow-Debreu projects. The projects correspond to different assets, which are traded on the market. Prices are determined by aggregate demand at home and in foreign countries. Agents set up more risky projects if asset prices are higher. Consequently, a country's market capitalization evolves endogenously. The model's main implication is that gross flows of asset trade between two countries depend inversely on transaction and/or information costs and proportionally on market sizes. The equation for transactions between country $i$ and country $j$, $T_{ij}$, that is the sum of purchases and sales, takes, in logarithms, the following form:

$$log(T_{ij}) \quad = \quad a_0 + a_1 log(M_i M_j) + a_2 log(\tau_{ij}). \tag{4.1}$$

$M_i$ and $M_j$ are measures for the economic masses of country $i$ and $j$. $\tau_{ij}$ denotes transaction and/or information costs that occur with asset trade. The model by Martin and Rey (2004) implies that $a_1 > 0$ and $a_2 < 0$; $a_0$ is a constant.

In empirical work, the model has proven to work very well.[7] As noted in Martin and Rey (2000) and Portes and Rey (2005), who are the first to use the present model for empirical work, one major limitation of the model, however, is its static nature. However, no dynamic theoretical models that are able to replicate the transaction volumes observed in financial data are available so far.

When going to the data, economic masses of country $i$ and $j$ are generally measured by GDP per capita.[8] In order to leave coefficients unrestricted, GDP and

[6] An empirical gravity model equation also emerges from a model by Obstfeld and Rogoff (2000) that introduces transaction costs solely in the goods market. Thereby it generates substantial amounts of home bias. See Lane and Milesi-Ferretti (2004) for an N-country extension of the Obstfeld and Rogoff (2000) model.

[7] E.g. Buch (2005) applies a gravity model to bank lending data, Portes and Rey (2005) to cross-border portfolio investment, Di Giovanni (2005) to M&A activity and Portes, Rey and Oh (2001) to corporate, government bonds and equities.

[8] Alternatively, stock market capitalization relative to GDP is used to measure market size (e.g. Portes and Rey (2005)). However, as the data employed in this paper does not only entail equity

population size of country $i$ and $j$ enter the regression in separate terms. Transaction or information costs, $\tau_{ij}$, are measured by two variables: geographical distance between country $i$ and $j$, $distance_{ij}$, and the percentage of foreigners of nationality $i$ or $j$ living in Germany, $foreigner_{ij,t}$.[9] As Portes and Rey (2005) have shown, geographical distance between two countries is a very good proxy for information costs. The variable $foreigner_{ij,t}$ depicts a proxy of familiarity and network effects between countries. It is an inverse measure of $\tau_{ij}$ and expected to have a positive influence on transactions through lower information costs, i.e., $\beta_6 > 0$. It complements the distance proxy of information asymmetries in so far as that it varies not only across country pairs but also over time. This is in line with French and Poterba (1991), who stress the importance of cultural familiarity as an explanation for international investment.

To summarize, the basic estimation equation becomes:

$$\begin{aligned} log(T_{ij,t}) &= \beta_0 + \beta_1 log(gdp_{i,t}) + \beta_2 log(gdp_{j,t}) + \beta_3 log(pop_{i,t}) \\ &\quad + \beta_4 log(pop_{j,t}) + \beta_5 log(distance_{ij,t}) + \beta_6 log(foreigner_{ij,t}) \\ &\quad + \sum_{n=7}^{N} \beta_n Z^n_{ij,t} + \epsilon_{ij,t}, \end{aligned} \tag{4.2}$$

where $i$ denotes the source or transacting country, $j$ the country invested in and $t$ time. The dependent variable, $T_{ij,t}$, is defined as country $i$'s transactions of country $j$'s portfolio investment. As derived from the theoretical model, the dependent variable and all explaining variables mentioned above enter in logarithms.[10] Additional variables, $Z^n_{ij,t}$, are included that account for time and country-fixed effects: a full set of time dummies, dummies for financial centers as well as a dummy variable describing whether a banking crisis is present in country $i$ or country $j$ in the relevant or precedent year ($crisis_{i,t}$ and $crisis_{j,t}$). $\beta_0$ is a constant and $\epsilon_{ij,t}$ is an error term, which captures all factors that have not explicitly been accounted for. In order to account for heteroscedasticity, the error term is assumed to be distributed $N(0, \sigma^2_{ij})$.

The basic specification of the gravity model described above is subsequently augmented in the following regression analysis in order to analyze different hypotheses concerning the course of European integration and its underlying driving forces. The estimation strategy is as follows: First, effects of the formation of the EMU are identified by adding dummy variables that stand for the starting point of the EMU in 1990 and the final fixation of exchange rates in 1999. Moreover, German

but also bonds, a country's GDP and population size are used as scaling variables. Anyhow, the use of stock market capitalization leads to qualitatively similar results.

[9] This variable always refers to foreigners living in Germany. Data on the percentage of Germans living in foreign countries is unfortunately very difficult to obtain.

[10] When taking the model to the data, reported zero transactions are replaced by very small values, namely 500 US Dollar. Note that the smallest reported positive transaction volume amounts to about 7 million US Dollar.

asset trade with EMU countries is investigated over time in comparison to trade with EU-15 countries that are not part of the Euro area, namely Denmark, the UK and Sweden. Second, variables that proxy financial reforms or changes and real economic integration are added in order to account for (part of) the EMU effect. Third, heterogeneous responses to increased European financial market integration are investigated by adding interaction effects with variables that measure financial market development and structure, information costs and business cycle synchronization.

In order to measure the impact of financial market integration - which is a continuous process over time - the time-series dimension is of interest. Therefore, not only standard pooled ordinary least squares (POLS) estimates but also fixed effects estimations are undertaken.[11] In this respect, the static nature of the model is a limiting assumption. Still, countries' market sizes proxied by GDP and population size are likely to explain asset transactions between countries also over time, given that shocks, new information and structural changes within countries lead to continued shifts in overall portfolio composition. However, in order to test the robustness of the estimation equation, additional regressions are undertaken: GDP growth in country $i$ and country $j$ are used as additional scaling variables.[12] The underlying hypothesis is that not the size of the market in levels generates asset demand but that changes in the size of the market lead to adjustments in international asset portfolios. This consideration is in line with the traditional Capital Asset Pricing Model (CAPM) by Sharpe (1964), Lintner (1965) and Mossin (1966) which states that portfolio shares should correspond to assets' market shares.

### 4.3.2 Data and Descriptive Statistics

This study investigates German cross-border portfolio investment. The dependent variable, $T_{ij,t}$, includes the amount of foreign purchases and sales of German portfolio assets - with $i$ referring to the foreign transacting country and $j$ to German assets - as well as the amount of German sales and purchases of foreign portfolio investment - in this case $i$ refers to Germany and $j$ to assets of the foreign country. The data in use was provided by the Deutsche Bundesbank. Portfolio investments are part of the balance of payments and include equity, mutual funds, bonds and notes as well as money-market papers.[13] The data is available for 47 countries from 1987 to 2002.[14] The period covers the three stages of the formation of the EMU from 1990 to 1999. Further financial and macroeconomic variables are necessary for the empirical analysis. Table 4.1 summarizes their definitions and sources. Summary statistics for all variables are provided in Appendix B.

[11] See Cheng and Wall (2005) for a comparison of different panel estimation methods for the estimation of bilateral goods trade.

[12] Results of these regressions and further robustness checks can be found in Appendix C).

[13] See Deutsche Bundesbank, Monthly Reports, www.bundesbank.de/volkswirtschaft/vo.php.

[14] For a list of countries see Table 4.9 in Appendix A.

Table 4.1: Variable definitions and sources

| Variable | Description |
|---|---|
| $T_{ij,t}$ | The volume of portfolio transactions refers to sales and purchases of assets from country $j$ undertaken by Germans, or sales and purchases of German assets undertaken by residents from country $i$; Portfolio investment includes equity, mutual funds, bonds and notes as well as money market papers. *Source: Deutsche Bundesbank* |
| $gdp_{i,t}$, $gdp_{j,t}$ | GDP in current US $. *Source: WDI (2004)* |
| $distance_{ij}$ | Geographical distance between capitals of country $i$ and $j$. *Source: Frankel, Stein and Wei (1995)* |
| $foreigner_{ij,t}$ | Percentage of foreigners of country $i$ or $j$ living in Germany; This variable only refers to foreigners living in Germany but not to Germans living in the foreign country $i$ or $j$. *Source: Statistisches Bundesamt* |
| $crisis_{i,t}$, $crisis_{j,t}$ | Dummy variable equal to one if a banking crisis exists in the relevant or precedent year in country $i$ or $j$ respectively. *Source: Caprio and Klingebiel (2003)* |
| $d1990_{ij,t}$ | Dummy variable equal to one since the first stage of the EMU if both countries are part of stage one of the EMU. It started in 1990 for Austria, Belgium, Finland, France, Germany, Italy, Luxembourg and the Netherlands. Ireland, Spain and Portugal followed in 1993, Greece in 1998. |
| $d1999_{ij,t}$ | Dummy variable equal to one since stage three of the EMU if both countries are part of stage three of the EMU, i.e., the fixation of the Euro exchange rate. It started in 1999 for all EMU countries except Greece that followed in 2001. |
| $dEMU_{ij}$ | Dummy variable equal to one during the whole sample period if both countries are in 2001 part of the EMU. |
| $dEUnonEMU_{ij}$ | Dummy variable equal to one during the whole sample period if one of the countries is part of the EU-15 but not part of the EMU (i.e., Denmark, the UK, Sweden). |
| $exratevol_{ij,t}$ | Exchange rate volatility between country $i$ and $j$ is calculated as the standard deviation of the mean monthly exchange rate over its mean in year $t$. *Source: IFS, own calculations* |

Table continues on the next page.

| | |
|---|---|
| $mcap_{i,t}$, $mcap_{j,t}$ | Value of listed shares for country $i$ and $j$ relative to GDP. *Sources: Demirgüc-Kunt and Levine (2001), WDI (2004)* |
| $credit_{i,t}$, $credit_{j,t}$ | Private credit by deposit money banks relative to GDP. *Sources: Demirgüc-Kunt and Levine (2001), WDI (2004)* |
| $gdpcorr_{ij,t}$ | GDP growth correlation in country $i$ and $j$ in the past 5 years, calculated as rolling windows for each year $t$. *Source: WDI (2004)* |
| $market_{i,t}$, $market_{j,t}$ | Dummy variable equal to one if a country's financial market is more market-based, and zero if it is more bank-based. *Source: Demirgüc-Kunt and Levine (2001)* |

Descriptive statistics of portfolio investments by direction of investment are presented in Table 4.2 for single years. Starting from the early 1990s, there is a very strong increase in overall portfolio investment (purchases and sales) for both directions, i.e., German assets purchased and sold by foreign countries as well as foreign assets purchased and sold by Germans. Moreover, percentage shares of portfolio investment within OECD, EU-15 and EMU countries are reported. About 98 percent of investments in either direction are undertaken with OECD countries. This share stays constant throughout the entire sample period. This is contrasted by an increase in the shares of investments with EU-15 and EMU countries.

Table 4.2: Descriptive statistics

| | 1987 | 1990 | 1993 | 1995 | 1998 | 2000 | 2002 |
|---|---|---|---|---|---|---|---|
| *German sales and purchases of foreign portfolio assets* | | | | | | | |
| (in Bn. US$) | 200.5 | 290.5 | 768.5 | 947.8 | 2,677.5 | 4,112.8 | 5,002.7 |
| *OECD (in %)* | 98.7 | 98.6 | 98.8 | 98.3 | 97.2 | 98.7 | 99.2 |
| *EU-15 (in %)* | 44.9 | 62.6 | 73.3 | 64.9 | 64.1 | 70.0 | 72.4 |
| *EMU (in %)* | 27.4 | 44.5 | 57.6 | 47.8 | 47.1 | 54.4 | 65.5 |
| *Foreign sales and purchases of German portfolio assets* | | | | | | | |
| (in Bn. US$) | 385.9 | 549.4 | 2,200.7 | 2,979.7 | 4,441.4 | 4,269.9 | 5,042.2 |
| *OECD (in %)* | 97.8 | 98.1 | 98.7 | 97.5 | 98.1 | 99.3 | 99.5 |
| *EU-15 (in %)* | 74.4 | 77.0 | 89.1 | 86.7 | 84.1 | 87.5 | 90.4 |
| *EMU (in %)* | 21.1 | 17.1 | 19.4 | 22.7 | 28.0 | 29.9 | 30.2 |

*Source:* Own calculations based on Deutsche Bundesbank

Level and timing of this increase depend on the direction of investment: The share of German investment (again purchases and sales) in EU-15 and EMU countries increases strongly in the late 1980s and early 1990s. The EU-15 share rises from 45 percent in 1987 to 72 percent in 2002. The EMU share grows even more

strongly, namely from 27 percent to 66 percent. A slightly different pattern arises for the other direction: Investment in German portfolio assets by EU-15 countries is also rising mainly in the early 1990s but less significantly: from 74 percent in 1987 to 90 percent in 2002. Investments undertaken by EMU countries increase later, in the mid-1990s, and both less dramatically, from 21 percent in 1987 to 30 percent in 2002.

Overall, the main difference between the two directions is due to a large share of foreign investment in German portfolio assets by EU-15 countries whereas the share of German sales and purchases of EMU and EU-15 portfolio assets is relatively low. This is partly driven by a large share of German portfolio assets purchased and sold by the UK due to its importance as a leading financial center. The empirical analysis accounts for this fact by including financial center dummies[15].

## 4.4 Empirical Results

First, the impact of European financial integration on German portfolio investment is investigated in general. Second, potential underlying forces driving European integration are explicitly taken into account. It is very likely that countries' responses to European financial integration differ. This issue is addressed in the last part of this section. Additional robustness checks can be found in Appendix C.

### 4.4.1 German Portfolio Investment and the EMU

The standard gravity regression equation described in Section 4.3.1 is used to identify the effect of European financial integration on portfolio investment. The effect is modeled by different dummy variables that mirror the formation of the EMU or, more generally, EMU membership. The effect of EU-15 versus EMU financial integration is disentangled and further robustness checks are undertaken.

#### The Formation of the EMU

To start with, results of the standard gravity model are compared with results in the existing literature. The coefficients of the first column in Table 4.3 are based on pooled OLS estimates with White-heteroscedasticity robust standard errors. Specification (1) includes the scaling variables, the percentage of foreigners and distance. Additional year dummies, dummies for financial centers, and dummies for financial crises in the transacting country $i$ or the country invested in, country $j$, are added

[15]Financial centers are Hong Kong, Ireland, Luxembourg, UK, Singapore and Switzerland. For each of these countries separate dummies enter that refer to country $i$ and $j$.

in all specifications but not explicitly reported.[16]

The results are consistent with earlier estimates of gravity models in the literature.[17] The distance coefficient is - as expected - negative and ranges in absolute size between 0.34 and 0.43. Portes and Rey (2005) report a coefficient around minus 0.6 estimating bilateral portfolio flows between 14 countries from 1989 to 1996. Buch (2005) considers assets and liabilities of commercial banks from five countries (France, Germany, Italy, UK and the US) for 1983 and 1999 and estimates a distance coefficient between minus 0.3 and 1.25 depending on the respective estimation sample.

The estimated coefficients of the remaining variables in specification (1) are in line with the theoretical considerations mentioned in Section 4.3.1: The coefficients of the scaling variables, $gdp_{i,t}$, $gdp_{j,t}$, $pop_{i,t}$ and $pop_{j,t}$ have the expected positive and negative effects. The percentage of people of the respective foreign country living in Germany, $foreigner_{ij,t}$, is associated with a positive effect on transactions. This result suggests that familiarity between two countries plays a role.

In addition to the scaling variables and proxies for information costs, specifications (2) to (5) include dummy variables for stage one or three of the EMU. For each specification, two estimates are reported: pooled OLS and country pair fixed effects.[18] Fixed effects capture omitted variables that are specific and constant in cross sectional units. Most of these effects are not random but deterministically associated with certain historical, political or geographical facts (Egger 2000). The pooled OLS estimator captures both the effect over time and the cross sectional effect of higher trade with EMU countries.

In the fixed effects model the coefficients on GDP and population size are not always significant and, in case of population size, yield different signs compared to the pooled OLS estimation. This may have different reasons: First, the inclusion of country pair fixed effects and year dummies may already account for a large part of the variation of these variables. Second, in the fixed effects estimation GDP and population size rather seem to influence portfolio transactions in the same direction whereas in the pooled OLS regression they do not. Third, as the sub-sample estimates in Table 4.11, Appendix C, show, effects are not as homogeneous across sub-samples as in the pooled OLS case and might therefore be even less significant in the aggregate full sample.

In specification (2) to (5), Table 4.3, the dummies for stage one and three of the EMU are highly significant. Based on these results, Germany experiences higher

[16] In order to take German reunification into account an additional dummy variable is considered. As the effect turns out to be insignificant, specifications without this additional dummy are presented in the following.

[17] Note that the $R^2$ amounts to 74 percent, which shows that the model performs very well in explaining the variation in the data.

[18] Separate country pair fixed effects for each direction are considered, i.e., country pair $ij$ is distinguished from country pair $ji$.

Table 4.3: Basic regression results I

| | (1) | (2) | (3) | (4) | (5) |
|---|---|---|---|---|---|
| $gdp_{i,t}$ | 2.209*** | 2.161*** | 0.581 | 2.192*** | 0.437 |
| | [0.069] | [0.069] | [0.375] | [0.069] | [0.374] |
| $gdp_{j,t}$ | 3.002*** | 2.953*** | 1.201* | 2.985*** | 1.028 |
| | [0.130] | [0.131] | [0.716] | [0.130] | [0.722] |
| $pop_{i,t}$ | -1.274*** | -1.244*** | -0.633 | -1.261*** | -0.377 |
| | [0.080] | [0.078] | [0.424] | [0.079] | [0.429] |
| $pop_{j,t}$ | -2.061*** | -2.031*** | 1.859** | -2.049*** | 2.157** |
| | [0.142] | [0.141] | [0.941] | [0.142] | [0.952] |
| $distance_{ij}$ | -0.429*** | -0.343*** | | -0.407*** | |
| | [0.046] | [0.054] | | [0.047] | |
| $foreigner_{ij,t}$ | 0.053*** | 0.054*** | -0.024 | 0.054*** | -0.019 |
| | [0.006] | [0.006] | [0.057] | [0.006] | [0.058] |
| $d1990_{ij,t}$ | | 0.572*** | 0.275* | | |
| | | [0.123] | [0.145] | | |
| $d1999_{ij,t}$ | | | | 0.584*** | 0.646*** |
| | | | | [0.167] | [0.130] |
| *Obs.* | 1440 | 1440 | 1440 | 1440 | 1440 |
| $R^2$ | 0.74 | 0.74 | 0.51 | 0.74 | 0.51 |
| *No. of pairs* | | | 94 | | 94 |

*Notes:* robust standard errors in brackets; dependent variable: gross portfolio flows, $T_{ij,t}$; *, **, *** denote 10%, 5% and 1% significance levels respectively; specifications (1), (2) and (4) are estimated using pooled OLS with White-heteroscedasticity robust standard errors, specifications (3) and (5) are estimated using country-pair fixed effects, $R^2$ refers to 'within' values in this case; a constant, year dummies as well as dummies for banking crises and for financial centers (Hong Kong, Ireland, Luxembourg, United Kingdom, Singapore and Switzerland) are included but not reported.

portfolio investment volumes since 1990 with countries that are also part of the first stage of the EMU. Specifications (2) and (3) suggest that ceteris paribus gross flows with EMU countries are on average more than 57 percent larger in the pooled OLS estimation and 28 percent higher in the fixed effects estimation. The third stage of the EMU is ceteris paribus associated with portfolio investments that are on average 58 percent higher in the pooled OLS and 65 percent higher in the fixed effects estimation (specifications (4) and (5)).[19]

When both dummies enter simultaneously (specifications (6) and (7), Table 4.4), the dummy for stage one is only significant in the pooled OLS estimation, whereas the coefficient of stage three is only highly significant and large in the fixed effects estimation. These results suggest that transactions increased over time especially

[19]For further robustness checks refer to Appendix C.

Table 4.4: Basic regression results II

| | (6) | (7) | (8) | (9) |
|---|---|---|---|---|
| $gdp_{i,t}$ | 2.159*** | 0.417 | 2.146*** | 2.063*** |
| | [0.069] | [0.374] | [0.069] | [0.070] |
| $gdp_{j,t}$ | 2.951*** | 1.01 | 2.940*** | 2.859*** |
| | [0.131] | [0.725] | [0.128] | [0.127] |
| $pop_{i,t}$ | -1.242*** | -0.334 | -1.234*** | -1.154*** |
| | [0.078] | [0.434] | [0.079] | [0.079] |
| $pop_{j,t}$ | -2.029*** | 2.196** | -2.023*** | -1.943*** |
| | [0.141] | [0.956] | [0.140] | [0.138] |
| $distance_{ij}$ | -0.343*** | | -0.310*** | -0.197*** |
| | [0.054] | | [0.058] | [0.064] |
| $foreigner_{ij,t}$ | 0.054*** | -0.01 | 0.053*** | 0.059*** |
| | [0.006] | [0.057] | [0.006] | [0.007] |
| $d1990_{ij,t}$ | 0.498*** | 0.155 | | |
| | [0.126] | [0.146] | | |
| $d1999_{ij,t}$ | 0.295* | 0.609*** | | |
| | [0.167] | [0.129] | | |
| $dEMU_{ij}$ | | | 0.615*** | 0.988*** |
| | | | [0.121] | [0.149] |
| $dEUnonEMU_{ij}$ | | | | 1.228*** |
| | | | | [0.158] |
| *Obs.* | 1440 | 1440 | 1440 | 1440 |
| $R^2$ | 0.74 | 0.51 | 0.74 | 0.74 |
| *No. of pairs* | | 94 | | |
| $F-test$ | | | | 5.25 |
| $p-value$ | | | | 0.02 |

*Notes:* see Table 4.3; specifications (6), (8) and (9) refer to pooled OLS with White-heteroscedasticity robust standard errors, (7) refers to country-pair fixed effects, $R^2$ refers to 'within' values in this case.

after 1999 whereas for the first stage since 1990 only cross sectional differences can be observed. As specification (8) shows, there exists also a positive level effect of enhanced portfolio flows over the entire estimation period from 1987-2002: German cross-border portfolio investment with EMU countries is on average 62 percent higher compared to trade with countries not being part of the EMU.

**EMU versus EU-15**

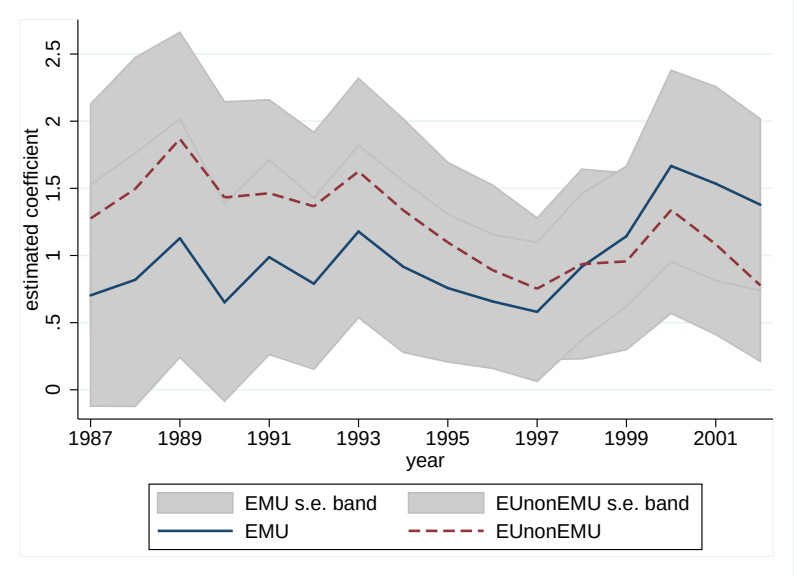
The question arises whether the results are really driven by increased integration in the wake of the EMU formation or rather by increased economic and financial

integration within all EU-15 countries. Therefore, an additional dummy for EU-15 countries that are not part of the EMU, namely Denmark, the UK and Sweden, is considered in the regression analysis, $dEUnonEMU_{ij}$.

When both the EMU dummy, $dEMU_{ij}$, and $dEUnonEMU_{ij}$ enter simultaneously the regression equation, the coefficient of $dEUnonEMU_{ij}$ is larger compared to the EMU dummy (specification (9)). The hypothesis of both coefficients being equal can be rejected at the 5 percent level, though not at the one percent level.[20] On average across the whole time period under consideration, transactions between Germany and Denmark, the UK and Sweden respectively tend to be larger compared to trade with EMU countries.

Next, these effects are estimated separately for each year. Interaction terms between the EMU dummy variable and year dummies as well as the dummy variable for EU-15 countries that are not part of the EMU and year dummies enter the regression. As stated in the *Delors Report* of 17 April 1989, the EMU was achieved in three "*discrete but evolutionary steps.*" Therefore, one expects a smooth impact of the EMU formation on financial indicators.

Figure 4.1: Estimated coefficients




*Note:* Estimated coefficients of interactions between year dummies and $dEMU_{ij}$ and $dEUnonEMU_{ij}$ respectively. Full regression results are documented in Table 4.1, Appendix C.

The estimated coefficients of the interaction terms plotted in Figure 4.1 are in line with this notion.[21] In the late 1980s, the estimated coefficients of the EMU-

[20]Refer to the documented F-test statistics in Table 4.4.

[21]Full regression results are documented in Table 4.15, Appendix C.

countries are smaller compared to the coefficients referring to Denmark, the UK and Sweden. Until 1998 the difference between the two coefficients decreases and it finally reverses. As the standard error bands show, the coefficients are always significantly different from zero, except for the EMU dummy in 1987 and 1988. F-tests reveal that the estimated yearly coefficients are significantly different from one another for the years up to 1992 and for the year 2002.[22]

The results suggest that German transactions with EMU countries are significantly lower compared to trade with Denmark, the UK and Sweden until the early 1990s. However, since the beginning of the new millennium this relationship seems to have reversed. The comparison between Euro area and non-Euro area countries suggests, that this might be due to the final step of the EMU, the abolishment of exchange rate risk. However, with one observations for 2002 only, this result is not robust but only an indication. It is left to future research using updated data to confirm or modify this indication.

### 4.4.2 Accounting for European Financial Integration

The dummy variables reflecting stage one and three of the EMU capture the effect of increased financial integration. What exactly are its driving forces? In this section, financial and real economic factors are investigated that might account for at least part of the effect.

#### Financial Factors

The introduction of the Euro has resulted in the elimination of exchange rate risk within the Euro area. The absence of exchange rate risk allows corporations to raise funds across countries with fewer constraints and costs. This can in general have a large effect on financial integration because exchange rate risk is an important source of risk priced on capital markets (e.g. Dumas and Solnik (1995) and Hardouvelis et al. (2006)). In addition, the launch of the common European currency is associated with lower costs of cross-country transactions, improved liquidity and better developed European capital markets (Fratzscher (2002) and Danthine, Giavazzi and von Thadden (2001)).

In order to investigate whether financial factors such as the abolition of exchange rate risk or financial market development and increased liquidity can explain part of the effect captured so far by the dummy variables for stage one and three of the EMU, measures for these factors are added to the regression analysis.

Exchange rate risk is measured as the standard deviation of the mean monthly bilateral exchange rate over its mean in year $t$, $exratevol_{ij,t}$. In order to account for enhanced financial development two commonly used measures are added to the

[22]F-tests are also documented in Table 4.15, Appendix C.

regression: stock market capitalization relative to GDP for country $i$ and $j$, $mcap_{i,t}$ and $mcap_{j,t}$, as well as private credit provided by the banking sector relative to GDP for country $i$ and $j$, $credit_{i,t}$ and $credit_{j,t}$.[23] The two sets of variables refer to different aspects of financial development. The relative volume of private credit mirrors the development of the private banking sector and, therefore, reflects the ability of financial institutions to carry out national as well as international capital transactions. Stock market capitalization relative to GDP reflects the size and development of a country's equity market.

These additional variables are not always available for the full sample and time period.[24] Therefore, a benchmark regression is reported that is based on the same observations but excludes the variables of interest. Then, the variables of interest are added and the coefficients of the dummy variables, $d1990_{ij,t}$ and $d1999_{ij,t}$ respectively, can be compared across regressions. In order to account for potential endogeneity, lagged values of relative stock market capitalization and credit provided by the banking sector are used.

Table 4.5 shows results of pooled OLS and of fixed effects estimations. The table documents only the estimated coefficients of interest: the first part refers to estimates of $d1990_{ij,t}$ and $d1999_{ij,t}$ respectively in a regression excluding $exratevol_{ij,t}$. The second part refers to estimates inclusive this variable. In the pooled OLS case, exchange rate volatility has a large negative influence, though only at the ten percent significance level. The coefficients on the dummy variables decrease slightly, but not significantly.[25] Also in the fixed effects estimations exchange rate volatility does not lead to significant changes of the coefficients of $d1990_{ij,t}$ and $d1999_{ij,t}$. It has again only a weakly significant negative coefficient.

Also, the inclusion of measures for financial development does not significantly alter the size of the dummy variables neither in the pooled OLS nor in the fixed effects estimations (Table 4.6). The variables themselves have the following effects in the pooled OLS regressions: Banking sector development in the transacting country, $credit_{i,t}$, is positively associated with cross-border transactions. This result is in line with the consideration that highly developed financial and banking institutions help to conduct international transactions. Stock market development at home, $mcap_{i,t}$, has a negative and much smaller influence. The finding suggests that less developed equity markets at home drive investors towards better developed foreign markets that offer more diversification and better investment possibilities. The positive coefficient on the stock market capitalization variable of the country invested in, $mcap_{j,t}$, supports this view. Countries with better developed equity markets tend to attract more portfolio transactions. In contrast, the development of the banking

[23] As an alternative measure for private credit, M2 to GDP is often used, see e.g. Chinn and Ito (2006) and Di Giovanni (2005). This variable is only available for a much smaller number of countries and years and, therefore, not considered.

[24] For the availability of variables across years refer to Table 4.10 in Appendix B.

[25] Refer to the reported F-test statistics in Table 4.5.

Table 4.5: Accounting for European financial integration I

| | *POLS* | | *F.E.* | |
|---|---|---|---|---|
| $d1990_{ij,t}$ | 0.589*** | | 0.288* | |
| | [0.124] | | [0.147] | |
| $d1999_{ij,t}$ | | 0.599*** | | 0.652*** |
| | | [0.168] | | [0.130] |
| $d1990_{ij,t}$ | 0.577*** | | 0.290** | |
| | [0.125] | | [0.147] | |
| $d1999_{ij,t}$ | | 0.594*** | | 0.646*** |
| | | [0.168] | | [0.130] |
| $exratevol_{ij,t}$ | -0.378* | -0.419* | -0.265* | -0.243 |
| | [0.228] | [0.232] | [0.157] | [0.158] |
| $Obs.$ | 1425 | 1425 | 1425 | 1425 |
| $F-test$ | 0.01 | 0.00 | 0.00 | 0.00 |
| $p-value$ | 0.92 | 0.98 | 0.99 | 0.97 |

*Notes*: see Table 4.3; $distance_{ij}$, $foreigner_{ij,t}$, $gdp_{i,t}$, $gdp_{j,t}$, $pop_{i,t}$, $pop_{i,t}$ are included but not reported. The upper part of the table refers to a regression excluding the variable of interest, the lower part to a regression inclusive the variable of interest. POLS denotes pooled OLS estimations with White-heteroscedasticity robust standard errors, F.E. refers to country pair fixed effects estimations. F-test refers to the F-test statistic of the hypothesis of equal coefficients on $d1990_{ij,t}$ and $d1999_{ij,t}$ respectively.

sector in in the country invested in, $credit_{j,t}$, has a negative effect. One reason for the strong negative effect might be the fact that the credit variable is strongly correlated with both stock market capitalization and GDP.[26]

In the fixed effects estimations only stock market capitalization in the country invested in, $mcap_{j,t}$, has a positive effect. This result suggests that over time larger and more developed capital markets lead to increased transaction volumes of assets located in these growing markets.

### Real Economic Integration

The empirical literature on real economic and financial integration has established the so called "quantity puzzle": A positive association between financial integration and GDP correlations is revealed in the data, whereas theory predicts a negative

[26]The two variables $mcap_{j,t}$ and $credit_{j,t}$ are positively correlated with a correlation coefficient of 0.75. This relation and also the estimation results point into a similar direction as findings in Berkel (2004) (see Chapter 3). Also Di Giovanni (2005) finds that countries with better developed equity markets attract more M&A activity whereas countries with better developed banking markets do not.

Table 4.6: Accounting for European financial integration II

| | *POLS* | | *F.E.* | |
|---|---|---|---|---|
| $d1990_{ij,t}$ | 0.601*** | | 0.346** | |
| | [0.130] | | [0.170] | |
| $d1999_{ij,t}$ | | 0.745*** | | 0.739*** |
| | | [0.212] | | [0.159] |
| $d1990_{ij,t}$ | 0.595*** | | 0.417** | |
| | [0.153] | | [0.171] | |
| $d1999_{ij,t}$ | | 0.782*** | | 0.784*** |
| | | [0.200] | | [0.151] |
| $credit_{i,t-1}$ | 0.853*** | 0.938*** | 0.00 | 0.066 |
| | [0.127] | [0.119] | [0.192] | [0.191] |
| $credit_{ij,t-1}$ | -0.583*** | -0.499** | 0.387 | 0.44 |
| | [0.217] | [0.208] | [0.452] | [0.449] |
| $mcap_{i,t-1}$ | -0.191*** | -0.232*** | -0.025 | -0.049 |
| | [0.072] | [0.069] | [0.078] | [0.076] |
| $mcap_{j,t-1}$ | 0.334** | 0.294** | 0.388** | 0.367* |
| | [0.145] | [0.141] | [0.190] | [0.189] |
| *Obs.* | 1159 | 1159 | 1159 | 1159 |
| $F-test$ | 0.00 | 0.04 | 0.17 | 0.09 |
| $p-value$ | 0.97 | 0.85 | 0.68 | 0.76 |

*Notes*: see Table 4.5.

relation if anything.[27] There is growing evidence that real integration among EMU members has been strengthened in terms of real business cycle synchronization and trade.[28] As both developments, real economic and financial integration, intertwine, real economic integration might account for part of the financial integration measured by the dummy variables of stage one and three.

Using the same methodology as above, GDP growth correlation is included in the regressions, $gdpcorr_{ij,t}$, as a proxy for real economic convergence (Table 4.7). In order to account for the effect that GDP growth correlations has for EMU countries, it also enters interacted with the EMU dummy, $dEMU_{ij}$.

The results of the pooled OLS regressions show that GDP growth correlations with EMU countries have a significant positive effect on transactions whereas they have no effect for the rest of the sample. In the fixed-effects case there is a weakly

[27]See Imbs (2004) and Imbs (2006) for a detailed discussion of the puzzle.

[28]Refer e.g. to Boewer and Guillemineau (2006) and Massmann and Mitchell (2004) with respect to business cycle synchronization as well as Frankel and Rose (1997) and Micco, Stein and Ordonez (2003) with respect to trade.

Table 4.7: Accounting for European financial integration III

| | *POLS* | | *F.E.* | |
|---|---|---|---|---|
| $d1990_{ij,t}$ | 0.552*** | | 0.293* | |
| | [0.122] | | [0.145] | |
| $d1999_{ij,t}$ | | 0.587** | | 0.663*** |
| | | [0.167] | | [0.130] |
| $d1990_{ij,t}$ | 0.421*** | | 0.270* | |
| | [0.140] | | [0.154] | |
| $d1999_{ij,t}$ | | 0.428** | | 0.652*** |
| | | [0.167] | | [0.128] |
| $gdpcorr_{ij,t}$ | -0.28 | -0.239 | 0.317 | 0.362* |
| | [0.173] | [0.170] | [0.194] | [0.188] |
| $gdpcorr_{ij,t} * dEMU_{ij}$ | 0.768*** | 0.945*** | 0.495* | 0.352 |
| | [0.233] | [0.233] | [0.254] | [0.242] |
| *Obs.* | 1437 | 1437 | 1437 | 1437 |
| $F-test$ | 0.87 | 0.91 | 0.02 | 0.01 |
| $p-value$ | 0.35 | 0.34 | 0.88 | 0.93 |

*Notes*: see Table 4.5

significant positive effect that is not significantly larger for EMU countries. The effect is smaller compared to the POLS estimation for EMU countries. This finding suggests that the link between real and financial integration is larger across countries than within countries over time. Moreover, the link within countries tends to be a more general phenomenon. The inclusion of GDP growth correlations leads to smaller coefficients of the stage one and stage three dummies. However, the F-test indicates that coefficients do not significantly change in size. Real integration proxied by GDP growth correlations in this empirical setting is not able to account for financial integration measured by $d1990_{ij,t}$ and $d1999_{ij,t}$.[29]

Estimated coefficients on GDP growth correlations in Table 4.7 might be biased due to endogeneity of GDP growth correlations, reflecting real economic integration, and transaction volumes, mirroring financial integration. Accounting for endogeneity would lead to a lower impact of business cycle correlations on transactions, thereby lowering also its ability to reduce the coefficients of the stage one and three dummies. As there is no significant reduction in the size of coefficients anyway, endogeneity does not affect the interpretation of the coefficients of interest on the dummy variables, $d1990_{ij,t}$ and $d1999_{ij,t}$.

Overall, none of the included variables in this section involve a decrease in the dummy variable effects measuring stage one and three of the EMU. Most strikingly,

[29]Similar results are obtained when using 10 year rolling correlations of GDP growth.

reduced exchange rate volatility does not even account for part of the effect.[30] Obviously, the effect of the formation of the EMU captures something more than is measured by the above mentioned explicit factors in this framework. As discussed in the conclusion this finding might be due to measurement or model specification issues.

### 4.4.3 Do Countries Respond Differently to the EMU?

European financial market integration and the formation of the EMU are likely to have a different impact in every country. One can easily think of differences that depend on countries' financial market development or structure and on how important costs associated with cross-border portfolio investment are. Countries with low transaction and information costs and relatively developed, efficient and large financial markets might see a large increase in gross flows induced by European financial market integration. At the same time, it is also possible that an increase in cross-border trading activity might be larger for countries starting with relatively high transactions costs as well as less developed, efficient and smaller financial markets. Ex ante, these effects are not clear. Countries can also be differentiated with respect to the extent of real economic integration. Given the results in Section 4.4.2, one expects countries with more synchronized business cycles, i.e., countries that are more integrated in real terms, to be more financially integrated in the sense that they experience larger transaction volumes.

In order to explore differences in the effect of European financial integration on portfolio investment across countries, the basic regression is expanded by an interaction term between the dummy variable for the first stage of the EMU and the variable of interest:[31]

$$\begin{aligned} log(T_{ij,t}) &= \beta_0 + \beta_1 log(gdp_{i,t}) + \beta_2 log(gdp_{j,t}) + \beta_3 log(pop_{i,t}) \\ &\quad + \beta_4 log(pop_{j,t}) + \beta_5 log(distance_{ij,t}) + \beta_6 log(foreigner_{ij,t}) \\ &\quad + \beta_7 X_{ij,t} + \beta_8 d1990_{ij,t} + \beta_9 X_{ij,t} * d1990_{ij,t} + \sum_{n=10}^{N} \beta_n Z^n_{ij,t} + \epsilon_{ij,t}, \end{aligned}$$

where $X_{ij,t}$ refers to the variable of interest. The estimated coefficient of the dummy variable for the first stage of the EMU, $\beta_8$, the effect of the interaction term, $\beta_9$, as well as the own effect of the variable of interest, $\beta_7$, are reported in Table 4.8. As heterogeneous responses of countries are of interest, only pooled OLS regressions are undertaken. First, financial market structure and development are considered as factors of interest that differentiate the EMU effect on transactions across countries.

[30] Also lagged values of exchange rate volatility and two or three year averages have been used. Results do not change.

[31] Similar results can be obtained using interactions with $dEMU_{ij}$ or $d1999_{ij,t}$.

Second, the role of information costs proxied by distance is explored. Finally, the link between the volume of transactions and real economic integration is investigated.

**Financial Market Structure and Development**

An indicator variable that equals one if a country is more market-based and zero if it is more bank-based, $market_{i,t}$ and $market_{j,t}$, is included. It is used to investigate whether economies with higher stock market or with higher banking activity respond differently. In bank-based systems, banks play a leading role in mobilizing savings and allocating capital whereas in market-based systems securities markets take the role of getting society's savings to firms, exerting corporate control and easing risk management. Demirgüc-Kunt and Levine (2001) find that financial systems tend to be more market-based in higher income countries where stock markets become more active and efficient than banks. The literature does not reveal a clear support for either the market-based or the bank-based system to perform better in attracting capital and favoring growth (Levine 2002).

In order to proxy the development of financial markets again two different measures are used for country $i$ and $j$: stock market capitalization relative to GDP and the amount of credit provided by the banking sector relative to GDP, $mcap_{i,t}$, $mcap_{j,t}$, $credit_{i,t}$ and $credit_{j,t}$.

Results in Table 4.8 show that, first, countries invested in, i.e., countries $j$, that are more market-based countries are associated with higher portfolio transactions (specification (1)). This result is consistent with the finding in Section 4.4.2 that relative stock market capitalization of country $j$ has a positive impact on portfolio transactions. However, the effect of higher transactions due to stage one of the EMU is not linked to the classification of countries into more market-based and bank-based financial markets as the interaction terms are insignificant. In this respect there is no heterogeneity among countries.

Second, transacting countries with more developed financial markets, in terms of more private credit provided by the banking sector relative to GDP, experience higher transaction volumes during stage one of the EMU (specification (2)). The same finding applies to financial development measured by stock market capitalization relative to GDP (specification (3)).[32]

[32]If both interaction effects are investigated in one single regression, the same effects can be observed. Note that the estimated coefficients on $credit_{i,t}$ and $mcap_{j,t}$ correspond very well to the estimated coefficients estimated in a joint regression (Table 4.6). Now, $mcap_{i,t}$ and $credit_{j,t}$ are insignificant and do not yield negative signs as before. This finding suggests that the negative signs are likely to be driven by positive correlations among the two variables and with GDP.

Table 4.8: Heterogenous country responses

| (1) | | (2) | |
|---|---|---|---|
| $d1990_{ij,t}$ | 0.882*** | $d1990_{ij,t}$ | 0.654*** |
| | [0.149] | | [0.173] |
| $market_{i,t}$ | -0.237 | $credit_{i,t-1}$ | 0.831*** |
| | [0.146] | | [0.096] |
| $market_{j,t}$ | 0.969*** | $credit_{j,t-1}$ | -0.171 |
| | [0.178] | | [0.209] |
| $d1990_{ij,t}$ * $market_{i,t}$ | -0.185 | $d1990_{ij,t}$ * $credit_{i,t-1}$ | 0.882*** |
| | [0.222] | | [0.238] |
| $d1990_{ij,t}$ * $market_{j,t}$ | -0.157 | $d1990_{ij,t}$ * $credit_{j,t-1}$ | 0.11 |
| | [0.234] | | [0.257] |
| (3) | | | |
| $d1990_{ij,t}$ | 1.197*** | | |
| | [0.246] | | |
| $mcap_{i,t-1}$ | 0.042 | | |
| | [0.067] | | |
| $mcap_{j,t-1}$ | 0.317*** | | |
| | [0.123] | | |
| $d1990_{ij,t}$ * $mcap_{i,t-1}$ | 0.284** | | |
| | [0.123] | | |
| $d1990_{ij,t}$ * $mcap_{j,t-1}$ | 0.157 | | |
| | [0.120] | | |
| (4) | | (5) | |
| $d1990_{ij,t}$ | 0.032 | $d1990_{ij,t}$ | 0.347** |
| | [0.640] | | [0.149] |
| $distance_{ij}$ | -0.393*** | $gdpcorr_{ij,t}$ | -0.204 |
| | [0.060] | | [0.166] |
| $d1990_{ij,t}$ * $distance_{ij}$ | 0.085 | $d1990_{ij,t}$ * $gdpcorr_{ij,t}$ | 0.630** |
| | [0.088] | | [0.252] |

*Notes*: Pooled OLS regressions with White-heteroscedasticity robust standard errors in brackets; dependent variable: gross portfolio flows, $T_{ij,t}$; *, **, *** denote 10%, 5% and 1% significance levels; a constant, year dummies, dummies for financial centers, $distance_{ij}$, $foreigner_{ij,t}$, $gdp_{i,t}$, $gdp_{j,t}$, $pop_{i,t}$, $pop_{i,t}$, and dummies for banking crises are included but not reported.

### Distance

Information costs proxied by distance play a major role when explaining volumes of portfolio investment in gravity models. Portes and Rey (2005) document that geographical distance presents a good proxy for these costs. The question arises of whether countries closer to Germany are associated with a larger increase in transaction volumes in the wake of the formation of the EMU compared to countries further away. The results in Table 4.8, specification (4) suggest that there is no difference in the positive effect of the first stage of the EMU on transactions with respect to distance.

### Real Economic Integration

Results in Table 4.8, specification (5), show that countries participating in stage one of the EMU and countries having higher GDP growth correlations ceteris paribus experience larger portfolio investment compared to the rest of the sample. If larger portfolio investment signifies increased financial integration, it can be concluded that increased financial integration is associated with increased business cycle synchronization for EMU countries. This finding is in line with the "quantity puzzle" documented in the recent empirical literature on real integration.[33] Imbs (2004) shows that business cycles in financially integrated regions are significantly more synchronized, even though financial integration may also result in more specialized economies, and consequently less synchronized cycles.

## 4.5 Conclusion

Although there is a growing literature on the effects of the EMU on different segments of financial markets, no comprehensive empirical analysis of the effects on portfolio asset trade using a gravity model approach has yet been undertaken. This paper not only investigates the increase in gross portfolio flows induced by European financial market integration and the EMU but also potential underlying driving forces and the heterogeneity of responses to European financial integration.

The estimations indicate that there is a substantial increase in gross portfolio flows with Germany since the first and the third stage of the EMU. The latter marks the fixation of exchange rates with the Euro. The estimations indicate that ceteris paribus gross portfolio flows increased on average by about 60 percent for countries taking part in the third stage. These are time series effects remaining after country pair fixed effects have been taken into account. As has been shown, the positive effect induced by the formation of the EMU evolves smoothly over time. Since the

[33] Again one has to be aware of the fact that real economic and financial integration are likely to be interdependent in both directions. However, this section aims at characterizing country responses and does not draw conclusions about causality.

end 1990s it increases relative to a group of countries including Denmark, the UK, and Sweden that are part of EU-15 but not of the Euro area. In 2002 it seems to be significantly larger for EMU countries compared to Denmark, the UK, and Sweden. Though it is left to future research using updated data to confirm whether this finding is indeed robust.

The formation of the EMU is intertwined with changes in financial markets and real economic integration. In a second step, this paper examines to what extent these developments account for the estimated positive effect measured by dummy variables. Lower exchange rate volatility, higher financial market development, and increased business cycle correlations have significant effects on gross portfolio flows. However, they are not able to account for the positive effect induced by the formation of the EMU.

In the third part of the empirical analysis of the present paper, the coefficients of the dummies for different stages of the EMU are forced to be equal across countries. This paper also analyzes factors that lead to heterogeneous country responses. The EMU effect on gross portfolio flows is larger for transacting countries with more developed banking and equity markets and country pairs with more correlated business cycles. The latter result is in line with other empirical studies investigating real economic and financial integration (Boewer and Guillemineau (2006), Imbs (2006), and Imbs (2004)). There are no differences in countries' responses to the EMU depending on geographical distance to Germany or on whether countries are more market-based.

The gravity model is a useful approach to empirically reveal and describe the differences of German portfolio flows with EMU countries compared to the other trading partners. It does not explain the effects of a common currency union on asset trade, though. The present empirical analysis can not sufficiently reveal, which factors actually account for the EMU effect on portfolio flows measured by dummy variables for different stages of the EMU. On the one hand, this finding can be due to measurement problems. One would expected that at least exchange rate risk explains part of the EMU effect. However, it is very difficult to effectively measure *expected* exchange rate risk at an annual frequency. On the other hand, these insignificant results might be comparable to the pessimistic "Nothing is Robust" in the growth literature (Levine and Renelt 1992). Similar to the set up in this paper, growth theories are not explicit about what variables belong in the regression. When simply trying and adding variables, results may turn out to be inconclusive and not robust. As Sala-i-Martin (1997) suggests, using alternative and less restrictive means of testing the relationship between variables by modeling whole distributions of estimators may nevertheless yield strong and meaningful relationships between variables.

As far as known by the author, no theoretical model yet exists in the literature that structurally links the formation of currency unions and asset trade and that provides testable empirical hypotheses. In line with the methodology stated in

Deaton (2000),[34] this lack of theory motivates the descriptive characterization of the effects of the EMU in the present paper. Based on the results, it is desirable to advance future theoretical and related empirical research that clarifies the channels through which a common currency union, e.g., the EMU, affects asset trade, financial and real economic integration.

## 4.6 Appendix

### 4.6.1 Appendix A - Countries by Regions

Table 4.9: Countries by regions

| | | |
|---|---|---|
| *Western Europe* | *Southern Europe* | *Eastern Asia* |
| Belgium | Greece | Japan |
| France | Italy | Korea |
| Luxembourg | Portugal | China |
| The Netherlands | Spain | |
| Austria | | *South-central Asia* |
| Switzerland | *Northern Africa* | India |
| | Egypt | Pakistan |
| *Northern Europe* | Morocco | Sri Lanka |
| Denmark | South Africa | |
| Finland | | *South-eastern Asia* |
| Ireland | *Northern America* | Indonesia |
| Norway | Canada | The Philippines |
| Sweden | USA | Singapore |
| The UK | | Thailand |
| | *Central America* | |
| *Eastern Europe* | Mexico | *Western Asia* |
| Czech Republic | Argentina | Israel |
| Poland | Brazil | Jordan |
| Russian Federation | Chile | Turkey |
| Hungary | Colombia | |
| | Peru | *Oceania* |
| | Venezuela | Australia |
| | | New Zealand |

[34] Rf. to p. 3ff.

### 4.6.2 Appendix B - Summary Statistics

Table 4.10: Summary statistics

| Variable | Obs. | Mean | Std. Dev. | EMU | | Non-EMU | Years |
|---|---|---|---|---|---|---|---|
| $T_{ij,t}^{a),b)}$ | 1440 | 45.9 | 202.2 | 70.3 | ** | 38.1 | 1987-2002 |
| $gdp_{i,t}^{a),b)}$ | 1440 | 1180 | 1160 | 1130 | | 1196 | 1987-2001 |
| $pop_{i,t}^{b)}$ | 1440 | 63.4 | 52.7 | 54.2 | ** | 66.3 | 1987-2001 |
| $foreigner_{ij,t}$ | 1440 | 1.548 | 4.5 | 2.281 | ** | 1.311 | 1987-2002 |
| $distance_{ij}^{b)}$ | 1440 | 5365 | 4795 | 950 | ** | 6794 | - |
| $mcap_{i,t}^{b)}$ | 1410 | 0.414 | 0.4 | 0.443 | ** | 0.405 | 1987-2001 |
| $credit_{i,t}^{b)}$ | 1319 | 0.793 | 0.3 | 0.876 | ** | 0.766 | 1987-2001 |
| $exratevol_{ij,t}$ | 1426 | 0.062 | 0.2 | 0.023 | ** | 0.075 | 1987-2002 |
| $market_{i,t}$ | 1039 | 0.184 | 0.4 | 0.108 | ** | 0.208 | 1989-2001 |
| $gdpcorr_{ij,t}$ | 1437 | 0.121 | 0.4 | 0.497 | ** | -0.001 | 1987-2002 |

*Note:* a) in US$ bn, b) no logarithms; EMU refers to the mean in a sample with only EMU countries; Non-EMU refers to the mean in a sample without EMU countries; ** denotes that the mean in the EMU sample is significantly different at the 5 percent level from the mean in a sample excluding EMU countries.

### 4.6.3 Appendix C - Further Robustness Checks

Further regressions have been undertaken to check the robustness of the results. First, the regressions discussed so far are reproduced for two sub-samples in order to check whether results are driven by one or the other: German investment in foreign portfolio assets is separated from investment in German assets undertaken by foreigners (see Table 4.11). Employing pooled OLS one finds that the effect of European financial integration measured either by $d1990_{ij,t}$ or $d1999_{ij,t}$ is larger for foreign purchases and sales of German assets compared to the full sample. Qualitatively, the results are very similar for both sub-samples in the pooled OLS regressions. In the fixed-effects estimations one main difference exists: There is no significant effect of stage one of the EMU for German transactions of foreign assets, whereas the effect for foreign transactions of German assets is highly significant and large in size. Changes over time with respect to stage two of the EMU are now larger for foreign transactions of German portfolio assets. Differences in size depending on whether pooled OLS or fixed effects estimations are used remain as in the full sample.

Second, the regressions described in Table 4.3 are redone for samples excluding the US and financial centers respectively, because these countries account for a large volume of transactions and might drive part of the results. The estimations

are robust with respect to the two dummy effects. Size and significance levels of the estimated coefficients of interest increase if financial centers are excluded (Table 4.12).

Third, as discussed in Section 4.3.1, GDP growth in country $i$ and $j$ are added as additional scaling variables, $gdpgrowth_{i,t}$ and $gdpgrowth_{j,t}$, (Table 4.13). However, as the results in specification (1) show, ceteris paribus these variables have no significant explanatory power. Fourth, in order to address a potential endogeneity problem, lagged values for the scaling variables, $gdp_{i,t}$, $gdp_{j,t}$, $pop_{i,t}$, and $pop_{j,t}$, are used instead of contemporaneous values. The estimated coefficients on these variables hardly change (specification (2), Table 4.13).

Fifth, one might also ask, whether other country linkages that are not accounted for by the empirical model drive the results. Standard variables employed in gravity models that might capture such effects are added: a dummy equal to one if both countries share a common border, $adjacency_{ij,t}$, and a dummy equal to one if both countries speak the same language, $language_{ij,t}$. The coefficient on $adjacency_{ij,t}$ is highly significant and results with respect to the other coefficients are unchanged, except for the distance coefficient, which decreases in absolute size (specifications (3) and (4), 4.13). $language_{ij,t}$ has no significant impact on portfolio transactions.

Sixth, as some cross-border portfolio flows are reported with zero values, estimating a linear model might lead to biased coefficients. In total only less than 5 percent of all observations are reported zero flows, though. In order to investigate the sensitivity of the estimated coefficients towards nonlinearities, a Tobit model is estimated for comparison (Table 4.14). As specifications (1) and (2) show, the estimated effects, especially on the various dummy variables measuring the financial integration within EMU and EU-15 countries, do hardly change.

Seventh, variables such as transaction volumes, GDP, market capitalization and bank credit might not be non-stationarity. If these variables are not stationary and not co-integrated, inference is screwed. Panel unit root tests by Im, Pesaran and Shin (2003) and Levin, Lin and Chu (2002) have been undertaken.[35] The tests suggest that non-stationarity is not a problem. As the power of panel unit root tests is often criticized, a time trend that may capture the persistence in time series of transactions, GDP, market capitalization and bank credit, is entered (specifications (3) to (6)). The time trend is significant in the fixed effects regressions (specification (5) and (6)), however, this does hardly affect the other estimated coefficients.

Finally, single year regressions are run in order to reproduce Figure 4.1.[36] In this case, the estimated coefficients on the non-interacted variables are not restricted to be constant over time. The estimated size and significance of the dummy variables do not change, however.

[35]Test statistics are not reported, but can be obtained from the author upon request.

[36]These results are not reported in the Appendix, but can be obtained from the author upon request.

Table 4.11: Regression results for sub-samples

| | *Foreign investment in German portfolio assets* | | | | *German investment in foreign portfolio assets* | | | |
|---|---|---|---|---|---|---|---|---|
| $gdp_{i,t}$ | 1.774*** | 0.764** | 1.804*** | 0.714* | | | | |
| | [0.072] | [0.382] | [0.073] | [0.386] | | | | |
| $gdp_{j,t}$ | | | | | 3.392*** | 0.955 | 3.420*** | 0.669 |
| | | | | | [0.152] | [0.763] | [0.150] | [0.775] |
| $pop_{i,t}$ | -1.067*** | -0.494 | -1.086*** | -0.404 | | | | |
| | [0.083] | [0.405] | [0.083] | [0.416] | | | | |
| $pop_{j,t}$ | | | | | -2.226*** | 1.774* | -2.238*** | 2.270** |
| | | | | | [0.156] | [0.967] | [0.156] | [0.994] |
| $distance_{ij}$ | -0.512*** | | -0.572*** | | -0.181* | | -0.237*** | |
| | [0.051] | | [0.047] | | [0.092] | | [0.077] | |
| $foreigner_{ij,t}$ | 0.043*** | -0.101 | 0.043*** | -0.119* | 0.065*** | 0.063 | 0.064*** | 0.095 |
| | [0.008] | [0.064] | [0.008] | [0.062] | [0.009] | [0.089] | [0.009] | [0.087] |
| $d1990_{ij,t}$ | 0.613*** | 0.581*** | | | 0.481** | -0.055 | | |
| | [0.110] | [0.164] | | | [0.218] | [0.245] | | |
| $d1999_{ij,t}$ | | | 0.726*** | 0.564*** | | | 0.495* | 0.755*** |
| | | | [0.146] | [0.130] | | | [0.258] | [0.229] |
| *Obs* | 737 | 737 | 737 | 737 | 703 | 703 | 703 | 703 |
| $R^2$ | 0.83 | 0.61 | 0.82 | 0.61 | 0.72 | 0.48 | 0.72 | 0.49 |
| No. of pairs | | 47 | | 47 | | 47 | | 47 |

*Notes:* robust standard errors in brackets; dependent variable: gross portfolio flows, $T_{ij}$; *, **, *** denote significant at the 10%, 5% and 1% significance level; odd columns are estimated with pooled OLS using White-heteroscedasticity robust standard errors, even columns with fixed effects, $R^2$ refers to 'within' values in this case; a constant, year dummies, and dummies for financial centers are included but not reported.

Table 4.12: Additional robustness checks I

| | *excluding the US* | | | | *excluding financial centers*[a] | | | |
|---|---|---|---|---|---|---|---|---|
| $gdp_{i,t}$ | 2.209*** | 0.564 | 2.245*** | 0.418 | 2.167*** | 0.717 | 2.200*** | 0.694 |
| | [0.076] | [0.377] | [0.076] | [0.375] | [0.069] | [0.483] | [0.069] | [0.484] |
| $gdp_{j,t}$ | 3.005*** | 1.191* | 3.042*** | 1.017 | 2.965*** | 1.972** | 2.998*** | 1.925** |
| | [0.139] | [0.717] | [0.137] | [0.723] | [0.131] | [0.972] | [0.130] | [0.966] |
| $pop_{i,t}$ | -1.252*** | -0.632 | -1.269*** | -0.376 | -1.251*** | -0.651 | -1.268*** | -0.49 |
| | [0.079] | [0.428] | [0.079] | [0.431] | [0.079] | [0.514] | [0.080] | [0.515] |
| $pop_{j,t}$ | -2.049*** | 1.872** | -2.066*** | 2.169** | -2.045*** | 1.256 | -2.063*** | 1.451 |
| | [0.141] | [0.949] | [0.141] | [0.959] | [0.141] | [1.150] | [0.142] | [1.145] |
| $distance_{ij}$ | -0.337*** | | -0.391*** | | -0.325*** | | -0.389*** | |
| | [0.054] | | [0.048] | | [0.055] | | [0.048] | |
| $foreigner_{ij,t}$ | 0.054*** | -0.025 | 0.053*** | -0.018 | 0.054*** | -0.01 | 0.054*** | -0.005 |
| | [0.006] | [0.057] | [0.006] | [0.058] | [0.006] | [0.058] | [0.006] | [0.060] |
| $d1990_{ij,t}$ | 0.515*** | 0.254* | | | 0.652*** | 0.333** | | |
| | [0.128] | [0.147] | | | [0.128] | [0.159] | | |
| $d1999_{ij,t}$ | | | 0.541*** | 0.638*** | | | 0.861*** | 0.801*** |
| | | | [0.170] | [0.132] | | | [0.179] | [0.137] |
| *Obs* | 1408 | 1408 | 1408 | 1408 | 1280 | 1280 | 1280 | 1280 |
| $R^2$ | 0.73 | 0.5 | 0.73 | 0.51 | 0.7 | 0.5 | 0.7 | 0.5 |
| No. of pair | | 92 | | 92 | | 84 | | 84 |

Notes: see Table 4.11

[a]Financial centers include Hong Kong, Ireland, Luxembourg, the UK, Singapore and Switzerland.

Table 4.13: Additional robustness checks II

| | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| $gdp_{i,t}$ | 2.009*** | | 2.137*** | 2.164*** |
| | [0.068] | | [0.067] | [0.068] |
| $gdp_{j,t}$ | 3.148*** | | 2.931*** | 2.959*** |
| | [0.145] | | [0.129] | [0.128] |
| $pop_{i,t}$ | -1.239*** | | -1.240*** | -1.253*** |
| | [0.077] | | [0.078] | [0.079] |
| $pop_{j,t}$ | -2.039*** | | -2.029*** | -2.042*** |
| | [0.149] | | [0.140] | [0.140] |
| $gdpgrowth_{i,t}$ | 0.026 | | | |
| | [0.020] | | | |
| $gdpgrowth_{j,t}$ | -0.018 | | | |
| | [0.032] | | | |
| $distance_{ij}$ | -0.444*** | -0.428*** | -0.162** | -0.221*** |
| | [0.047] | [0.046] | [0.079] | [0.072] |
| $foreigner_{ij,t}$ | 0.056*** | 0.056*** | 0.065*** | 0.065*** |
| | [0.007] | [0.007] | [0.007] | [0.007] |
| $d1990_{ij,t}$ | | | 0.547*** | |
| | | | [0.128] | |
| $d1999_{ij,t}$ | 0.610*** | | | 0.562*** |
| | [0.152] | | | [0.171] |
| $gdp_{i,t-1}$ | | 2.205*** | | |
| | | [0.071] | | |
| $gdp_{j,t-1}$ | | 2.980*** | | |
| | | [0.130] | | |
| $pop_{i,t-1}$ | | -1.280*** | | |
| | | [0.082] | | |
| $pop_{j,t-1}$ | | -2.058*** | | |
| | | [0.143] | | |
| $language_{ij}$ | | | -0.159 | -0.023 |
| | | | [0.147] | [0.121] |
| $adjacency_{ij}$ | | | 0.913*** | 0.909*** |
| | | | [0.172] | [0.171] |
| *Obs.* | 1421 | 1356 | 1440 | 1440 |
| $R^2$ | 0.75 | 0.74 | 0.74 | 0.74 |

Notes: see Table 4.11

Table 4.14: Additional robustness checks III

| | (1) | (2) | (3) | (4) | (5) | (6) |
|---|---|---|---|---|---|---|
| $gdp_{i,t}$ | 2.163*** | 2.194*** | 2.161*** | 2.192*** | 0.581 | 0.437 |
| | [0.081] | [0.080] | [0.069] | [0.069] | [0.375] | [0.374] |
| $gdp_{j,t}$ | 2.965*** | 2.997*** | 2.953*** | 2.985*** | 1.201* | 1.028 |
| | [0.084] | [0.083] | [0.131] | [0.130] | [0.716] | [0.722] |
| $gdp_{i,t}$ | -1.245*** | -1.262*** | -1.244*** | -1.261*** | -0.633 | -0.377 |
| | [0.100] | [0.100] | [0.078] | [0.079] | [0.424] | [0.429] |
| $gdp_{j,t}$ | -2.039*** | -2.057*** | -2.031*** | -2.049*** | 1.859** | 2.157** |
| | [0.102] | [0.102] | [0.141] | [0.142] | [0.941] | [0.952] |
| $distance_{ij}$ | -0.344*** | -0.407*** | -0.343*** | -0.407*** | | |
| | [0.053] | [0.048] | [0.054] | [0.047] | | |
| $foreigner_{ij,t}$ | 0.054*** | 0.054*** | 0.054*** | 0.054*** | -0.024 | -0.019 |
| | [0.011] | [0.011] | [0.006] | [0.006] | [0.057] | [0.058] |
| $d1990_{ij,t}$ | 0.568*** | | 0.572*** | | 0.275* | |
| | [0.161] | | [0.123] | | [0.145] | |
| $d1999_{ij,t}$ | | 0.581** | | 0.584*** | | 0.646*** |
| | | [0.247] | | [0.167] | | [0.130] |
| $year_{ij,t}$ | | | -0.022 | -0.024 | 0.134*** | 0.144*** |
| | | | [0.018] | [0.018] | [0.038] | [0.039] |
| *Obs.* | 1440 | 1440 | 1440 | 1440 | 1440 | 1440 |
| $R^2$ | 0.25 | 0.25 | 0.74 | 0.74 | 0.51 | 0.51 |
| No. of pairs | | | | | 94 | 94 |

*Notes:* robust standard errors in brackets; dependent variable: gross portfolio flows, $T_{ij}$; *, **, *** denote 10%, 5% and 1% significance levels; column (5) and (6) refer to Tobit estimations, columns (3) and (4) refer to pooled OLS, and (5) and (6) to country-pair fixed effects estimations; a constant, year dummies, and dummies for financial centers are included but not reported.

Table 4.15: Regression and F-tests of Figure 4.1

| variable | coefficient | std. err. | variable | coefficient | std. err. | F-test | p-value |
|---|---|---|---|---|---|---|---|
| $gdp_{i,t}$ | 2.058*** | 0.070 | | | | | |
| $gdp_{j,t}$ | 2.853*** | 0.128 | | | | | |
| $pop_{i,t}$ | -1.147*** | 0.080 | | | | | |
| $pop_{j,t}$ | -1.934*** | 0.139 | | | | | |
| $distance_{ij}$ | -0.199*** | 0.064 | | | | | |
| $foreigner_{ij,t}$ | 0.059*** | 0.007 | | | | | |
| $dEMU_{ij} * 1987$ | 0.703* | 0.421 | $dEUnonEMU_{ij} * 1987$ | 1.276 *** | 0.435 | 2.77 | 0.096 |
| $dEMU_{ij} * 1988$ | 0.819* | 0.481 | $dEUnonEMU_{ij} * 1988$ | 1.496*** | 0.499 | 2.87 | 0.091 |
| $dEMU_{ij} * 1989$ | 1.129** | 0.452 | $dEUnonEMU_{ij} * 1989$ | 1.868*** | 0.405 | 7.29 | 0.007 |
| $dEMU_{ij} * 1990$ | 0.652* | 0.375 | $dEUnonEMU_{ij} * 1990$ | 1.432*** | 0.363 | 7.9 | 0.005 |
| $dEMU_{ij} * 1991$ | 0.988*** | 0.370 | $dEUnonEMU_{ij} * 1991$ | 1.464*** | 0.355 | 3.77 | 0.053 |
| $dEMU_{ij} * 1992$ | 0.790** | 0.325 | $dEUnonEMU_{ij} * 1992$ | 1.366*** | 0.281 | 5.39 | 0.020 |
| $dEMU_{ij} * 1993$ | 1.179*** | 0.327 | $dEUnonEMU_{ij} * 1993$ | 1.626*** | 0.354 | 2.29 | 0.131 |
| $dEMU_{ij} * 1994$ | 0.917*** | 0.325 | $dEUnonEMU_{ij} * 1994$ | 1.337*** | 0.347 | 2.9 | 0.089 |
| $dEMU_{ij} * 1995$ | 0.758*** | 0.281 | $dEUnonEMU_{ij} * 1995$ | 1.097*** | 0.304 | 1.6 | 0.206 |
| $dEMU_{ij} * 1996$ | 0.658** | 0.254 | $dEUnonEMU_{ij} * 1996$ | 0.891*** | 0.323 | 0.71 | 0.399 |
| $dEMU_{ij} * 1997$ | 0.580** | 0.264 | $dEUnonEMU_{ij} * 1997$ | 0.753*** | 0.268 | 0.83 | 0.362 |
| $dEMU_{ij} * 1998$ | 0.916*** | 0.277 | $dEUnonEMU_{ij} * 1998$ | 0.936*** | 0.360 | 0.000 | 0.949 |
| $dEMU_{ij} * 1999$ | 1.144*** | 0.266 | $dEUnonEMU_{ij} * 1999$ | 0.956*** | 0.336 | 0.41 | 0.524 |
| $dEMU_{ij} * 2000$ | 1.667*** | 0.363 | $dEUnonEMU_{ij} * 2000$ | 1.339*** | 0.392 | 1.22 | 0.270 |
| $dEMU_{ij} * 2001$ | 1.535*** | 0.369 | $dEUnonEMU_{ij} * 2001$ | 1.084*** | 0.343 | 2.54 | 0.111 |
| $dEMU_{ij} * 2002$ | 1.378*** | 0.326 | $dEUnonEMU_{ij} * 2002$ | 0.777*** | 0.288 | 3.97 | 0.047 |
| *Obs.* | 1440 | | | | | | |
| R2 | 0.75 | | | | | | |

*Notes:* Pooled OLS regressions with White-heteroscedasticity robust standard errors; dependent variable: gross portfolio flows, $T_{ij}$; *, **, *** denote 10%, 5% and 1% significance levels; F-test and corresponding p-values refer to F-tests of equality of both dummy variables in the respective year, i.e., $H_0 : dEMU_{ij} * 1997 = dEUnonEMU_{ij} * 1997$ ; a constant, year dummies, and dummies for financial centers are included but not reported.

# Chapter 5

# Retirement Age, Retirement Entry Decisions and Pension Reforms

## 5.1 Pension Reform in Germany: The Impact on Retirement Decisions

### 5.1.1 Introduction[1]

The option of early retirement is a highly prized, but at the same time highly costly, social achievement in Germany. With an increasingly aging population and the precarious financial state of the public pension system, these costs are once again the focus of discussion about pension reform, especially as the government has committed itself to take adjustment measures should contributions exceed 20 percent of gross income in the year 2020 (22 percent in the year 2030) or pension benefits fall below a certain minimum level. This minimum level is defined as 67 percent of net pensions by the "Riester reform" in 2001, and as 46 percent of tax-adjusted gross pensions in the "Sustainability Law" of 2004. The latest forecasts based on new population and labor force projections show that, barring further reform, these two goals are incompatible and further reform is required.

Since the 2004 reform has kept the retirement age largely untouched, the reform discussion is shifting once again to the pivotal retirement age, currently age 65. An increase in the age of retirement will boost the number of contributors to the system whilst simultaneously reducing the number of beneficiaries. This is particularly attractive from a financial point of view in a system, which is not fully actuarially neutral, since changing the ratio of contributors to beneficiaries will then also

[1]This is a joint paper with Axel Börsch-Supan that has been published in *FinanzArchiv* (2004), 5(1), pp. 71-90.

improve the financial balance of the system. Bearing increasing life expectancy in mind, raising the age of retirement would also appear to be a rather natural reform option. What is more, there is no sign that an increase in the age of retirement is likely to be prevented by deteriorating health. On the contrary, age-specific rates of illness have dropped even faster than mortality rates (Cutler and Sheiner 1998).

The aim of this paper is to provide an econometric estimate of the long-term impact of various reform options on retirement decisions in Germany, especially on the distribution of actual retirement ages and its mean, the effective average retirement age. "Long term" is defined as the state of play after all transitional regulations and behavioral changes have taken effect. A model is presented which relates the actual retirement decisions of older workers, as observed in the data provided by the 1984-1997 German Socio-Economic Panel (GSOEP), to the relevant statutory pension rules. Based on the model estimates, future retirement decisions under reformed pension rules are predicted. However, the full budget implications of these changes in retirement behavior are not modeled. This is a complicated exercise due to complex interactions of the pension budget with other parts of the German social safety net, and is left to future research.[2]

The approach in the present paper takes as point of departure the econometric analysis by Börsch-Supan, Schnabel, Kohnz and Mastrobuoni (2004b) which was undertaken in the framework of an international project on the causes and implications of early retirement.[3] In contrast to this international comparative analysis, however, the present paper takes account of the institutional peculiarities applying in Germany and, specifically, addresses the 1992 and 1999 reforms as well as the proposals discussed by the "Commission for Sustainability in Financing the German Social Security System", referred to in the following as the "Rürup Kommission". Some of these proposals have been adopted as recommendations by the Commission, while other proposals did not find a majority in the Commission. The reform options encompass an increase in the normal pension age by one or two years, adjustment factors of between 4.5 and 6 percent per year of earlier retirement, and the introduction of actuarial individual pension accounts based on the Swedish model[4] with their implied adjustment factors and no predefined "normal" retirement age. While none of these proposals have been explicitly put into the pension reform law of 2004, it includes a clause that will provide for a formal review of the system of retirement ages by 2008.

The paper is structured as follows: Section 5.1.2 describes the institutional framework determining retirement in Germany. Section 5.1.3 looks at the reform options analyzed. Section 5.1.4 presents the data, model specifications, and the results of estimates. Section 5.1.5 discusses the simulations which represent the core aspect of the present work. Finally, the most important findings are summarized.

[2]See Börsch-Supan, Kohnz and Schnabel (2004a) for a first and preliminary analysis.

[3]Refer to Gruber and Wise (1999, 2004a and 2004b).

[4]*Notional Defined Contribution* (NDC) System, see Section 5.1.3.

### 5.1.2 The German Public Pension System

The largest part of the German public pension system is the "public retirement insurance" ("Gesetzliche Rentenversicherung", GRV). It covers about 85 percent of the German workforce. Most of these are private sector workers but the GRV also includes those public sector workers who are not civil servants. Civil servants, about 7 percent of the workforce, have their own pension system. The self-employed, about 9 percent of the workforce, are mainly self-insured although some of them also participate in the public retirement insurance system. For the average worker, occupational pensions do not play a major role in the German system of old-age provision, neither do individual retirement accounts yet, but their importance is increasing since the last reform in 1999/2001.

The sample, taken from the German Socio-Economic Panel (GSOEP) 1984-1997, includes only cohorts that enter retirement until 1997. Therefore, in the retrospective econometric analysis, retirement entry decisions are modeled on the basis of the 1972 legislation. Because most parts of the 1992 reform have not been phased in by 1997, the 1972 legislation is relevant for the present sample and therefore described in the following section. Where necessary, however, those institutional changes which have been legislated in the 1992 and 1999 reforms are mentioned. The description is limited to the possible pathways into retirement, which are particularly relevant for the analysis, whereas a detailed description of retirement payments, which go into the estimations as well, can be found in Börsch-Supan et al. (2004b). A detailed description of the recent history of institutional changes is surveyed by Börsch-Supan and Wilke (2003).

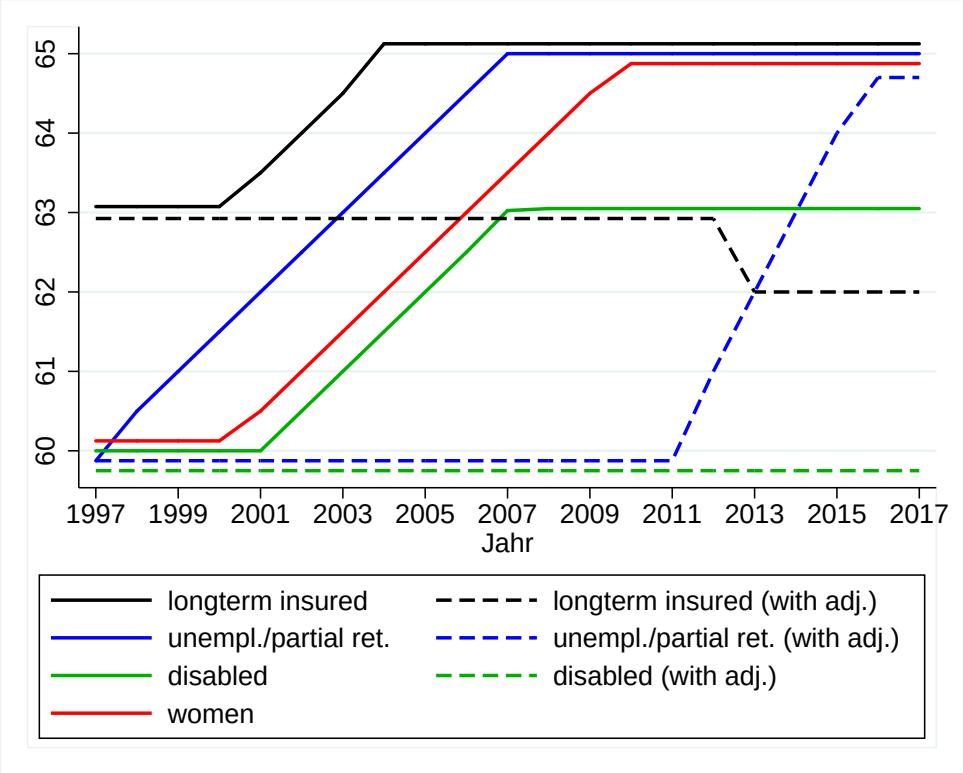
#### Private Sector Pensions

First, old-age pensions are considered. Until 1972, retirement was mandatory at age 65. In 1972, several early retirement options were introduced, "early" defined as before age 65, the "normal" retirement age. Since then the system of the GRV pays old-age pensions for employees from age 60 on if certain conditions are met. A main feature of the German old-age pensions is "flexible retirement" from age 63 for workers with a long service history. Moreover, retirement at age 60 is possible for women, the unemployed, and workers who cannot be appropriately employed for health or labor-market reasons. In addition, preretirement (i.e., retirement before age 60) is possible using other parts of the public transfer system, mainly unemployment compensation. Labor force exit before age 60 is frequent: about 45 percent of all men call themselves "retired" at age 59. Only about half of them retire because of disability; the other 50 percent make use of one of the many official and unofficial preretirement schemes, e.g., unemployment compensation in combination with severance pay.[5]

[5]For a comprehensive illustration of retirement entry rules see also Reimann (2003).

Because of the numerous exceptions that enable retirement entry before age 65, the reforms of 1992 and 1999 introduced an increase of retirement age limits to age 65. The system has been simplified, in that there will no longer be exceptions for the unemployed, part-time employees and women. After a transitional period retirement entry rules of these persons will be adjusted to those of long-time insured. If adjustments (see below) are accepted, long-time insured can choose early retirement from age 62 on. Similarly disabled people can obtain old-age pensions at age 63 and with adjustments even at age 60. The transitional rules of retirement entry are displayed in Figure 5.1.

Figure 5.1: Statutory retirement age




The 1992 reform introduced explicit adjustment factors for retirement before age 65. Before 1992, adjustment of benefits to retirement age was only implicit via contribution periods. There were no actuarial adjustments at all. The 1992 social security reform will change this stepwise by the year 2004. Age 65 will then act as the "pivotal age" for benefit computations.

Table 5.1 displays the retirement-age-specific adjustments for a worker who has earnings that remain constant after age 60. The table relates the retirement income for retirement at age 65 to that for retirement at earlier and later ages, and compares

the implicit adjustments after 1972 with the total adjustments after the 1992 social security reform is fully phased in. As references, actuarial adjustments computed using a 3 percent discount rate are shown as well.[6]

According to the 1992 reform benefits will be reduced by 0.3 percent per month (up to a maximum of 10.8 percent) for each year of earlier retirement. The 1992 reform also introduced rewards for later retirement in a systematic way. For each year of retirement postponed past the minimum age indicated in Table 5.1, the pension is increased by 0.5 percent per month or 6 percent p.a.

Table 5.1: Adjustment of public pensions by retirement age

| Pension as a percentage of the pension that one would obtain if one had retired at age 65 | | | |
|---|---|---|---|
| age | $pre-1992^{a)}$ | $post-1992^{b)}$ | $Actuarial fair^{c)}$ |
| 62 | 100 | 89.2 | 80.5 |
| 63 | 100 | 92.8 | 86.3 |
| 64 | 100 | 96.4 | 92.8 |
| 65 | 100 | 100 | 100 |
| 66 | 107.2 | 106 | 108.1 |
| 67 | 114.4 | 112 | 117.2 |
| 68 | 114.4 | 118 | 127.4 |
| 69 | 114.4 | 124 | 139.1 |

*Notes:* a) GRV 1972-1992. b) GRV after 1992 reform has fully phased in. c) Evaluated at a 3 percent discount rate.
*Source:* Börsch-Supan and Schnabel (1999).

Besides old-age pensions the contributions to the German retirement insurance also finance disability benefits to workers of all ages. These are converted into old-age pensions latest at age 65.

The disability pathway has provided a frequently used option for entrance into early retirement (besides the flexible retirement option) before the pivot age of 65. A person who was not able to carry on a regular employment received full old-age benefits, the so called disability pension ("Erwerbsunfähigkeitsrente", EU). A person who could work at most half the time a healthy person could received two-thirds of the standard old-age benefits ("Berufsunfähigkeitsrente", BU). In the 1970s and early 1980s, the German authorities have interpreted both rules very broadly, in particular the applicability of the first rule.

The previous rules governing total and partial disability pensions, as well as the special old-age pension for those aged 60 or over and suffering from partial or total

[6]A higher discount rate yields steeper adjustments.

disability, were abolished in 2001 under the 1999 Pension Reform Act. However, generous hardship and other provisions designed to sustain confidence in the system mean that the old rules will continue to be effective over a relatively long transitional period (some rules until 2017). After this period, insured beneficiaries will still be able to draw pension benefits for partial or full disability until the age of 65 but under different conditions.[7] One main aspect is that the current labor-market situation needs no longer be taken into account. Moreover, if a pension is claimed for disability prior to the age of 63, adjustment costs similar to those which apply to old-age pensions payable to the long-term insured are phased in until 2004. The pension adjustment factor for each calendar month for which the pension is drawn for a partial or full disability prior to age 63 is -0.3 percent, up to a maximum of -10.8 percent (see Table 5.1).

Besides the above-mentioned retirement pathways, survivor pensions are paid to wives if the insured husband dies. Survivor pensions are 60 percent of the husband's applicable pension for widows who are aged 45 and over or have children in the household ("grosse Witwenrente"), otherwise they are 25 percent ("kleine Witwenrente"). For couples married after the year 2001 a new law applies: Survivor pensions are no longer 60 percent, but only 55 percent, of the husband's disability pension. In return, however, the number of children is now taken positively into account when determining survivor benefits.

Survivor benefits are a large component of the public pension budget and of total pension wealth. Certain earnings tests apply if the widow has her own income, e.g., her own pension. This is only relevant for a very small (below 10 percent) share of widows. Only recently have male and female survivors been treated symmetrically. Additionally, spouses can now choose whether to receive a survivor pension or a newly introduced pension splitting.

The average retirement age in 1999 was 59.7 years for men and 60.7 years for women. These numbers refer to West Germany. In the East, retirement age was 57.9 years for men and 58.2 years for women. The fraction of those who enter retirement through a disability pension has declined and was 29 percent in 1998. Only about 20 percent of all entrants used the "normal" pathway of an old-age pension at age 65. The most popular retirement age is age 60.[8]

### Public-Sector Pensions

Civil servants do not pay explicit contributions for their pensions as the other employees in the private and public sectors do.[9] Instead, the "gross" wage for civil

[7] They are now referred to as partial or full "Erwerbsminderungsrente (EM)".

[8] Cf. Börsch-Supan and Schnabel (1999) for a distribution of pathways to retirement over time.

[9] Civil servants are also exempt from unemployment insurance contributions, since civil servants have a life-time job guarantee. The government pays a certain fraction of health expenses of the civil servant and his or her dependents (ranging from 50 to 80 percent). The rest has to be covered

servants is lower than that of other public sector employees with a comparable education. The generosity of gross pensions received by civil servants vis-à-vis the private sector workers is partially offset by the preferential tax treatment of private sector pensions.

There are three pathways for civil servants: the standard, the early, and the disability retirement option. The standard retirement age is 65. Before July 1, 1997 the early retirement age for civil servants was 62 and thus one year less than in the social security system. In 1997 it was raised to 63. Adjustment factors for early retirement were phased in linearly between the years 1998 and 2003, and are now 0.3 percentage points per month of early retirement, the same as in the private sector.[10]

The average retirement age for civil servants in the year 1999 was 58.9 years and thus almost one year lower than in the private sector. Disability is the most important pathway to retirement for civil servants: 47 percent of those who retired in the year 1999 used disability retirement. Only about 9 percent of civil servants retired at the regular retirement age of 65.[11]

### 5.1.3 Pension Reform Scenarios

As stated in the introduction, this generous system is financially unsustainable due to the pressures exerted by the rapid aging of the German population.[12] Various incremental reform steps have been legislated and are currently being phased in, other reform steps are under discussion. The aim of this paper is to estimate the long-term impact of these reform measures on the retirement decisions of older workers in Germany.

Six possible reform measures are considered. As a reference scenario, the pension reforms already implemented in 1992 and 1999 are examined. Then, four reform proposals involving higher actuarial adjustment factors and higher statutory retirement age are considered. Finally, it is of interest to investigate how retirement probabilities would respond to the introduction of an individual pension account system based on the Swedish model. These six reform scenarios are defined in more detail in the following.

The core aspects of the reference scenario encompass an increase of the early retirement ages, the introduction of actuarial adjustment factors in the 1992 pension

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by private insurance.

[10]Very specific rules apply to some civil servants. For example, the regular retirement age for police officers is age 60; for soldiers it is even lower and depends on their rank.

[11]Refer to "Zweiter Versorgungsbericht der Bundesregierung", Bundesdrucksache 14/7220, 19.10.2001.

[12]See Börsch-Supan (2000b) for a concise account of the demographic and economic problems confronting the German public pension system. The term "unsustainable" is not well defined in the literature, see Kommission für die Nachhaltigkeit der Finanzierung der Sozialen Sicherungssystem (2003), Section 1.2. A system is defined as sustainable if the (possibly implicit) debt left to the next generation by this system does not increase over time.

reform described in Section 5.1.2, and the new rules, which took effect in 1999, designed to accelerate the implementation of the 1992 reform. The transition path is neglected. Instead, the long-term impact of the reforms after full implementation is simulated. The rules for the reference scenario are stated in the following:

- The adjustment factors for early retirement introduced by the 1992 reform amount to 3.6 percent (not exceeding a maximum of 10.8 percent) for each year of early retirement. The adjustment factors introduced in 1992 only began to be implemented on an incremental basis subsequent to the period covered by the present sample and will only take full effect after 2017 (see Figure 5.1). A long-term insured employee will then only be able to take retirement, with a maximum deduction of 10.8 percent, at the age of 62. The value of 3.6 percent corresponds (under current mortality rates) to an implicit discount rate of 0.5 percent, which corresponds to the expected interest rate of return of the German pay-as-you-go system.[13]

- Adjustment factors will now also be introduced for each calendar month during which an insured person claims a disability pension prior to the age of 63. These adjustment factors are the same as those for old-age pensions: 0.3 percent per month and a maximum of 10.8 percent.

- There will be reductions in widow/widower's pensions from 60 percent to 55 percent of the spouse's partial disability pension.[14]

- The child-raising pension and unemployment pensions are no longer available. The only channels now open to all claimants are those of early retirement for the long-term insured, the partially or severely disabled.

This reference scenario describes the retirement probabilities generated if the statutory status quo remains unchanged and no new reform measures are passed. These outcomes are then compared with those of five reform elements. To begin with, the effects of higher actuarial adjustment factors on retirement decisions are examined.[15]

- *Variant adjustment factor of 4.5 percent*: Compared with the reference scenario which provides for deductions of 3.6 percent p.a., this scenario is based on deductions of 4.5 percent p.a., and a maximum of 13.5 percent. All other rules are identical to those in the reference scenario. The value of 4.5 percent corresponds to a discount rate of 1.75 percent.

[13]See Kommission für die Nachhaltigkeit in der Finanzierung der Sozialen Sicherungssysteme (2003), p. 86.

[14]As the incentives to retire are specified in case of married couples as a unit, the estimates take account of the survivor's pension rules but not of pension splitting.

[15]Börsch-Supan and Schnabel (1998) describe the direct effects of these adjustment factors on the total value of German pension benefits.

- *Variant adjustment factor of 6.0 percent*: This scenario introduces deductions of 6.0 percent p.a. (maximum 18 percent). All other factors remain unchanged. The value of 6.0 percent corresponds to a discount rate of 3.5 percent.

There was no majority in the "Rürup Kommission" for these proposed increases in the actuarial adjustment factors. The actuarial adjustment is highly unpopular, and the recent increase from 0 to 3.6 percent percent is still not fully phased in. Therefore, little is known about the actual response to this recent reform step.

The right level of the adjustment factors depends on one's point of view.[16] The value of 3.6 percent is approximately actuarially neutral in the sense that the present discounted value of benefits is not affected by the actual retirement age if the present discounted value is computed at the internal rate of return of the pension system. However, workers are likely to use a different rate of interest when they are computing the present discounted value in order to make retirement decisions. Also, society will use a different rate of interest when evaluating social expenditures. This difference then creates a wedge between actuarial neutrality and the absence of labor supply disincentives, the latter being defined as the case in which the present discounted value of benefits is independent of the retirement age, if the present discounted value is computed using the personal discount rate of workers. The crucial question is then, what is the personal discount rate of workers, and what is society's discount rate? If it is the market rate of interest, then it is usually larger than the internal rate of return of the pension system, especially in times of aging populations.[17]

The distinction is important: Pension systems may be actuarially neutral, but they may still create substantial labor-supply disincentives. The root cause for this discrepancy is the difference in the discount rates that are applied to the actuarial adjustment. There are at least three candidates: (a) the internal rate of return, which is $n + g$ in a pay-as-you-go-system; (b) the market rate of interest $r$, which is also the internal rate of return of a funded system; (c) and the rate of time preference of the employees who make the retirement decision. The market rate of interest $r$ tends to be higher than $n + g$. While one may argue that the average rate of time preference should be approximately equal to the market rate of interest, the empirical evidence shows that the worker's rate of time preference, guiding their retirement behavior, is even larger than $r$.

In addition to different adjustment factors, the effect of a further increase in the statutory retirement ages is examined. A rule of thumb used by the Federal Ministry for Health and Social Security (BMGS) states that, in response to a change in the retirement rules, one-third of workers retire at the new retirement age, one-third continue to retire at the old one and accept the deductions that this implies, and

[16] See Ohsmann, Stolz and Thiede (2003).

[17] Börsch-Supan and Schnabel (1998) describe the direct effects of these adjustment factors on the total value of German pension benefits.

one-third avoid the new rules by claiming benefits for disability. The next two variants examine the validity of this rule of thumb. Note that these changes affect not only the "normal" retirement age but the entire system of statutory retirement entry ages.

- *Variant age limit +1*: All the age limits reached after the transition period shown in Figure 5.1 are increased by one year. As a result, the normal pension age, for example, is raised from age 65 to 66; the earliest retirement age for the long-term employed from age 62 to 63; etc. Only the contributory periods for old-age pensions of partially and fully disabled persons remain unchanged at age 60.

- *Variant age limit +2*: All age limits are increased by 2 years. All other factors remain unchanged. This is the proposal submitted by the "Rürup Kommission".

Finally, as an alternative to these parametric reforms, the transition from the current defined benefit system to a "notional defined contribution (NDC)" system is modeled. As its proponents argue, it would be more sustainable, more flexible, and more transparent while retaining the essential features of the current public pension system.[18] Notional defined contributions involve an "individual pension accounts system" in which pension entitlements would be based on the actual amount of contributions paid in to an otherwise unchanged (i.e., pay-as-you-go) pension system. Paid contributions would be accumulated on individual pension accounts where they would receive fictitious ("notional") interest based on the rate of return provided by the pay-as-you-go system. As a rule, the interest rate would correspond to the growth rate of the total wage bill, responding to both demographic and employment changes. Assets bearing fictitious interest of this type would be converted, on retirement, into a lifelong pension annuity based on actuarial calculations. The level of pension would depend on remaining life expectancy and would therefore respond to demographic factors.

- *Variant NDC system*: In this case a system is considered which is again based on the 1992 and 1999 legislative reforms. The most significant difference between this and the reference scenario is the change in the actuarial adjustment factors which are implicitly based on the internal rate of interest in the NDC system and remaining life expectancy. This system does not, therefore, have fixed adjustment factors. They increase with age and decrease with increasing life expectancy. The latter effect is almost exactly compensated by the declining internal rate of return, so that the age-specific adjustment factors are roughly constant over time. In 2015, 65 year old workers will receive about 7.7

[18] See Börsch-Supan (2003) and Clemens (2003) regarding the introduction of an NDC system in Germany.

percent higher pensions if they postpone their retirement by one year, while workers, who shift their retirement from age 62 to 63, will receive 7.2 percent higher benefits.

A similar system has been legislated in Sweden about ten years ago.[19] A reform package along these lines was also passed in Italy in 1995.

### 5.1.4 Econometric Estimation of the Incentive Effects to Retire

The methodology follows the seminal work by Stock and Wise (1990). They introduced the option value as a central incentive variable that captures the impact of pension rules on retirement behavior.

Earlier analyses of the German pension system using this framework were carried out by Börsch-Supan (1992), Schmidt (1995), Börsch-Supan and Schmidt (1996), Siddiqui (1997), and Börsch-Supan (2000a and 2001). The present work is directly linked to Börsch-Supan et al. (2004b), which is part of an international project about the causes and consequences of early retirement. Their work is improved along the following lines: First, cumulative retirement entry probabilities are estimated instead of hazard rates, which they employ. Cumulative retirement entry probabilities turn out to generate more robust estimation results for Germany than hazard rates. Second, a broader sample is employed that ascertains a representative estimation of retirement entry decisions of German workers and employees. Finally, the special features and institutional conditions in Germany are taken into account. The concrete reform options mentioned in Section 5.1.3 rather than the synthetic hypothetical reform proposals in Gruber and Wise's (2004a) international comparisons are simulated.

In the following first the data and methodology is described, then the econometric estimation procedure and, finally the base model estimates.

#### Data and Methodology

The German Socio-Economic Panel (GSOEP) is an annual panel study of some 6,000 households and some 15,000 individuals.[20] The panel started in 1984; 14 waves through 1997 are used.[21] The GSOEP data provide a detailed account of income and employment status. The sample is an unbalanced panel of all persons aged

[19] See Palmer (2000), Settergren (2001) and Wadensjö (2003) for the workings of and initial experiences with the Swedish system.

[20] Burkhauser (1991) provides an English-language description, code books and links to an internationally accessible GSOEP version. Börsch-Supan (2000a) discusses the merits and limits of the GSOEP data for studies of retirement behavior.

[21] Ending in 1997 gives a clean estimate of the actual pension rules in place.

55 through 70 in West Germany for which earnings data is available.[22] This panel includes 2,223 individuals with 14,401 observations. Average observation time is 6.5 years. The panel is left-censored as only persons are included who have worked at least one year during the sample window in order to reconstruct an earnings history.[23] Aggregate information on average earnings, system entries, and the actual distribution of retirement age by year is provided by the Association of German Retirement Insurance Organizations ("Verband deutscher Versicherungsträger", VDR).

The variable to be explained is old-age labor force status. Because Germany has very few part-time employees, only two states are modeled - fully in labor force and fully retired. The definition of "retired" is problematic, because there exist different alternatives. Retirement definitions commonly employed in the literature include inter alia the retirement status self-reported by the respondent, the fact that there are few work hours, and the receipt of retirement benefits. The first concept is used in this context - self-reported status. It includes preretirement, mainly financed by a mixture of unemployment compensation and severance pay.

The main explanatory variable is the option value established by Stock and Wise (1990). This "incentive variable of the retirement decision" evaluates all current and future payments of the different retirement pathways less possible required contributions, and compares these present values with the utility of leisure when being retired. It is explained in the following how to calculate these present values under different retirement pathways.

*Handling of Multiple Retirement Programs*

At least theoretically, a worker at age 55 has the choice among three retirement programs:

- old-age pensions starting with age 60,
- disability pensions, and
- preretirement schemes.

The set of choices is actually larger because some of these programs have several branch programs (within old-age pensions: unemployment, long service life, etc.) as was depicted in Figure 5.1. These choices are referred to in the following as "pathways". It is important to notice that all of these pathways pay the same benefit, once a person is eligible.[24]

[22]East Germany is excluded because retirement patterns in the East are dominated by the transition problems to a market economy. See Börsch-Supan and Schmidt (1996) for a comparison.

[23]See Börsch-Supan et al. (2004b) for a detailed construction of the earnings history.

[24]In principle, preretirement programs can have any benefit level because they are negotiated between workers and employers. In practice, however, the outcome of these negotiations is guided by the public insurance benefits.

In practice, there is no free choice, since most of these pathways are subject to eligibility criteria. Among those, "strict eligibility rules" are distinguished from "soft eligibility rules". Strict rules are tied to objective variables such as age, gender and previous contribution history whereas soft rules are subject to discretionary decisions,[25] notably the determination of a worker's disability status.[26]

In the construction of social security wealth and the incentive variables below, expected pension benefits need to be computed which depend on the choice of pathway. In the computation of this expected value, observed frequencies are used as weights. Let's suppose, the observed frequency of disability status at age 59 is 33 percent, and the sample person is not eligible for any other pathway at that age. Then expected benefits at age 59 for this person would be a third of the (common) benefit level.[27]

*Construction of Social Security Wealth*

A key statistic in the computation of budget impacts is the change in the net present value of all future benefits (which is the present value of all future benefits less contribution payments) when retirement is postponed. In a slight misuse of terminology, the net present value of all future benefits is called "social security wealth" (SSW). Social security wealth is defined as the expected present discounted value of benefits (YRET) minus applicable contributions that are levied on gross earnings ($c{\cdot}YLAB$). Seen from the perspective of a worker who is $S$ years old and plans to retire at age $R$, social security wealth ($SSW$) is

$$SSW_S(R) = \sum_{t=R}^{\infty} YRET_t(R) \cdot a_t \cdot \delta^{t-S} - \sum_{t=S}^{R-1} c_t \cdot YLAB_t \cdot a_t \cdot \delta^{t-S}, \tag{5.1}$$

with:

| | | |
|---|---|---|
| | $SSW$ | net present discounted value of retirement benefits, |
| | $S$ | planning age, |
| | $R$ | retirement age, |
| | $YLAB_t$ | gross labor income at age $t$, |
| | $YRET_t(R)$ | net pension income at age $t$ for retirement at age $R$, |
| | $c_t$ | contribution rate to pension system at age $t$, |
| | $a_t$ | probability to survive at least until age $t$ given survival until age $S$, |
| | $\delta$ | discount factor $= 1/(1+r)$. |

[25] See Schnabel (1999) for details.

[26] Under the 1972 legislation "disability" depends on health as well as labor-market characteristics.

[27] Börsch-Supan (2001) provides an instrumental variables interpretation of this method and explores the sensitivity with respect to a more sophisticated choice of instruments.

A discount rate of 3 percent is chosen. Conditional survival probabilities are computed from the standard life tables of the German Bureau of the Census ("Statistisches Bundesamt"). $SSW$ depends also on the joint survival probabilities of spouses through survivor pensions.[28] Independence of survival of spouses is assumed to compute the joint probability.

Moreover, future contribution rates and pensions have to be predicted. In order to obtain consistent policy simulations, they are simulated using the macroeconomic pension model underlying Birg and Börsch-Supan (1999). This internal consistency is important. Assume a policy proposal, which reduces the replacement rate by x percent. This immediately lowers the contribution rates by the same x percent if the system is pay-as-you-go and financed through contributions. The effect on $SSW$ is ambiguous and varies by cohort.

*The Option Value of Delayed Retirement*

Economic incentives to retire also include the value of leisure in retirement. It is captured in the option value to postpone retirement (Stock and Wise 1990). This value expresses for each retirement age the trade-off between retiring now (resulting in a stream of retirement benefits that depends on this retirement age) and keeping all options open for some later retirement date (with associated streams of first labor then retirement incomes for all possible later retirement ages).

The option value function adds utility from consumption and leisure to the financial incentives. Let $V_t(R)$ denote the expected discounted future utility at age $t$ if the worker retires at age $R$, specified as follows:

$$V_S(R) = \sum_{t=S}^{R-1} u(YLAB_t^{NET}) \cdot a_t \cdot \delta^{t-S} + \alpha \sum_{t=R}^{\infty} u(YRET_t(R)) \cdot a_t \cdot \delta^{t-S}, \qquad (5.2)$$

with: $YLAB_t^{NET}$ after-tax labor income at age $t$, $t = S \ldots R-1$,
$YRET_t(R)$ after-tax pension income at age $t$, $t \geq R$,
$\alpha$ relative utility of leisure, to be estimated.

Utility from consumption is represented by an isoelastic utility function in after-tax income, $u(Y) = Y^{\gamma}$. To capture utility from leisure, utility during retirement is weighted by $\alpha > 1$, where $1/\alpha$ is the marginal disutility of work.

The option value for a specific age is defined as the difference between the maximum attainable consumption utility if the worker postpones retirement to some later year minus the utility of consumption that the worker can afford if he or she would retire now. Let $R^*(S)$ denote the optimal retirement age if the worker postpones retirement past age $S$, i.e., $argmax[V_S(R)]$ for $R > S$. With this notation, the option value is

[28] For the significance of this extension, see Coile (1999).

$$G(S) = V_S(R^*(S)) - V_S(S). \tag{5.3}$$

Since a worker is likely to retire as soon as the utility of the option to postpone retirement becomes smaller than the utility of retiring now, retirement probabilities should depend negatively on the option value.

The option value captures the economic incentives created by the pension system and the labor market because the retirement income $YRET_t(R)$ depends on retirement age according to the adjustment factors in Table 5.1 and on previous labor income according to the benefit computations.[29]

For every person in the sample the option value is computed using the applicable pension regulations and the imputed earnings histories. The parameters chosen are a discount rate $\delta$ of 3 percent and a curvature parameter $\gamma$ of 1.0; the relative utility parameter $\alpha$ has been estimated by a grid search algorithm and amounts to 2.8.[30] Additional private pension income is ignored, because it represents only a very small proportion of retirement income in Germany.

*Other Explanatory Variables*

Besides the option value and the social security wealth, the usual socio-demographic variables such as age, gender and marital status are incorporated in the regression analysis. The complexity of possible age effects is modeled by a set of age-specific dummy variables. Moreover, wealth (variables for labor income, financial assets and home ownership) and a self-assessed health measure are included. The legal disability status is not used as a measure of health since this is endogenous to the retirement decision. The desire for early retirement may prompt workers to seek disability status, and frequently the employer helps in this process in order to alleviate restructuring. Until recently, disability status was sometimes granted for labor-market reasons without a link to health.

### Econometric Estimation Method

A decision model is estimated with labor status "retired" as dependent variable that covers normal retirement as well as different forms of early retirement. The explanatory variables are linked to the dependent variable by a binary probit model. Using this simple functional form has two disadvantages from a theoretical point of view.

First, a cross-sectional probit model does some injustice to the panel nature of the present data and probably underestimates the true effect; see Börsch-Supan

[29]Benefits are computed on a lifetime contribution basis. They are the product of four elements: (1) the employee's relative wage position, averaged over the entire earnings history, (2) the number of years of service, (3) several adjustment factors, and (4) the average pension level. For more details see Börsch-Supan et al. (2004b).

[30]For details of the grid search see Börsch-Supan et al. (2004b).

(2001), who experiments with several specifications of panel probit models with parameterized correlation patterns over time. He demonstrates that the effects of the incentive variables are slightly strengthened. However, the results did not change significantly.

Second, the probit functional form ignores the structure of the dynamic optimization that underlies the worker's decision when to retire.[31] Inserting the option value in this type of a regression model, however, can be interpreted as a flexible discrete-time duration model explaining the timing of retirement entry. Previous investigations have shown that this pragmatic approach generates robust estimates of the average effects of the incentive variables on retirement, although it is likely to fail predicting the individual variation as precisely as the true dynamic optimization model.[32]

In order to correct for possible sample bias, the dependent variable (the observations of retired and non-retired persons) are weighted by aggregate sample frequencies computed from the VDR statistics which include all retirement entries into the public retirement insurance system.[33] Therefore, after scaling the present sample using age-specific weights the base model that is based on the 1972 legislation is able to reproduce representative retirement probabilities.

The estimation approach is slightly different from the one applied by Gruber and Wise (2004a and 2004b). The international comparisons in Gruber and Wise use for the dependent variable the probability of entering retirement (the hazard rate), which is the probability of being retired, given that the sample person has worked during the year before. Therefore, they include repeated observations of the same person only while this person is employed. In contrast, the present estimation sample includes repeated observations of the same person while employed and while retired, since retirement is not necessarily an absorbing state. Hence, the dependent variable is the probability of being retired, given that the sample person has worked until the beginning of the window period (age 53):

$$p_t = Prob(\text{retired in } t \mid \text{worked until 53}),$$

which is the cumulative distribution function. Given the estimated probability of being retired, the probability of retiring can be computed - if the sample person has not been retired before - as the differences of the cumulative distribution function at each age between 54 and 72:

[31] The full underlying dynamic programming model has been estimated by Rust and Phelan (1997).

[32] See Lumsdaine, Stock and Wise (1992) for a comprehensive account of the relative predictive properties of three competing approaches: the full dynamic optimization model, the FIML-option-value-model, and the discrete-choice-cum-option-value approach employed in the present paper.

[33] "*Rentenversicherung in Zeitreihen*", various issues.

$$q_t = p_t - p_{t-1} = Prob(\text{retired in } t \mid \text{not retired in } t-1).$$

The probability of choosing a retirement age $a$ is then $q_a$ and the expected retirement age is $\sum q_a \cdot a$.

Both estimation approaches are compared. For Germany the estimated and simulated cumulative probabilities of retiring are more robust than those estimated by a hazard model.[34]

### Base Model Estimates

Table 5.2 shows full regression results. A positive coefficient indicates that the explanatory variable increases the probability of being retired.[35] In addition to the option values, health and an array of socio-economic variables, a full set of age dummies is included to capture non-parametrically all other unmeasured effects on the retirement decision that are systematically related to age. Because of the different employment histories of men and women, resulting in very different claims on the retirement insurance and different incentives to retire, separate regressions for males and females are undertaken.

The incentive variable (option value) and the set of age dummies are highly significant for both males and females. For males the age dummies clearly elevate the probabilities to retire after ages 60, 63 and 65, the earliest retirement ages under the various pathways. Self-reported health is also highly significant: Healthier workers retire substantially later than those who report poor health.

Married males do not have a different retirement behavior compared to single males. However, if there is (still) a child in the household, retirement is more likely to be deferred. The effect of an university degree on retirement age is very strong and remains though an income measure is included as an additional control.

The wealth effect on retirement is clearly significant: Persons with higher wealth (home ownership, financial securities) afford earlier retirement. The income effect is not significant for males. Note that the higher opportunity costs of retirement have already been accounted for in the option value variable and in the wealth variables. Hence, the effect of higher labor income is over and above those variables and therefore only significant for income squared at the 10 percent level.

[34] More "robust" in the following sense: The methodology in Gruber and Wise (2004a and 2004b) produces quite a few individual negative retirement probabilities when they are computed from the hazards, since no summation constraint is imposed on several observations of the same individual in the panel data. This is not the case in the approach of the present paper, although the implicit summation constraints when computing $q_t = p_t - p_{t-1}$ are also ignored.

[35] The estimated coefficients represent the marginal effects of each variable on the implicit indirect utilities in the discrete-choice equations. Their absolute values have therefore no intuitive interpretation. Hence, the reader should focus on their signs and their levels of significance, but ignore their absolute values. Descriptive statistics of the variables used in Table 5.2 can be found in the Appendix, Table 5.4.

Table 5.2: Regression output

| | Males | | Females | |
|---|---|---|---|---|
| Variable | Coef. | Std. Err. | Coef. | Std. Err. |
| Optval | -0.006 | 0.001*** | -0.003 | 0.001*** |
| SSW | -0.002 | 0.001*** | 0.001 | 0.001 |
| SSW partner | 0.001 | 0.000 | 0.000 | 0.002 |
| Age=55 | 0.363 | 0.220 | 0.305 | 0.131** |
| Age=56 | 0.684 | 0.215*** | 0.445 | 0.131*** |
| Age=57 | 0.588 | 0.217*** | 0.551 | 0.131*** |
| Age=58 | 0.581 | 0.314** | 0.579 | 0.135*** |
| Age=59 | 0.570 | 0.249** | 0.582 | 0.138*** |
| Age=60 | 1.422 | 0.273*** | 2.010 | 0.147*** |
| Age=61 | 1.641 | 0.282*** | 2.178 | 0.153*** |
| Age=62 | 1.748 | 0.284*** | 2.263 | 0.163*** |
| Age=63 | 2.127 | 0.282*** | 2.317 | 0.178*** |
| Age=64 | 2.443 | 0.306*** | 2.242 | 0.178*** |
| Age=65 | 3.722 | 0.283*** | 3.916 | 0.185*** |
| Age=66 | 3.824 | 0.348*** | 3.974 | 0.225*** |
| Age=67 | 4.051 | 0.496*** | 3.963 | 0.259*** |
| Age=68 | 3.376 | 0.396*** | 4.007 | 0.269*** |
| Age=69 | 3.993 | 0.453*** | 4.264 | 0.281*** |
| Age=70 | 4.374 | 0.505*** | 4.370 | 0.337*** |
| Age=71 | 4.582 | 0.514*** | 4.864 | 0.380*** |
| Age=72 | 5.319 | 0.484*** | 6.293 | 0.418*** |
| Health status | -0.133 | 0.0131*** | -0.145 | 0.016*** |
| Married | -0.127 | 0.145 | -0.966 | 0.112*** |
| University degree | -0.566 | 0.270** | -1.011 | 0.223*** |
| Skill | -0.141 | 0.093 | -0.120 | 0.060** |
| Home ownership | 0.367 | 0.080*** | -0.193 | 0.060*** |
| No financial assets | -0.168 | 0.149 | -0.142 | 0.942 |
| Financial securities | 0.227 | 0.088** | 0.142 | 0.068** |
| Period of insurance | 0.035 | 0.025 | 0.046 | 0.009*** |
| Period of insurance squ. | -0.001 | 0.000* | -0.001 | 0.000*** |
| Labor income | 0.011 | 0.010 | 0.012 | 0.005*** |
| Labor income squared | 0.000 | 0.000* | 0.000 | 0.000*** |
| Self-employed | -0.458 | 0.170*** | -0.786 | 0.128*** |
| Civil service | 0.621 | 0.156*** | 0.977 | 0.289*** |
| Kids | -0.363 | 0.087*** | -0.078 | 0.065 |
| Constant | 0.037 | 0.483 | -0.162 | 0.224 |
| No. of obs. | | 2321 | | 4206 |

*Notes:* dependent variable: labor status "retired"; probit estimation; *, **, *** denote significant at the 10%, 5% and 1% significance level; *Source:* GSOEP, working sample 1984-1997.

Two dummy variables are indicating the former labor-force status. These variables take the value one if the person is currently (or used to be) self-employed or a civil servant. The model indicates that the self-employed tend to work longer, while civil servants retire earlier, even after all other variables such as pension rules and income levels have been taken into account.

For females the peaks of the age dummies are much more pronounced at age 60 and 65, in accordance with an accentuation of habitual effects over and above the economic incentives created by different pension rules for women. In contrast with males, the coefficient on social security wealth is not significant for females. A probable explanation is the fact that women have a less continuous working life.

Most socio-economic variables have effects of size similar to that in the male sample, but are more significant. This is especially the case for the effect of being married: Married women retire later, probably because they have raised children and therefore have an interrupted earnings record such that they are not eligible for retirement at age 60. This effect dominates that of the fact that married women, who are in general younger than their husbands, often try to retire at approximately the same time as their husbands.[36] There is no additional effect of having children on the retirement decision of women. The fact of being married appears to absorb the effect of having children in the household for the cohorts in the present sample.

### 5.1.5 Simulations of Reform Variants

Now the estimated coefficients are applied to several simulation experiments mentioned in Section 5.1.3. First the 1992 and 1999 reform is simulated as the reference scenario such as if it was already fully implemented. Note that until 1997, the end of the sample period, the rules of the 1992 pension reform had not been fully phased in. On top of the reference scenario the implementation of different actuarial adjustment factors and a change in the regular statutory retirement age of 65 by one or two years is simulated. Finally the impact of installing a *Notional Defined Contribution* (NDC) System is demonstrated.

The parameter values estimated in Section 5.1.4 are applied to each reform scenario to calculate the retirement probabilities for the ages 54 to 72, based on the assumption that an employee has previously worked up to the age of 53. The incentive variables implicit in each reform scenario are calculated, i.e., a new option value and a new social security wealth for each of the individuals in the present sample. The age indicators in the scenarios involving an increase in retirement age are also increased by one or two years in the forecast, as these capture the habitual effect of, for example, the statutory pension age.

[36]Note that joint retirement decisions of married couples are not considered. In the case of marriage the social security wealth variable of the married partner is included. However, the effect is insignificant.

The results are shown in Table 5.3 and Figures 5.2 and 5.3. Table 5.3 summarizes the key data for the distribution of retirement ages, separately for men and women, - viz., the average retirement age and the percentage of people retiring before ages 60, 62 or 65.

Table 5.3: The impact of different reform options on retirement age

| | Mean retirement age | Percentage of persons who retire before age 60 | 62 | 65 |
|---|---|---|---|---|
| *MEN* | | | | |
| 1972 legislation | 61.2 * | 17.20 | 58.20 | 81.90 |
| Pension reforms 1992 + 1999 | 63 | 4.70 | 42.40 | 51.70 |
| ... plus adjustment costs of 4,5% | 63.7 | 3.20 | 31.30 | 37.40 |
| ... plus adjustment costs of 6% | 64.9 | 2.10 | 18.60 | 20.00 |
| ... plus "pivotal age" +1 year | 63.3 | 5.80 | 26.00 | 52.60 |
| ... plus "pivotal age" +2 years | 63.7 | 7.20 | 11.30 | 53.40 |
| NDC System | 65.3 | 2.30 | 19.20 | 19.40 |
| *WOMEN* | | | | |
| 1972 legislation | 61.7* | 10.80 | 58.60 | 66.90 |
| Pension reforms 1992 + 1999 | 62.4 | 6.30 | 52.40 | 54.80 |
| ... plus adjustment costs of 4,5% | 62.7 | 5.30 | 48.60 | 50.10 |
| ... plus adjustment costs of 6% | 63.2 | 4.10 | 42.00 | 42.90 |
| ... plus "pivotal age" +1 year | 62.6 | 6.70 | 42.80 | 55.00 |
| ... plus "pivotal age" +2 years | 62.3 | 6.90 | 9.40 | 55.10 |
| NDC System | 63.3 | 4.20 | 41.80 | 41.80 |

*Note:* *) These values correspond to the mean retirement age calculated from the VDR statistics of 1995, based on old-age pensions and disability entries for all persons aged 54 to 72.

The overall distribution of new retirees is shown in diagrammatic form in Figures 5.2 and 5.3, again separately for men and women. The graphs on the left show the distribution of retirement ages, i.e., the probability that a person will enter retirement at a specific age. The graphs on the right show the accumulated retirement probabilities, i.e., the probability with which a person of a specified age has retired, for each age. The calculations include all people retiring between the ages of 54 and 72 who draw an old-age pension or disability benefits.

First the results for male workers are presented, then follows a discussion of women's responses to the introduction of actuarial adjustment factors and the changes in initial retirement rules. Finally, the results with respect to the introduction of a NDC system are described.

Based on the status quo established by the 1972 reform - i.e. the main provisions

affecting the people in the present sample - the full implementation of the 1992 and 1999 reforms would lift the average male retirement age by almost two years, from age 61.2 to 63. The impact on women, as shown below, is much weaker. An increase in the average age of retirement is thus foreseeable in the future on the basis of existing legislation alone and is already apparent in the latest figures issued by the VDR (Reimann 2003).

An upward shift in the entire fabric of age limits by two years increases the average effective retirement age for men by a further 9 months from age 63 to 63.7. Figure 5.2 (lower left) clearly illustrates how the two ages at which most insured persons retire - 60 or 65 - increase by two years. However, some people draw benefits for loss of earning capacity or put up with the actuarial deductions attached to earlier retirement rather than going along with this shift in age limits. The resulting increase in the effective age of retirement is somewhat greater than suggested by the BMGS, the German ministry of social security. Its rule of thumb states that in response to a change in the retirement rules, one-third of workers retire at the new retirement age, one-third continue to retire at the old age of retirement and accept the deductions this implies, and one-third avoid the new rules by claiming benefits for disability. This rule of thumb would suggest an increase in the average retirement age of less than 9 months.

The introduction of higher adjustment factors also has a very distinctive impact on retirement decisions. Deductions of 4.5 percent p.a. increase the average retirement age by nine months from age 63 to 63.7. Deductions of 6 percent have a considerably stronger incentive effect and even lift the average retirement age up to age 64.9. As shown in Figure 5.1, more people retire at age 65 and fewer at age 60 or 61.

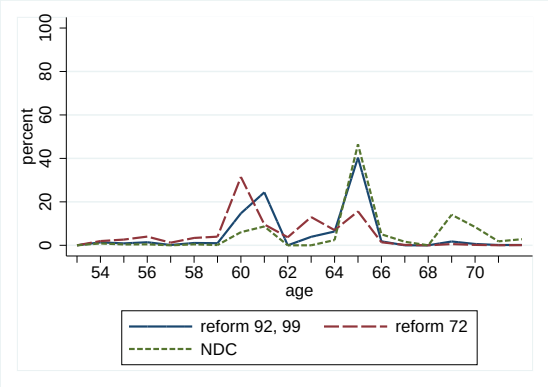
Women respond less strongly than men to a shift in age limits. Under the 1972 pension legislation, the average age of retirement for women is 61.7 and will only rise by 0.7 years to 62.4 when all the 1992 and 1999 pension reform rules are implemented in full.

An increase in the entire fabric of age limits for women by one year produces a postponement of 3 months, and the average age of retirement moves up from 62.4 to 62.6. An increase of two years is accompanied by a stronger drift towards disability benefits. The average age of retirement in this scenario is only 62.3, and thus remains to all intents and purposes unchanged.

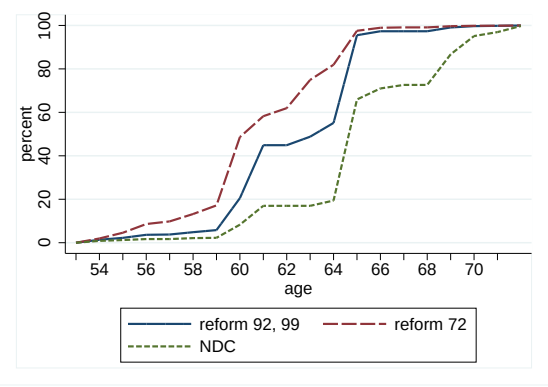
This behavior is very clearly illustrated by Figure 5.3 (below left): In the basic scenario, most women retire between the ages of 60 and 65. A shift in the age limits by one (or two) years also postpones the bulk of retirements among women by the same one-year (or two-year) period. However, not everybody retires later. Some people claim disability benefits earlier (the second peak flattens out as the age limits are progressively increased, while the first peak rises). This is the primary effect for women.

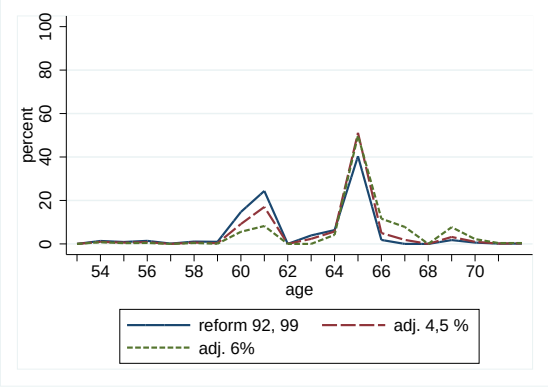
Figure 5.2: Predicted distribution of retirement ages, men

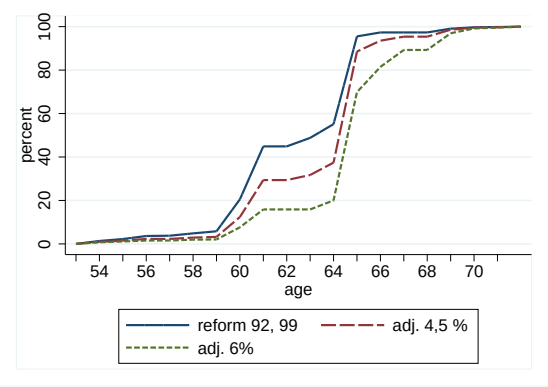
a. distribution of retirement age

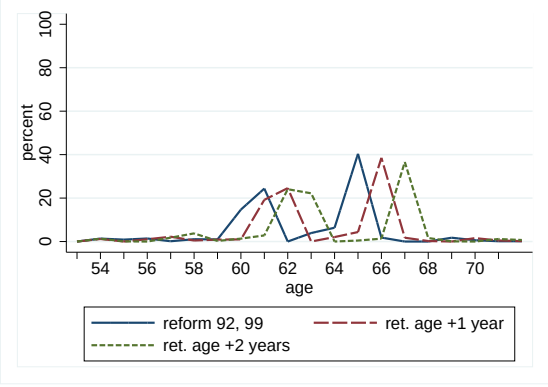



b. cumulative distribution



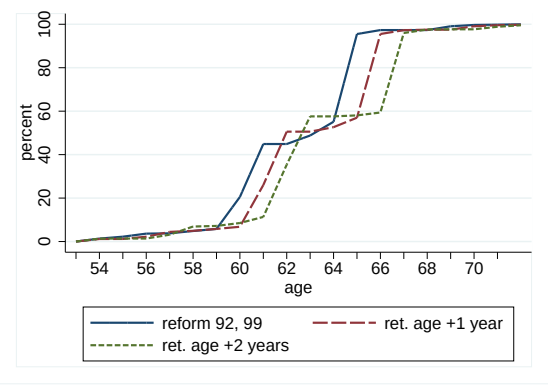
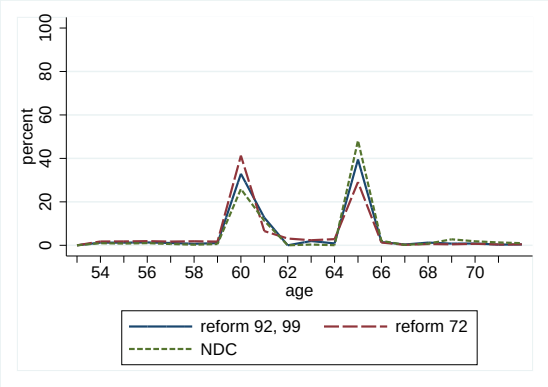
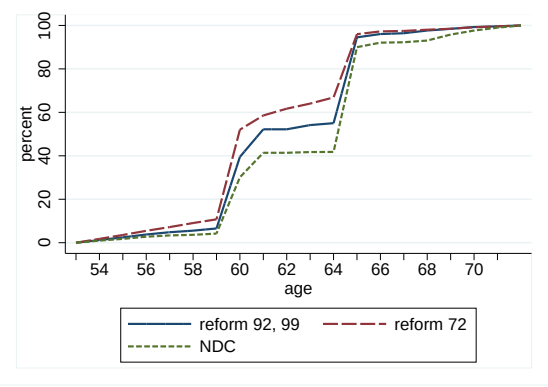



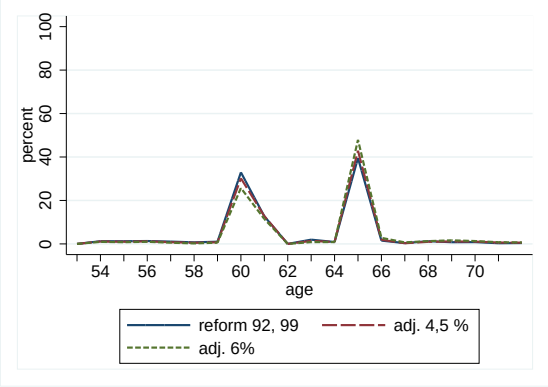
Figure 5.3: Predicted distribution of retirement ages, women

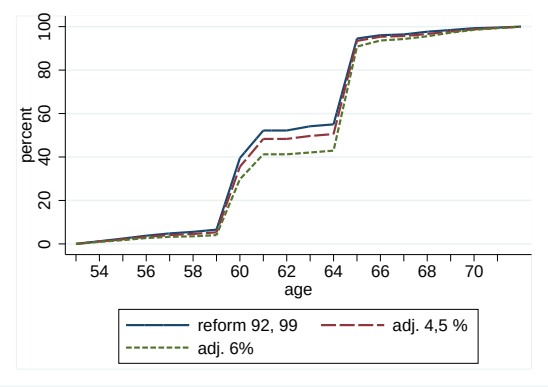
a. distribution of retirement age

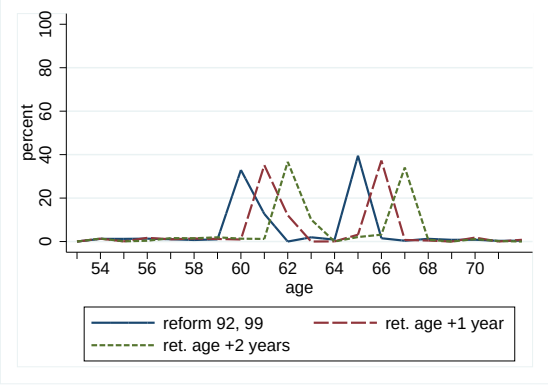


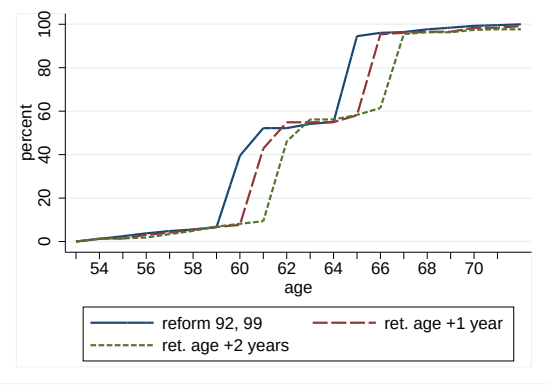

b. cumulative distribution



The incentive effect of higher adjustment factors is also weaker for women: a deduction of 4.5 percent p.a. increases the average age of retirement by 3 months from 62.4 to 62.7. A deduction of 6 percent p.a. increases the average retirement age by another 6 months to 63.2 years.

Finally, the simulations demonstrate that the introduction of the NDC system would also have a major impact on the average age of retirement in comparison with the 1992 and 1999 reforms (refer to Table 5.3). The average age of retirement increases by more than two years for men (from 63 to 65.3) and, less dramatically, by almost one year for women (from 62.4 to 63.3). Of the five reforms examined, this variant generates the highest average retirement age and thus evidently has the most powerful incentive effects. As demonstrated by Figures 5.2 and 5.3, the distribution of new retirements is similar to that in the scenario involving higher adjustment factors. This applies equally to men and women.

Although the NDC system in fact differs both in technical respects and in underlying transfer philosophy from the pay-as-you-go system, the earnings points rules embodied in the German pay-as-you-go system resemble fairly closely the actuarial principle of equivalence between contributions and benefits. The main difference between the two systems is that the NDC system includes explicit actuarial adjustment factors that are considerably higher than in the reference scenario.

It is important to bear in mind that the estimates summarized in this paper are based on the behavior of employees and employers from the mid-1980s to the 1990s. The future behavior particularly of female workers may well change significantly, viz., more closely resemble that of male workers, in the period 2005 to 2025 to which the projections in this paper apply.

### 5.1.6 Summary and Conclusions

The accelerating process of population aging will have a momentous impact on the financial sustainability of the German pay-as-you-go pension system. The increase in the old-age dependency ratio means that the pensions of a growing number of people at retirement age will have to be financed by a smaller workforce. Quite apart from these demographic problems, there are also strong incentive effects favoring early retirement built into the German pension system. These incentives increase the old-age dependency ratio even more than would be dictated by demographic factors alone.

In the present paper the influence of pension legislation on retirement decisions in Germany is modeled and estimated. Retirement probability is summarized as a function of an incentive variable, which encompasses pension legislation and other control variables. The option value of postponing retirement by one year is employed as an incentive variable. This model is then used to simulate various reforms to the retirement rules: the 1992 and 1999 reforms, as well as a range of reform variants offered for discussion by the "Rürup Kommission", including an increase in

standard retirement age limits, an increase in the actuarial adjustment factors, and the implementation of a notional defined contribution (NDC) system modeled after the Swedish pension system.

The calculations show that the introduction of an actuarial adjustment factor of 3.6 percent p.a. and other changes to the retirement rules already introduced by the 1992 and 1999 reforms will, over the next few years, increase the average effective retirement age for men by almost two years and that for women by a considerably shorter period of not quite 9 months.

A shift in the structure of age limits as a whole by a further two years would postpone the effective retirement age of men by, on average, around 9 months, and would have little or no effect on the retirement age of women. Alternatively, an increase in the actuarial adjustment factor from 3.6 percent to 6 percent would increase the average age of retirement of men by almost 2 years. This effect would be considerably weaker for women; nevertheless, their average age of retirement would increase by around one year.

These results illustrate that an increased actuarial adjustment factor and an increase in the statutory retirement age based on higher remaining life expectancy offer major potential for postponing the effective age of retirement. This is an important finding. Since the pension system from which we depart distorts the retirement decision - in that the present discounted value of pension benefits as seen by a current worker decreases substantially with increasing age of retirement - an increase in the effective retirement age will reduce the financial burden of the public pension system.[37] This is the case as long as the adjustment factors are based on an interest rate below the economy-wide discount rate.[38] From an economic perspective, therefore, these policy options offer suitable measures which help to put the German pay-as-you-go public pension system on a path on which it can regain its financial sustainability.

[37]Börsch-Supan and Schnabel (1998) provide empirical estimates and graphical representations of the decline in the present value of benefits with increasing retirement age. It is important to note that the budget effect is caused by the current actuarial non-neutrality of the German pension system. It vanishes once the system has gained actuarial neutrality, see e.g. Breyer and Kifmann (2002) for a theoretical analysis, and Gruber and Wise (2004b), in their introduction, for an empirical international comparison of the size of these budget effects. The exact quantification of the budget effects is a subject of current research. Börsch-Supan, Kohnz and Schnabel (2004a) provide preliminary budget effect estimations based on a simplified model of the German social security system.

[38]For a discussion of the involved discount and interest rates, see Börsch-Supan (2003).

### 5.1.7 Appendix

Table 5.4: Descriptive statistics of variables used in Table 5.2

| | Males | | Females | |
|---|---|---|---|---|
| Variable | Mean | Std. Err. | Mean | Std. Err. |
| labor status "retired" | 0.400 | 0.011 | 0.312 | 0.007 |
| Optval | 184.62 | 3.606 | 141.36 | 9.925 |
| SSW | 301.39 | 3.135 | 129.89 | 1.820 |
| SSW, sqrd. | 52.37 | 2.302 | 218.50 | 2.889 |
| Health status | 8.223 | 0.063 | 9.197 | 0.032 |
| Married | 0.947 | 0.005 | 0.913 | 0.004 |
| University degree | 0.079 | 0.006 | 0.038 | 0.003 |
| Skill | 0.850 | 0.011 | 0.478 | 0.009 |
| Home ownership | 0.488 | 0.011 | 0.517 | 0.008 |
| No financial assets | 0.085 | 0.006 | 0.105 | 0.005 |
| Financial securities | 0.251 | 0.009 | 0.226 | 0.007 |
| Period of insurance | 39.92 | 0.145 | 21.02 | 0.201 |
| Period of insurance squ. | 1640.1 | 9.245 | 604.3 | 9.681 |
| Income | 55.64 | 0.490 | 29.64 | 1.062 |
| Income squared | 3637.5 | 73.06 | 5452.6 | 1756.9 |
| Self-employed | 0.072 | 0.005 | 0.086 | 0.004 |
| Civil service | 0.119 | 0.007 | 0.010 | 0.002 |
| Kids | 0.312 | 0.010 | 0.303 | 0.007 |
| No. of obs. | 2321 | | 4206 | |

*Source*: GSOEP, working sample, 1984-1997.

## 5.2 Retirement Age and Preretirement in German Administrative Data

### 5.2.1 Introduction

Early retirement and preretirement[39] are costly achievements that aggravate the already tight financial situation of the German pay-as-you-go pension system due to population aging. Since 1992, pension and labor-market reforms have been adopted and they greatly restrain publicly subsidized early retirement and preretirement possibilities. Because of these reforms, the distribution of retirement age of older workers is expected to be changing. These changes can be exploited to investigate the impact of policy reforms on retirement entry behavior.

So far, there is hardly any research on the impact of pension reforms on preretirement in Germany. The difficulty consists in observing preretirement in the data and in providing for a sufficiently long time-series that allows to analyze policy reforms. The only empirical analysis in this area has been undertaken by Wübbeke (2005) who uses a data set based on administrative information of labor-market histories and retirement entries.[40] She investigates the impact of firms' employment and public social security policy on employees' changes from employment into retirement in the period of 1975 to 1995.

Recently, the German Pension Insurance ("Deutsche Rentenversicherung") has started to release administrative data for research purposes. This administrative data is a promising source for investigating the impact of labor and pension reforms on individual retirement behavior, because it includes detailed information about individuals' employment status and pension insurance characteristics. So far, only cross-sectional but no time-series data of individuals' retirement entries and insurance histories are available. The data set used in this study, i.e., the *Scientific Use File (SUF) Versichertenrentenzugang 2003*, is a representative sample of publicly insured persons who retired in 2003. This data is used to learn more about how to describe preretirement which will be useful for future economic analysis of policy reforms based on German administrative data.[41] The present paper discusses

[39]Preretirement refers to effective retirement before old-age public pension payments can be received from age 60 onwards and includes the option of partial retirement ("Altersteilzeit"). Negotiations between employers and employees, and state subsidies enable preretirement. In contrast, official retirement is defined as receiving public old-age pension payments and, thus, includes early retirement from age 60 onwards. For a more detailed description of early retirement pathways see Section 5.1.2.

[40]This data is not publicly available but results from an - until now - unique example of combining data on labor-market histories issued by the Institute for Employment Research ("Institut für Arbeitsmarkt- und Berufsforschung") of the Federal Employment Agency ("Bundesargentur für Arbeit") and data on retirement entries issued by the German Pension Insurance ("Deutsche Rentenversicherung")

[41]As discussed in Appendix B the data provided so far by the German Pension Insurance, i.e.,

differences between individual determinants of retirement for those choosing preretirement programs as opposed to official public pension plans. A reduced form econometric approach is employed in order to explore this question.

Based on the *SUF Versichertenrentenzugang 2003*, the present sample reveals that 40 percent of all men and women preretire, that is they withdraw from the labor market before official pathways into old-age retirement can be taken. On average individuals stay 2.4 years in preretirement before taking one of the official early retirement entries based on the unemployment or partial retirement ("Altersteilzeit") pathway or retirement plans for women. Moreover, differences in effects of individual determinants - such as rehabilitation services, income before retirement and pension payments - on retirement age can be observed for preretired persons compared to persons taking official retirement entries.

The paper proceeds as follows: Section 5.2.2 summarizes institutional facts and recent changes of early retirement, partial retirement and preretirement in Germany. In Section 5.2.3 the data, the sample, and the definition of preretirement are discussed. Characteristics of the retirement age are presented in Section 5.2.4 and, finally, Section 5.2.5 concludes.

### 5.2.2 Early Retirement, Partial Retirement and Preretirement in Germany

Early retirement, preretirement and partial retirement refer to regularly used official and unofficial pathways into retirement before reaching the statutory age of 65. In order to clarify these concepts and in order to motivate institutional changes with respect to the public pension system and unemployment insurance since 1992, they are described in the following.

Early retirement refers to retirement entry before age 65 by one of the official pathways into old-age retirement, which results in an income stream paid by the German public pension system. It has been introduced in Germany with the pension reform in 1972. With the age of 60 women, partial retirees,[42] unemployed or employees, who can not be appropriately employed due to health or labor-market reasons, can enter retirement ("Frührente"). All other employees who have been contributing to the public pension system for at least 35 years can retire at the age of 63. These pathways into retirement are not related to any additional adjustment costs. Consequently, strong incentives are set to retire before the age of 65 and individuals react accordingly.

A recent survey reveals that two out of three employees would leave the labor

the *SUF Versichertenrentenzugang*, does not allow for policy analysis of retirement entry behavior based on option value models.

[42]The term "partial retirees" refers to persons who enter a partial retirement plan ("Altersteilzeit").

force between age 55 and 60 if this was financially feasible (Pfeiffer and Simons 2004). Preretirement ("Vorruhestand") meets these preferences and refers to labor force exits that take place before early retirement is possible. This labor force exit can be referred to as preretirement if a person receives income paid by the unemployment insurance or other state subsidies that burden the tax and social security systems and/or income that results from arrangements between employers and employees.

One can distinguish between two different ways of entering preretirement. On the one hand, unemployment compensation is an important way of financing preretirement. If a firm wants to lay off older workers in a restructuring process, employees can receive a negotiable combination of unemployment compensation and a supplement or severance pay. At the age of sixty they enter early retirement via the public pension system, i.e., by taking the unemployment pathway. In the case of preretirement, the date of the labor force exit is very often determined by the maximum duration of unemployment benefit payments. Until 2005 the duration of benefits paid by the unemployment insurance ("Arbeitslosenversicherung") lasted between 24 and 32 months.[43] Even earlier labor force exits and corresponding retirement entries can be induced by paying the employee the difference between the last salary and unemployment assistance ("Arbeitslosenhilfe"), which, until 2005, lasted for one additional year. Unemployment insurance benefits can amount to 67 percent of the last salary and are especially attractive as the unemployment insurance additionally pays the contributions to the public pension system.

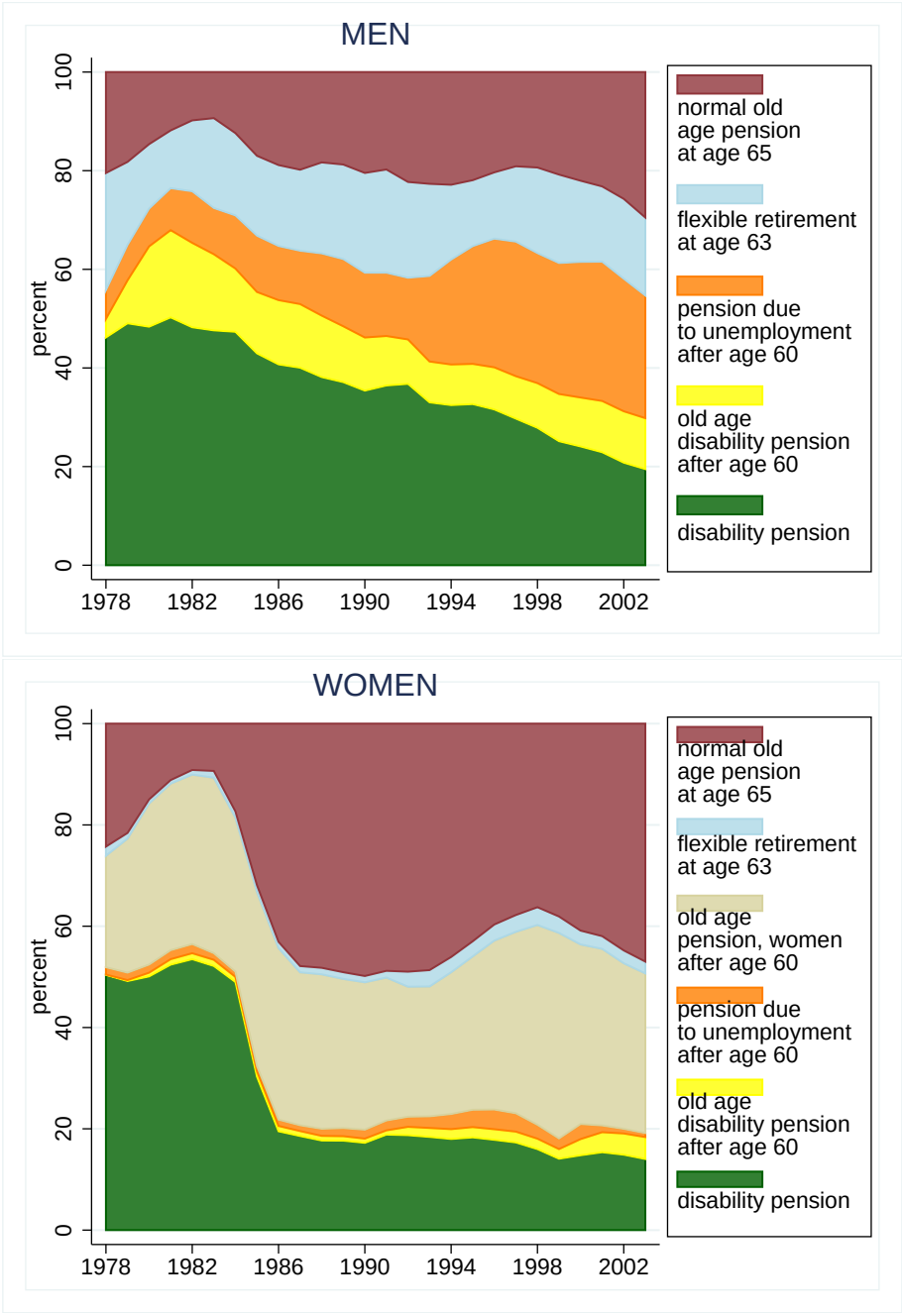
On the other hand, partial retirement ("Altersteilzeit") is another means of preretirement. This scheme provides for part-time work between the age of 55 or above and early retirement at age 60 or 63 depending on the above mentioned pathways. Effectively, many employees continue to work full time at first and then leave their job earlier ("Blockmodell"). Partial retirement is state-subsidized: The unemployment insurance pays an additional 20 percent of the usual part-time earnings if the employer hires a young employee. This rule also encourages employers to substitute older by younger employees and meets employees' interest in retiring early.

Figure 5.4 shows the fraction of different pathways into retirement relative to total retirement for the period of 1978 to 2003. It demonstrates that old-age pensions due to unemployment have become an important pathway into retirement since the early 1990s for men, whereas among women the unemployment pathway is not frequently used. Due to low labor-market participation, women rather take the pathway for women which allows to enter retirement at age 60.

Starting with the pension reforms of 1992 and 1999 and continuing with labor-market reforms in 2003, several changes to these rules have been adopted. These changes constrain generous early retirement and preretirement options. The reforms of 1992 and 1999 introduced an increase of the retirement age limits to age 65 or

[43]The exact duration depended on the duration of compulsory insurance coverage and on the age of the beneficiary.

Figure 5.4: Pathways into retirement




*Sources*: Own calculations based on VDR (1978-2004).

age 63 for long-term insured. These changes will be fully implemented after a long transitional period in 2015.[44] There will no longer be exceptions for the unemployed, partially retired or women. In Figure 5.4 a small decrease in the early retirement options of unemployment pensions for men and women old-age pensions can already be observed since the late 1990s. Moreover, the government introduced adjustment costs that reduce pension payments by 0.3 percent for each month of early retirement before age 65. If employers do not want to accept the lower pension benefit, they either need to work longer or have to extend the preretirement period, i.e., the period between labor force exit and retirement payments. From 2005 onwards, unemployment benefits are shortened from a maximum of 32 to 18 months ("Hartz IV"). Unemployment assistance will be paid only if the preconditions for welfare payments are fulfilled ("Arbeitslosengeld II"). Thus, state-promoted preretirement between labor force exit and pension benefit payments is now greatly reduced and limited to 18 months. Transition rules of the pension reforms of 1992 and 1999 already apply to most cohorts retiring in 2003, whereas the new labor-market regulations have not been effective before 2005.

All these reform steps indicate a change in paradigm from promoting early and preretirement towards working longer. These reform steps are backed by the insight that skills of older workers are needed, especially in the course of population aging, and encouraged by governmental initiatives to bring older workers above age 50 back into work ("Initiative 50 plus"). Based on descriptive statistics of recent administrative data of aggregate retirement entries, Reimann (2003) shows that these changes have already had an effect as the retirement entry behavior slowly starts to change. However, the pension reforms in 1992 and 1999 have long transitional periods and are not yet fully phased in. It is of great interest to exploit this policy change in future research in more detail and to investigate the responsiveness of retirement entries, preretirement and old-age unemployment to institutional changes for simulations of future pension and labor-market reform scenarios.

### 5.2.3 The Data and Sample

The data employed in this study is based on administrative data of the German public pension insurance that are collected and provided by the German Pension Insurance ("Deutsche Rentenversicherung"). As these data are made virtually anonymous, scientific use files entail only a representative sub-sample of all publicly insured individuals or pensioners of the public pension system. This paper employs the *SUF Versichertenrentenzugang 2003* (SUFRTZN03XVST_Berk) which is a sample of about 100,000 individuals that started to receive public pensions in 2003. People that are publicly insured but are not yet retired are not part of the sample.

[44]For a more detailed description of the 1992 and 1999 reforms and a graphical description of statutory age limits during the transition period refer to Berkel and Börsch-Supan (2004) or Figure 5.1, Section 5.1.2.

Administrative data are very valuable to analyze questions on retirement entry behavior. They have the following advantages compared to German survey-based data such as the GSOEP: First, samples are large representative draws of the whole population of publicly insured persons. Second, there is no attrition. Third, there are no problems with the interpretation of questions as it is often the case with survey responses. Fourth and most importantly, the sample provides information on individuals' insurance status before retirement and entails all the relevant information to determine a person's pension claims, e.g., information on earnings points[45], on various contribution periods and the type of pension that is received.

But administrative data are also associated with difficulties.[46] One major issue is the measurement of the effective retirement age, which is discussed in detail in the remainder of the paper. Other issues are the measurement of income, wealth and socio-economic variables.[47] Information on these characteristics are available as far as the public pension system retains them for the determination of individual pension claims. Income refers to income subject to social security contributions only and wealth is not recorded at all. Person's health status can be inferred by using a variable that describes whether medical rehabilitation services have been taken in the last 5 years before retirement. Direct information is available, for example, on education, family status, residence and details necessary for the calculation of public pension payments.

For some variables more than pure cross-sectional information is provided, i.e., gross yearly income subject to social security contributions and the status of insurance in the three years before retirement. The latter provides additional information on individuals' situation, i.e., whether they are self-employed or unemployed before retirement.

For the subsequent analysis the sample is limited to individuals between age 54 and 72 that receive an old-age or disability pension for the first time in 2003. Individuals with partial pensions are excluded from the sample as these persons are likely to be still partially employed. Observations with pension payments that are significantly determined by inter- or supranational legislation are not considered, because these are determined by factors that are out of reach in this study. Problematic for the analysis are also pensions paid on the basis of the "Fremdrentengesetz" (FRG) which include mainly East-Germans that took refuge from Eastern to Western Germany and resettlers ("Aussiedler" and "Spätaussiedler"). As suggested by Mika (2005), these observations are excluded from the sample as their pension payments and corresponding information in the data are based on fictive contributions.

[45]In Germany the calculation of pension payments is based on earnings points. For each person the number of earnings points depends mainly on the relative earnings position and the number of contributions.

[46]These difficulties differ from problems with German survey data. It would therefore be interesting to compare the GSOEP to the present administrative data in detail. This, however, lies beyond the scope of the present paper.

[47]For a detailed description of the data see also Himmelreicher (2006) and Radl (2005).

The adjustment of pension payments in East Germany to West German levels has almost been completed in 2003. Therefore, differences affecting the retirement entry age should be minimal and observations from both East and West Germany are included in the sample.

**Retirement Age in German Administrative Data**

Administrative data provide detailed and reliable information on individual pension claims that are necessary for meaningful analyses of individual retirement entries and labor force exits. The retirement age in administrative data is defined as the age at which a pension is received from the German public pension insurance for the first time. This retirement age is referred to in the following as the official retirement age. Thus preretirement is not considered. There are three main motivations for taking account of preretirement and for considering the effective instead of the official retirement age in economic analyses of retirement entries: First, recent pension and labor-market reforms, among other things, aim at limiting preretirement as it aggravates the financial situation of the social security systems. It is of great interest to investigate the impact of these reforms on preretirement using administrative data. Second, it is important to take account of preretirement if overall financial effects of retirement entries on social security systems are of interest instead of financial effects on the public pension system alone as preretirement typically burdens the unemployment insurance. Third, survey-based data show that individuals refer to themselves as retired when they have not yet officially retired but are preretired (Börsch-Supan et al. 2004b). For a consistent estimation of individual retirement entry decisions it is, thus, necessary to use the effective as opposed to the official retirement entry age.

Preretirement cases can be identified in the data as information on individuals' insurance status is available not only for the year before retirement, i.e., for 2002, but also for 2001 and 2000. The insurance status specifies whether a person (i) had an employment that was subject to social security contributions, whether a person was (ii) marginally employed ("geringfügig beschäftigt"),[48] (iii) eligible for a partial pension plan ("Altersteilzeit"), (iv) voluntarily insured,[49] (v) compulsorily insured mainly due to unemployment or sickness,[50] (vi) passively insured or (vii) in some other insurance category.[51] Table 5.5 summarizes the fraction of each insurance category in the present sample. Half of the individuals have been passively insured

[48] A person is considered marginally employed if he or she does not earn more than 400 Euros per month. Special rules with respect to social security insurance apply to these persons.

[49] These are mainly self-employed persons or housewives who have no income subject to social security insurance but voluntarily take part in the German public pension system.

[50] For exact definitions refer to the German Social Security Code ("Sozialgesetzbuch"), SGB III and § 3 Nr. 3 SGB VI.

[51] This category includes for example persons that were eligible to insurance credits ("Anrechnungszeiten") or other compulsory insurances that are not part of (v).

or compulsorily insured due to unemployment or sickness. Passive insurance refers to all persons that have not paid any social insurance contributions in the year before retirement. 50 percent of these individuals have not paid any contributions for more than 20 years. This group inter alia includes civil servants or self-employed that have earned pension claims due to employment subject to social security insurance at some point in time, typically very early in their career. A third group is made up of individuals that gave up employment early which are mostly housewives.

Table 5.5: Insurance status before official retirement

| insurance status | percent* |
|---|---|
| employment s.t. social insurance contributions | 20.64 |
| marginally employed | 4.14 |
| compulsorily insured (unemployment, sickness) | 23.92 |
| partial retirement plan | 12.46 |
| voluntarily insured | 3.31 |
| passively insured | 25.60 |
| others | 9.93 |

*Source*: Own calculations based on *SUF Versichertenrentenzugang 2003* (SUFRTZN03XVST_Berk).
*) Percentages relative to all individuals in the sample that officially retired in 2003.

As summarized in Section 5.2.2 individuals are considered to be preretired if they were unemployed, partially retired, marginally employed or passively insured. In order to rule out cases that have been passively insured for a very long period, (e.g. housewives, self-employed or civil servants) only those are included that have paid contributions to the public pension insurance at least once during the last 10 years before official retirement in 2003. At the same time, persons that return to an employment status subject to social security contributions or to voluntary insurance are not included in this pool of preretired persons.[52] This classification of preretirement is taken from Pfeiffer and Simons (2004) who investigate preretirement in Germany using various data sources. With this definition, 47 percent of men and 37 percent of women preretired in the present sample, i.e., effectively retired before 2003.[53]

[52]Also, persons that enter preretirement at age 63 or later are not considered as preretired. These are only a few cases.

[53]Due to a censoring problem for the year 2000 it is not possible to determine whether individuals who are effectively retired in 2000 entered retirement in 2000 or before. For the determination of the effective retirement age this is, however, necessary. All individuals preretired before 2001 are assumed to have entered preretirement in 2000. Compared to the alternative of excluding these

The sample also includes disability pensions. Note that preretirement in this study covers part of the disability cases. Persons retiring due to disability amount to 10 percent in the present sample. Half of them receive a disability pension directly after leaving the labor force, another 30 percent after a period of unemployment. According to the above mentioned definition, the latter case may fall into the preretirement category, whereas the first does not. Declaring part of the disability cases as preretired is reasonable, because obtaining a disability pension due to labor-market reasons is still possible for cohorts retiring in 2003. However, it has become much more difficult over time.[54]

Figure 5.5 displays retirement entry probabilities in 2003 for men and women aged 54 to 72 that take official pathways into retirement. Preretirement is not accounted for in the data underlying this figure. The distributions for men and women are characterized by two large spikes at age 60 and 65. There is also a third spike for men at age 63. For women the spikes at age 60 and 65 are more pronounced than for men. These differences can be explained by differences in employment histories and different retirement pathways for men and women. 27 percent of all women retire at age 60. This high value is due to a pension pathway that allows women under certain conditions to enter retirement at age 60. This pathway still exists in 2003, however, adjustment costs have to be taken into account. Another 41 percent of all women retire at age 65. Due to interrupted employment histories, women often have not contributed a sufficiently long time period into the public pension system such that they are not eligible to choose this or any other pathway to retire before age 65.

The distribution of retirement age between age 54 and 72 is smoother for men: 20 percent retire at age 60, 18 percent at age 63 and 25 percent at age 65. From age 60 onwards men can retire via the unemployment or partial retirement pathway. From age 63, they are eligible for retirement if they are long-term insured. In 2003 adjustment costs apply to almost all cohorts that choose one of these retirement pathways.

The average official retirement entry age[55] for men and women as reported in the present sample amounts to 62.3 and 62.5 years respectively. Once preretirement is considered, the average effective retirement age is about one year lower: 61.3 years for men and 61.6 years for women. In the present sample men and women preretire on average at age 59.3 and 59.2 respectively and officially retire after 2.4 years.[56]

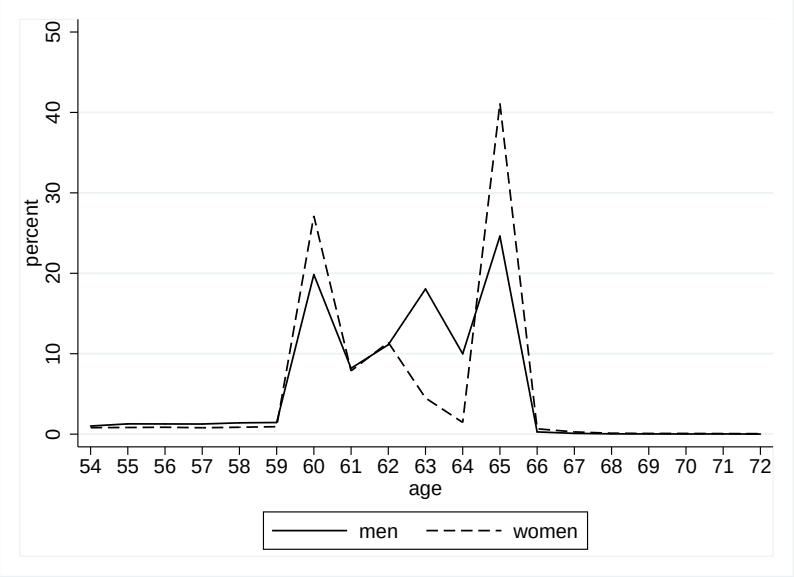
observations from the sample, this assumption is justified: The resulting average of duration in preretirement in the present sample amounts to 2.4 years and is only slightly lower than the average duration of preretirement in the GSOEP data which is 2.5 years (Pfeiffer and Simons 2004).

[54] Note the reduction in disability pensions since 1978 in Figure 5.4.

[55] "Official" refers to the fact that these individuals enter retirement through one of the official pathways (old-age or disability pensions) and receive pension payments from the German Pension Insurance. The numbers refer to average values in the present sample and, therefore, do not exactly match statistics issued by the German Pension Insurance.

[56] These average values are only approximately correct. Note that the group of preretired persons

Figure 5.5: Distribution of retirement entry age in 2003




*Source:* Own calculations based on *SUF Versichertenrentenzugang 2003* (SUFRTZN03XVST_Berk), German Pension Insurance ("Deutsche Rentenversicherung").

### Other Variables

In order to characterize retirement entry age the data set provides several variables for the subsequent regression analysis: income before retirement, pension payments, socio-demographic characteristics such as highest educational degree, status of sickness, marital status, and times of child-caring.

Income in administrative data refers to income subject to social security contributions. It does not mirror a person's complete income position. Therefore, income of passively or voluntarily insured individuals is missing. These individuals mainly obtain income from other sources, e.g., self-employed or civil servants who have had an employment subject to social security contributions only at the beginning of their career. Also housewives belong to this group. In case of housewives but also more generally in the case of couples, especially with children, it would be desirable to use a couple's income. However, the data does not allow to match couples.

As the idea of the following econometric analysis is to provide a picture of the

in this sample refers to persons preretiring in 2000 to 2002 and officially retiring in 2003. In order for this group to be representative for preretirement cases in 2003, one has to assume that preretirement cases in 2000 to 2002 are representative for preretirement cases in 2003 that officially retire in 2004 to 2006, i.e., one has to assume that no cohort and time effects exist for the years 2000 to 2006. As retirement entry rules are changing due to long transitional periods of the reforms of 1992 and 1999, time effects can not fully be ruled out.

characteristics of retirement entry age as provided by the administrative data at hand, observations with missing income values are not dropped, but explicitly controlled for. An income dummy is constructed that is equal to one if the income value is missing, *income_mis*. 26 percent of all men and 44 percent of all women have reported missing incomes values. Almost 70 percent of these men and women are passively insured.[57]

Another shortcoming of the income variable is the censoring of yearly income values greater than 55,000 Euros. In order to circumvent the censoring problem at the top end of the income distribution, dummies for income quintiles are constructed for men and women with reported income values.[58]

Pension payments are directly obtained from the data. The corresponding variable refers to public pensions only. As pension payments are censored at values greater than 1800 Euros per month, again dummies for pension payment quintiles are constructed.[59]

Information on education is classified by the highest individual educational degree: secondary school ("Hauptschule" and "Mittlere Reife"), high school ("Abitur"), technical college ("Fachhochschule") or university. The categories secondary and high school are subdivided into cases with and without vocational training ("Berufsausbildung"). Dummy variables equal to one for the highest educational degree are constructed and included in the regression analysis. Furthermore, there is one category referring to unknown education levels and another category referring to missing values. The latter category includes about one-third of all observations. These are mostly individuals that entered retirement not directly after employment: 57 percent are passively insured and 20 percent are unemployed in the year before retirement. Thus, no information on the educational degree was provided by a former employer.[60] The category of missing educational degrees is clearly non-random and related to the insurance status before retirement and is, therefore, separately included in the regression. The distribution of observations with unknown educational degree across income classifications is also likely to be non-random and enters as an additional dummy variable.[61]

The health status can be proxied by two different variables: An indicator variable that denotes whether a person has claimed rehabilitation services during the last 5

[57]Because of missing income values one could alternatively consider to drop all passively insured persons who have not contributed to the public pension system within the last 10 years and all voluntarily insured persons. Another way to deal with the problem would be to impute income and wealth by using the GSOEP.

[58]For exact quintile ranges see Table 5.9, Appendix A.

[59]For the exact range of quintiles see Table 5.9, Appendix A.

[60]For further background information on the education variable refer to Fitzenberger, Osikominu and Völter (2005).

[61]In this group 33 percent of individuals are employed subject to social security contributions, 21 percent are unemployed and 25 percent are marginally employed, the rest splits up into all other categories.

years previous to retirement[62] and a variable that comprises months of insurance credits due to sickness or rehabilitation.

Information on a person's marital status and on the number of months dedicated to child-caring are provided. It is important to mention that this number refers only to cases in which times of child-caring are credited and lead to higher pension benefits. This variable, therefore, does not directly measure the number of children.

Finally, information on individuals insurance status is categorized. The following dummy variables are included in the regression analysis: employment subject to social insurance contributions; partial retirement; compulsory insurance due to unemployment, sickness or rehabilitation; marginal employment; voluntary employment; passive insurance and others.

Tables 5.9 and 5.10 in Appendix A provide definitions and summary statistics of all variables that are of interest in the subsequent regression analysis.

### 5.2.4 Characteristics of the Official and Effective Retirement Age

As all people in the sample officially retire in 2003 or effectively retire during the short window between 2000 and 2003, the main sample variation results from the differences in retirement age across individuals. The determinants of this variation are investigated using standard OLS regressions with heteroscedasticity robust standard errors. Estimations are undertaken separately for men and women as retirement entry behavior and the corresponding retirement age are likely to be affected by systematic differences in employment histories. In a first step, retirement age is defined as a person's age in 2003, which is the official retirement age. In a second step, retirement entry age refers to a person's age when effectively retiring. Therefore, individuals who preretire are identified and their official retirement age is adjusted to their effective retirement age.

#### The Official Retirement Age

Two different specifications are estimated: The first one includes variables for income, pension, education, health status, marital status and child-caring (Table 5.6), whereas the second specification additionally includes dummies for insurance categories as described in the previous section (Table 5.6). Variables referring to income subject to social security contributions in the year before retirement and retirement income paid by the public pension insurance in 2003 are defined as dummy variables of income or pension income classes: A dummy for missing income values, *income_mis*, as well as dummies for income and pension payment quintiles are

[62] Persons that receive a disability pension have often taken rehabilitation services before retiring. However, this is no precondition for obtaining a disability pension in Germany.

constructed: *income_1st*, ..., *income_5th*, *pension_1st*, ..., *pension_5th*. This classification does not allow to interpret the absolute effects but effects relative to the reference category, which is the third quintile for both income and pension payments respectively, *income_3rd* and *pension_3rd*.

Table 5.6: Characteristics of the official retirement age I

| | men | women | | men | women |
|---|---|---|---|---|---|
| *income_mis* | 1.728*** | 1.039*** | *high_school* | -0.547** | 0.271 |
| | [0.087] | [0.067] | | [0.269] | [0.316] |
| *income_1st* | -0.336*** | 0.065 | *high_school_VT* | -0.538*** | -0.029 |
| | [0.067] | [0.051] | | [0.120] | [0.145] |
| *income_2nd* | -0.354*** | -0.444*** | *sec_sch* | -0.936*** | -0.365*** |
| | [0.042] | [0.032] | | [0.071] | [0.099] |
| *income_4th* | -0.081** | -0.301*** | *sec_sch_VT* | -0.955*** | -0.437*** |
| | [0.033] | [0.044] | | [0.056] | [0.095] |
| *income_5th* | 0.365*** | 0.472*** | *edu_unknown* | -0.643*** | -0.054 |
| | [0.076] | [0.064] | | [0.069] | [0.100] |
| *pension_1st* | 1.598*** | 2.814*** | *edu_missing* | -1.350*** | -0.179* |
| | [0.050] | [0.032] | | [0.063] | [0.097] |
| *pension_2nd* | 0.607*** | 1.188*** | *reha* | -3.279*** | -3.576*** |
| | [0.053] | [0.030] | | [0.066] | [0.070] |
| *pension_4th* | -0.360*** | 0.136*** | *sickness* | -0.034*** | -0.020*** |
| | [0.029] | [0.031] | | [0.004] | [0.005] |
| *pension_5th* | -0.219*** | -0.677*** | *childcare* | 0.013*** | 0.014*** |
| | [0.072] | [0.034] | | [0.003] | [0.001] |
| *tech_col* | -0.722*** | -0.571*** | *married* | 0.178*** | -0.288*** |
| | [0.083] | [0.151] | | [0.031] | [0.022] |
| *No. of obs.* | 33917 | 38285 | | | |
| $R^2$ | 0.3 | 0.51 | | | |

*Notes*: The dependent variable is the retirement entry age in 2003, *age*; OLS estimations with White-heteroscedasticity robust standard errors.

The results show that men and women with missing income values, that are mainly passively and voluntarily insured individuals, retire later compared to all other income classes. On the one hand, this could be explained by the fact that passively insured individuals are often not eligible to retirement pathways that allow for retirement before age 65. On the other hand, voluntarily insured individuals are often self-employed and typically retire at higher ages than employees.

Relative to the third income quintile, low incomes (first and second quintile) are associated with lower retirement ages among men whereas very high incomes (fifth quintile) are associated with higher retirement ages. Except for the first quintile

the effect for women looks similar. This category tends to retire later: Women with very low incomes have typically very unstable employment histories and insurance periods due to child-caring. Therefore, they often might not be eligible to early retirement, i.e., retirement before age 65.

The lower pension payments, the higher are - relative to the third quintile - retirement entry ages (refer to the coefficients on $pension\_1^{st}$ and $pension\_2^{nd}$). This result is in line with the following consideration: Many people who retire late, i.e., with the age of 65, are not eligible to one of the pathways into early retirement. These are mostly passively and voluntarily insured people that typically receive low pension payments. This way into retirement applies to the typical housewife and is, therefore, more common among women compared to men. In line with this consideration, there is a much larger effect for women compared to men.

Income and pension payments are of course strongly correlated. Note, however, that in the present data this correlation is actually weaker than one might expect at first:[63] For several cases income values are not reported (see previous section) or employment histories are rather instable before retirement such that income measured in the year before retirement is no perfect proxy for individuals' relative income positions over the life cycle.

Compared to persons with lower educational degrees, men with a university degree, *uni*, have a higher retirement age.[64] This finding is in line with the general notion that people with higher education are more attached to their jobs and, therefore, tend to work longer. Moreover, they are typically less physically strained and are able to work longer. Men with a technical college degree, *tech_col*, or secondary schooling degree, *sec_sch* or *sec_sch_VT*, have comparatively low retirement ages, i.e., they retire on average between 8 to 11 month earlier. Men with high school degrees, *high_sch* and *high_sch_VT*, lie in between these two extremes. Results for women are similar, though smaller in size and less significant. The fact that the association between education and retirement age is much weaker for women could again be explained by interrupted employment histories. Due to child bearing and caring, many women have not followed a career that is suggested by their educational degree.

Both health measures, *reha* and *sickness*, reveal that a higher degree of health is associated with a higher retirement entry age for men and women which is a well documented phenomenon.[65] The number of months credited by the public pension insurance due to sickness or rehabilitation has only a very small quantitative effect on the retirement age.[66] If men or women have claimed rehabilitation services due to sickness, they retire on average more than three years earlier. The present data

[63]The actual correlation coefficient amounts to 0.71.

[64]The reference category are men or women with a university degree.

[65]Refer to e.g. Larsen and Gupta (2004) who provide for a large literature on this topic.

[66]An exact quantitative interpretation is not very reliable as the measure is censored at 48 months of credited insurance contributions due to sickness.

show that these are mostly cases that take the disability pathway into retirement. However, rehabilitation is no necessary precondition for receiving a disability pension in Germany.

The number of months dedicated to child-caring as measured by the public pension insurance, *childcare*, on average leads to a higher retirement age for both men and women, though the effect is low in size. This result is well in line with Hank (2004) who investigates in great detail the relationship between women's retirement behavior and fertility biographies.

Married women retire on average three to four months earlier than singles or widows. This finding could be explained by the fact that wives are generally younger than husbands and often try to retire at approximately the same age as their husbands. For men the effect is mirror-inverted: Married men retire about two months later on average. The result is in line with the consideration that in the generation of interest married men are mostly responsible for the main family income source and, thus, work longer in order to afford retirement for the couple and possibly education for the children.

In a second specification, additional dummy variables for individuals with partial retirement, *part_ret*, compulsory insurance due to unemployment, sickness or rehabilitation, *comp_ins*, marginal employment, *marg_emp*, voluntary insurance, *vol_ins*, passive insurance, *pas_ins*, and other insurance status, *others*, before retirement in 2003 are added (Table 5.7). The reference category is employment subject to social social security contributions.

Men and women with partial retirement or compulsory insurance due to unemployment have a lower retirement age. Both groups are able to retire early due to a special retirement pathway for unemployment and partial retirement that still applies to cohorts in the present sample, though adjustment costs have already phased in. The effect is smaller for women. This corresponds well with the possibility of women to enter retirement under the same conditions and as early as unemployed persons or as individuals subject to a partial retirement plan. Marginally employed, voluntarily and passively insured persons on average retire much later. Most of the individuals in these three categories are not eligible for retirement before age 65, probably because of too short insurance and contribution periods. Effects for men and women are qualitatively the same and just slightly differ in size.[67]

Naturally, correlations between individual characteristics and the retirement age are largely driven by the institutional framework such as insurance categories or rehabilitation services and to a smaller extent by socio-economic characteristics such

[67]Note that in this specification the estimated coefficients of the income and pension payment dummies differ. The change is due to a correlation of income and insurance categories. Only in the case of the missing income category, *income_mis*, there is a substantial qualitative change in the estimated coefficient. As this category is strongly correlated with the insurance categories of passively and voluntarily insured persons, the positive effect is now captured by these dummies, *passive* and *vol_ins*.

Table 5.7: Characteristics of the official retirement age II

| | men | women | | men | women |
|---|---|---|---|---|---|
| *income_mis* | -0.818*** | -1.262*** | *sec_sch_VT* | -0.982*** | -0.318*** |
| | [0.116] | [0.076] | | [0.070] | [0.098] |
| *income_1st* | -0.366*** | -0.465*** | *edu_unknown* | -0.672*** | -0.118 |
| | [0.066] | [0.051] | | [0.069] | [0.099] |
| *income_2nd* | -0.194*** | -0.305*** | *edu_missing* | -1.341*** | -0.251*** |
| | [0.043] | [0.032] | | [0.065] | [0.097] |
| *income_4th* | -0.027 | -0.273*** | *reha* | -3.262*** | -3.340*** |
| | [0.033] | [0.042] | | [0.067] | [0.069] |
| *income_5th* | 0.284*** | 0.259*** | *sickness* | -0.034*** | -0.017*** |
| | [0.075] | [0.061] | | [0.004] | [0.004] |
| *pension_1st* | 0.871*** | 2.049*** | *childcare* | 0.010*** | 0.013*** |
| | [0.054] | [0.036] | | [0.003] | [0.001] |
| *pension_2nd* | 0.141*** | 0.821*** | *married* | 0.165*** | -0.275*** |
| | [0.053] | [0.030] | | [0.030] | [0.021] |
| *pension_4th* | -0.304*** | 0.104*** | *part_ret* | -0.683*** | -0.294*** |
| | [0.028] | [0.030] | | [0.035] | [0.035] |
| *pension_5th* | -0.243*** | -0.862*** | *comp_ins* | -0.683*** | -0.308*** |
| | [0.074] | [0.041] | | [0.038] | [0.036] |
| *tech_col* | -0.688*** | -0.465*** | *marg_emp* | 0.951*** | 1.848*** |
| | [0.081] | [0.150] | | [0.119] | [0.060] |
| *high_school* | -0.539*** | 0.028 | *vol_ins* | 2.520*** | 2.360*** |
| | [0.119] | [0.143] | | [0.110] | [0.090] |
| *high_school_VT* | -0.629** | 0.267 | *pas_ins* | 3.000*** | 2.999*** |
| | [0.266] | [0.328] | | [0.100] | [0.070] |
| *sec_sch* | -0.978*** | -0.362*** | *others* | 0.261*** | 0.743*** |
| | [0.056] | [0.094] | | [0.081] | [0.057] |
| *No. of obs.* | 33917 | 38285 | | | |
| $R^2$ | 0.35 | 0.57 | | | |

*Notes*: see Table 5.6.

as education, child-caring or marriage. The level of income subject to social security contributions and pension payments are also but to a smaller extent important determinants. The results in Tables 5.6 and 5.7 underline the importance of employing incentive variables that bundle the institutional framework as well as individuals' employment histories and future expected pension payments when determining individuals' retirement entry ages, as e.g. undertaken in Berkel and Börsch-Supan (2004) in Section 5.1.

### The Effective Retirement Age

Due to generous preretirement possibilities, about 40 percent of individuals in the sample effectively retire before their official retirement date. These cases are identified and their effective retirement age is defined as described in Section 5.2.3. The present section investigates whether individuals' characteristics are significantly different with respect to retirement age for preretired individuals as opposed to individuals taking official pension plans. The regressions documented in Table 5.6 are repeated with interaction terms between a preretirement dummy, $P$, and each explanatory variable (Table 5.8).[68]

Table 5.8: Characteristics of the effective retirement age

| | men | women | | men | women |
|---|---|---|---|---|---|
| $income\_mis$ | 0.32 | 0.054 | $income\_mis * P$ | 0.349 | 0.108 |
| | [0.197] | [0.120] | | [0.273] | [0.192] |
| $income\_1^{st}$ | -0.071 | -0.058 | $income\_1^{st} * P$ | 0.073 | -0.228 |
| | [0.143] | [0.097] | | [0.201] | [0.143] |
| $income\_2^{nd}$ | -0.210** | -0.503*** | $income\_2^{nd} * P$ | -0.365*** | 0.029 |
| | [0.083] | [0.048] | | [0.106] | [0.069] |
| $income\_4^{th}$ | -0.251*** | -0.587*** | $income\_4^{th} * P$ | 1.342*** | 1.423*** |
| | [0.053] | [0.064] | | [0.064] | [0.073] |
| $income\_5^{th}$ | 0.166 | 0.059 | $income\_5^{th} * P$ | -0.751*** | -0.663*** |
| | [0.168] | [0.122] | | [0.242] | [0.182] |
| $pension\_1^{st}$ | 1.481*** | 2.672*** | $pension\_1^{st} * P$ | 0.276* | 0.239*** |
| | [0.056] | [0.044] | | [0.150] | [0.062] |
| $pension\_2^{nd}$ | 0.761*** | 1.400*** | $pension\_2^{nd} * P$ | -0.664*** | -0.632*** |
| | [0.065] | [0.044] | | [0.115] | [0.058] |
| $pension\_4^{th}$ | -0.560*** | 0.081* | $pension\_4^{th} * P$ | 0.228*** | 0.104* |
| | [0.050] | [0.048] | | [0.058] | [0.059] |
| $pension\_5^{th}$ | -0.207*** | -0.680*** | $pension\_5^{th} * P$ | -0.304 | -0.085 |
| | [0.067] | [0.043] | | [0.283] | [0.060] |
| $tech\_col$ | -0.673*** | -0.791*** | $tech\_col * P$ | 0.182 | 0.363 |
| | [0.118] | [0.231] | | [0.155] | [0.279] |
| $high\_school$ | -0.740* | 0.631* | $high\_school * P$ | 0.098 | -0.771 |
| | [0.403] | [0.377] | | [0.500] | [0.508] |
| $high\_school\_VT$ | -0.655*** | 0.054 | $high\_school\_VT * P$ | 0.303 | -0.465* |
| | [0.167] | [0.214] | | [0.222] | [0.268] |

Note: This table continues on the next page.

[68] The estimation of interacted effects for preretired persons is equivalent to a separate regression for this group.

| | | | | | |
|---|---|---|---|---|---|
| *sec_sch* | -1.028*** | -0.399*** | *sec_sch* $*$ *P* | 0.112 | -0.162 |
| | [0.095] | [0.151] | | [0.130] | [0.186] |
| *sec_sch_VT* | -1.151*** | -0.407*** | *sec_sch_VT* $*$ *P* | 0.466*** | -0.159 |
| | [0.070] | [0.145] | | [0.102] | [0.179] |
| *edu_unknown* | -0.578*** | 0.096 | *edu_unknown* $*$ *P* | -0.269** | -0.510*** |
| | [0.091] | [0.152] | | [0.126] | [0.187] |
| *edu_missing* | -0.848*** | 0.293* | *edu_missing* $*$ *P* | 0.028 | -0.805*** |
| | [0.106] | [0.150] | | [0.132] | [0.183] |
| *reha* | -4.245*** | -4.000*** | *reha*P* | 2.533*** | 1.936*** |
| | [0.089] | [0.093] | | [0.124] | [0.132] |
| *sickness* | -0.043*** | -0.022*** | *sickness*P* | 0.008 | 0.01 |
| | [0.006] | [0.006] | | [0.008] | [0.008] |
| *childcare* | 0.009** | 0.012*** | *childcare*P* | 0.009 | 0 |
| | [0.004] | [0.001] | | [0.007] | [0.001] |
| *married* | 0.069 | -0.368*** | *married*P* | 0.222*** | 0.215*** |
| | [0.046] | [0.028] | | [0.060] | [0.041] |
| *P* | -3.317*** | -2.664*** | No. of obs. | 33557 | 37992 |
| | [0.388] | [0.257] | $R^2$ | 0.54 | 0.67 |

*Notes:* The dependent variable is retirement entry age in 2000-2003 which is adjusted for pre-retirement, $age_f$; *P* is a dummy equal to one if a person preretires as defined in Section 5.2.3; OLS estimations with White-heteroscedasticity robust standard errors.

Overall, the effects for preretired individuals[69] are qualitatively similar to the reference category, i.e., individuals that take official pension plans. Main differences exist with respect to the size of the effects on rehabilitation, income and pension payments: Most importantly, the negative association between claims of rehabilitation services before retirement, *reha*, and retirement age is much smaller for preretired men and women. If rehabilitation services are taken, the retirement age of persons with regular pension plans is on average almost four years lower whereas preretired men are only about one and a half years and preretired women two years younger compared to persons not claiming any rehabilitation services. This observation can be explained by the fact that the frequency of rehabilitation services in the present data is much higher for persons between age 54 and 60 compared to older persons. At the same time, rehabilitation is strongly correlated with disability pension entries at ages below 60. Therefore, persons who take rehabilitation services seem less likely to take the preretirement pathway but rather the disability pathway.

Differences in effects between preretired individuals and the rest of the sample are large for individuals with middle and high incomes: The estimated effects differ substantially for the fourth and fifth quintile, whereas there is no or only a small difference with respect to the missing values dummy and the first and second income

[69]These effects are obtained by adding the interaction effect and the respective effect for the reference group.

quintile.

There are also significant differences between preretired individuals and those taking official pathways into retirement across all pension payments quintiles, except for the fifth quintile. In spite of the quantitative differences, there is still a similar qualitative pattern for both groups, though: Relative to the third quintile, lower pension payments are associated with a higher retirement age and higher pension payments are associated with a lower retirement age.

To summarize: Claiming rehabilitation services before retirement has a much lower effect on retirement age for preretired individuals compared to the rest of the sample. Also income in the year before retirement and pension payments in 2003 have different effects for preretired persons. However, there is no obvious and easy to interpret pattern of differences in income and pension effects between the two groups. Further minor differences can be observed with respect to marital status and education.[70] Overall, the estimated differences in effects with respect to rehabilitation services, income and pensions as well as the large number of identified preretirement cases underline the relevance of taking account of preretirement in administrative data when individual retirement entry decisions and effects of retirement entries on the overall social security system are of interest.

### 5.2.5 Conclusion and Outlook

The present paper employs administrative data of individuals' retirement entries in 2003 (*SUF Versichertenrentenzugang 2003*) provided by the German Pension Insurance. Retirement entry in administrative data is defined as receiving pension payments for the first time. This does, however, not include the possibility of preretirement. The issue of preretirement plays an important role in recent pension and labor-market reforms.

Preretirement is defined as leaving the labor force and effectively retiring before any official pathways into retirement can be taken. Until official retirement individuals receive financial support through arrangements between the state, employers and employees that typically burden the social security system. These arrangements are often very generous for the employee such that this option has been frequently used: 40 percent of all men and women in the sample preretire. They stay on average 2.4 years in preretirement before taking one of the regular retirement plans. Moreover, the present paper investigates individual determinants of retirement entry age such as income, pension payments, measures for education, health and family status. It is investigated whether individuals' characteristics are significantly different with respect to retirement age for the group of preretired individuals and individuals taking regular pension plans. Noticeable differences arise with respect to rehabilitation

[70] There is a difference in estimated effects of *edu_unknown* and *edu_missing* which is per definition mainly driven by a larger number of passively insured persons in the preretired sub-sample.

claims before retirement, income before retirement and pension payments.

These insights are based on analyzing German administrative data. Such data is very advantageous with respect to detailed and reliable information on individuals pension characteristics and the number of observations. Information is only provided as far as it is relevant for the calculation of pensions. Consequently, income variables are censored, information on wealth is non-existent and retirement entry is defined as obtaining public pension payments. In order to provide useful information for future studies based on German administrative data provided by the German Pension Insurance, the paper discusses those issues.

In light of recent reform initiatives in Germany concerning the labor market (unemployment insurance) or social security legislation (retirement entry rules and adjustment costs) interesting future research questions arise: What is the impact of these reforms on retirement entries, labor force exits and preretirement? How will future pension and labor-market reforms change the distribution of retirement entry age? Such research questions are typically analyzed in option value models of individual retirement entry behavior, e.g., Börsch-Supan (1992), Schmidt (1995), Börsch-Supan and Schmidt (1996), Siddiqui (1997), Börsch-Supan (2000a), Berkel and Börsch-Supan (2004), Antolin and Scarpetta (1998). Administrative data that is available so far, i.e., the *SUF Versichertenrentenzugang 2003*, does not yet include sufficient variation in individuals' retirement entry decisions in order to investigate these questions. Appendix B discusses why an option value approach is not feasible with the data at hand and describes the necessary data characteristics for such an undertaking. In particular, it is essential to have data that includes not only observations of retirement entries but also of older workers still in the labor force and not yet retired. It is of great interest to release such administrative data in order to accomplish the estimation of structural models of retirement entry decisions and labor force exits that can be used for policy analysis.

### 5.2.6 Appendix

#### Appendix A - The Data

Table 5.9: Variable definitions

| Variable | Description |
|---|---|
| *age* | retirement entry age in 2003 |
| $age_f$ | retirement entry age in 2000-2003, preretirement is taken into account as described in Section 5.2.3 |
| *income_mis* | dummy variable equal to one if income subject to social security . contributions is missing in 2002 |
| $income\_1^{st}$ | dummy variable equal to one if income subject to social security ranges between ]0; 428] Euros per month in 2002 |
| $income\_2^{nd}$ | dummy variable equal to one if income subject to social security ranges between ]428; 1141] Euros per month in 2002 |
| $income\_3^{rd}$ | dummy variable equal to one if income subject to social security ranges between ]1141; 1957] Euros per month in 2002 |
| $income\_4^{th}$ | dummy variable equal to one if income subject to social security ranges between ]1957; 2870[ Euros per month in 2002 |
| $income\_5^{th}$ | dummy variable equal to one if income subject to social security is above 2870 Euros per month in 2002 |
| $pension\_1^{st}$ | dummy equal to one if public pension payments range between ]0; 266] Euros per month in 2003 |
| $pension\_2^{nd}$ | dummy equal to one if public pension payments range between ]266; 537] Euros per month in 2003 |
| $pension\_3^{rd}$ | dummy equal to one if public pension payments range between ]537; 794] Euros per month in 2003 |
| $pension\_4^{th}$ | dummy equal to one if public pension payments range between ]794; 1122[ Euros per month in 2003 |
| $pension\_5^{th}$ | dummy equal to one if public pension payments are above 1122 Euros per month in 2003 |
| *reha* | dummy variable equal to one if rehabilitation services were claimed during the last 5 years before retirement |
| *sickness* | number of months with insurance credits due to sickness or rehabilitation |
| *childcare* | number of months with insurance credits for child-caring |
| *married* | dummy variable equal to one if an individual is married or widowed |
| *sec_sch* | dummy variable equal to one if the highest educational degree is from secondary school |

| | |
|---|---|
| *sec_sch_VT* | dummy variable equal to one if the highest educational degree is from secondary school plus vocational training |
| *high_sch* | dummy variable equal to one if the highest educational degree is from high school |
| *high_sch_VT* | dummy variable equal to one if the highest educational degree is from high school plus vocational training |
| *tech_col* | dummy variable equal to one if the highest educational degree is from a technical college |
| *uni* | dummy variable equal to one if the highest educational degree is from university |
| *edu_missing* | dummy variable equal to one if the highest educational degree is a missing value |
| *edu_unknown* | dummy variable equal to one if the highest educational degree is unknown |
| $full\_emp$ | dummy variable equal to one if the individual had an employment subject to social social security contributions in the year before retirement |
| *partial_ret* | dummy variable equal to one if the individual was partly retired in the year before retirement |
| *comp_ins* | dummy variable equal to one if the individual was compulsorily insured due to unemployment, sickness or rehabilitation[71] in the year before retirement |
| *marg_emp* | dummy variable equal to one if the individual was marginally employed in the year before retirement |
| *vol_ins* | dummy equal to one if a person was voluntarily insured in the year before retirement |
| *pas_ins* | dummy equal to one if a person was passively insured in the year before retirement |
| *others* | dummy equal to one for all other individuals that are neither passive, *vol_ins*, *marg_emp*, *comp_ins*, *part_ret* or $full\_emp$, which includes the following employment categories: credited insurance, other compulsory insurances, other status and unknown status |

[71] Refer to SGB III and § 3 Nr. 3 SGB VI.

Table 5.10: Summary statistics

| | Men | | | | | Women | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Variable | Obs | Mean | Std. Dev. | Min | Max | Obs | Mean | Std. Dev. | Min | Max |
| *age* | 33917 | 62.26 | 2.48 | 54 | 72 | 38285 | 62.48 | 2.61 | 54 | 72 |
| $age_f$ | 33557 | 61.28 | 2.94 | 54 | 72 | 37992 | 61.63 | 3.03 | 54 | 72 |
| *income* | 33917 | 16.84 | 13.47 | 0 | 45.15 | 38285 | 7.66 | 9.01 | 0 | 45.36 |
| *pension* | 33917 | 9.70 | 4.24 | 0.17 | 18.97 | 38285 | 4.80 | 3.05 | 0.05 | 18.97 |
| *uni* | 33917 | 0.03 | 0.18 | 0 | 1 | 38285 | 0.01 | 0.10 | 0 | 1 |
| *tech_col* | 33917 | 0.03 | 0.17 | 0 | 1 | 38285 | 0.01 | 0.09 | 0 | 1 |
| *high_sch_VT* | 33917 | 0.01 | 0.10 | 0 | 1 | 38285 | 0.01 | 0.08 | 0 | 1 |
| *high_sch* | 33917 | 0.00 | 0.05 | 0 | 1 | 38285 | 0.00 | 0.04 | 0 | 1 |
| *sec_sch_VT* | 33917 | 0.42 | 0.49 | 0 | 1 | 38285 | 0.25 | 0.43 | 0 | 1 |
| *sec_sch* | 33917 | 0.08 | 0.27 | 0 | 1 | 38285 | 0.10 | 0.30 | 0 | 1 |
| *edu_unknown* | 33917 | 0.09 | 0.28 | 0 | 1 | 38285 | 0.11 | 0.32 | 0 | 1 |
| *edu_missing* | 33917 | 0.34 | 0.47 | 0 | 1 | 38285 | 0.51 | 0.50 | 0 | 1 |
| *reha* | 33917 | 0.06 | 0.25 | 0 | 1 | 38285 | 0.04 | 0.20 | 0 | 1 |
| *sickness* | 33917 | 0.98 | 3.14 | 0 | 48 | 38285 | 0.63 | 2.39 | 0 | 48 |
| *childcare* | 33917 | 0.30 | 3.03 | 0 | 60 | 38285 | 23.39 | 14.65 | 0 | 60 |
| *married* | 33917 | 0.82 | 0.39 | 0 | 1 | 38285 | 0.73 | 0.44 | 0 | 1 |
| $full\_emp$ | 33917 | 0.28 | 0.45 | 0 | 1 | 38285 | 0.22 | 0.42 | 0 | 1 |
| *part_ret* | 33917 | 0.17 | 0.37 | 0 | 1 | 38285 | 0.08 | 0.27 | 0 | 1 |
| *comp_ins* | 33917 | 0.29 | 0.45 | 0 | 1 | 38285 | 0.19 | 0.39 | 0 | 1 |
| *marg_emp* | 33917 | 0.01 | 0.11 | 0 | 1 | 38285 | 0.07 | 0.25 | 0 | 1 |
| *vol_ins* | 33917 | 0.04 | 0.19 | 0 | 1 | 38285 | 0.03 | 0.16 | 0 | 1 |
| *pas_ins* | 33917 | 0.17 | 0.37 | 0 | 1 | 38285 | 0.33 | 0.47 | 0 | 1 |
| *others* | 33917 | 0.07 | 0.26 | 0 | 1 | 38285 | 0.12 | 0.33 | 0 | 1 |

*Source:* German Pension Insurance ("Deutsche Rentenversicherung"), *SUF Versichertenrentenzugang 2003* (SUFRTZN03XVST_Berk).
*Note*: *income* and *pension* are summarized in 100 Euros per month.

## Appendix B - The Option Value Model and SUF Versichertenrentenzugang 2003

The individual retirement decision is a sequential inter-temporal discrete choice problem under uncertainty that depends on socioeconomic as well as present and future institutional and legal determinants. This inter-temporal nature of the decision process is reflected in option value models such as by Stock and Wise (1990).[72] The option value model assumes that individuals compare the present value of all future discounted retirement income when retiring now to all present values of retiring in all possible future points in time. An individual chooses to retire now if the utility from retiring today is higher than utility from retiring at any later point in time.

Due to its structural nature the estimation of an option value model allows policy analyses. More specifically, one can simulate the impacts of pension reforms on individuals retirement entry decisions and, therefore, on the distribution of retirement age in the population. This section discusses, why the option value model can not be applied to the data of the *SUF Versichertenrentenzugang 2003*.

In order to employ an option value model based on Stock and Wise (1990) as estimated e.g. by Berkel and Börsch-Supan (2004) (see Section 5.1), panel data on individuals retiring during the sample period is required. Ideally, the data should be a representative draw from the German population of the elderly. Most importantly, variation in the option value is needed that arises from different characteristics across individuals retiring at different ages and still working, and from differences in pension legislation across years and cohorts. The time series information on each individual has to be sufficiently long in order to observe changes in the option value before retiring.

The data structure of the *SUF Versichertenrentenzugang 2003* does not sufficiently match these requirements. First, the data is cross-sectional as it refers to retirement entries in 2003 only. The mechanism of the option value model can not be revealed in such data as the decision of each single individual has to be followed over time. A very short but insufficient time series can be extracted from the data, though, as one has information on individuals' labor-market and insurance status in 2000 to 2002.

Second and most importantly, all individuals retire in 2003. The importance of this point becomes clear if one describes the final measure of interest, the probability of retiring at age $a$ conditional on the option value at age $b$ in the present sample, $Pr(RA = a|OV_b)$, more formally by applying Bayes' Rule:

[72] The model by Stock and Wise (1990) does not provide for a complete solution of the complex inter-temporal optimization problem, but includes all relevant economic incentives. Models solving the full inter-temporal optimization problem can be found e.g. in Rust (1996), Rust and Phelan (1997). Lumsdaine, Stock and Wise (1992) discuss and compare three alternative approaches of estimating an option value model. More general surveys about option value models can be found in Arnds and Bonin (2002) and Lumsdaine and Mitchell (1999).

$$Pr(RA = a|OV_b) = Pr(RA = a)\frac{Pr(OV_b|RA = a)}{Pr(OV_b)},$$

where $Pr(RA = a)$ is the unconditional probability of retiring at age $a$, $Pr(OV_b)$ is the unconditional probability of an option value $OV$ at age $b$, and $Pr(OV_b|RA = a)$ is the probability of observing an option value $OV$ at age $b$ if an individual retires with age $a$. In the present sample $a$ refers to retirement age in 2003 and $b$ takes the values $b = a$, $b = a - 1$, $b = a - 2$ or $b = a - 3$. The unconditional probability of retirement age $a$, $Pr(RA = a)$, and the probability of an option value $OV_b$ conditioned on retirement entry age $a$, $Pr(OV_b|RA = a)$, can be obtained from the data sample at hand. If necessary both terms can be weighted by age such that the representative age structure in the population is matched. However, information on $Pr(OV_b)$ is only available for individuals retiring in 2003 and not for a representative draw from the whole population including also individuals retiring later. If $Pr(OV_b)$ is significantly different for individuals inside and outside the sample, the sample has too little variation and estimation results will be biased.[73] Additional variation would come from a longer time-series dimension including people that are still working and covering a longer period of institutional changes. Potentially German data of retirement entries between 1997 and 2015 are very useful as during this period adjustment costs of early retirement are phased in and retirement age limits are gradually increased. As no true time-series information is contained in the data at hand, such variation is not sufficiently provided. Crucial information for the model is not existent and econometric models with weighting procedures, such as the "weighted" exogenous sampling Maximum-Likelihood estimator (WESLM)[74], can not help. As the option value is a complex construction, it can not be easily obtained from other data sources.

Third, the sample is only representative with respect to the population of all retirement entries in 2003 whereas it is not representative for the German population of retired and non-retired individuals. There is a large portion of 60, 63 and 65 years old individuals retiring, as these are popular retirement ages, but there are only few people with age 59, 61 and 64. After constructing an artificial panel from 2000 to 2003 with all individuals retiring in 2003 the sample is not at all representative to the German population. One can solve this problem by weighting observations by age classes. However, weights take very extreme values.

[73]Estimations indeed reveal that there is not sufficient variation concerning the option value in the data. In the model individuals have an incentive to retire if the option value of postponing the retirement entry decision becomes negative. The option value falls the closer an individual gets to its optimal moment of retirement. Therefore, individuals tend to have small option values around the moment of retirement. In order to obtain variation, observations on individuals still being further away from their entries into retirement are essential.

[74]Refer to Manski and McFadden (1981).

Overall, no robust estimation method can be found to solve the most severe problem of missing information on individuals not retiring during the sample period. Additional data on older individuals not yet retired is needed. Ideally, a random draw of insured persons of age 54 to 72 is needed that covers a period of about 15 years and that includes persons that retire within the sample period and others who are still in the labor force or not yet retired.

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# Ehrenwörtliche Erklärung

Hiermit erkläre ich ehrenwörtlich, dass ich diese Dissertationsschrift selbständig angefertigt habe und mich anderer als der in ihr angegebenen Hilfsmittel nicht bedient habe. Entlehnungen aus anderen Schriften sind ausdrücklich als solche gekennzeichnet und mit Quellenangaben versehen.

Mannheim, 18. Juli 2006 Barbara Berkel