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Essays on Entrepreneurship

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Abstracts

Chapter 1

In this paper I investigate whether the effect of access to finance on females differs between self-employed and business-owning women. I adopt a linear probability model with instrumental variables, using the receipt of windfall income and inheritances as instruments. The dataset being used is the German Socio-Economic Panel (GSOEP) for the period 2001 to 2012. I find that the probability that a woman enters into business ownership increases by 7.09 percentage points after experiencing a one percent increase in her level of wealth. This wealth effect is 0.6 times the size for female self-employed, at 4.2 percentage points. This paper is one of the first to describe the difference in size of wealth effects and constraints to finance for these two types of self-employed women. These results are consistent with findings in the literature, and add to it by showing that the impact of access to finance is underestimated when using the group of self-employed as a proxy for entrepreneurs.

Chapter 2

In this paper we examine differences in access to finance and business value by gender. Using recent data from the German Socio-Economic Panel, instrumented linear probability models show that an increase in personal wealth substantially affects the probability of being a business owner only among females. This is indicative of differential access to finance by gender. Among business owners, fixed-effects regressions reveal that obtaining a bank loan increases mean total business value more for females than for males. Thus, possession of a bank loan appears to be a critical factor in explaining the business value gender gap.

Chapter 3

In this paper I develop a life-cycle model of entrepreneurship, which captures the impact of borrowing constraints, business capital and entrepreneurial human capital. I include two types of entrepreneurs in the set of occupational choices, where I separate out business owners from otherwise self-employed individuals. Using the estimated model I perform three counterfactual

policy evaluations. I find that lowering the borrowing constraint for every individual reduces the percentage of the population in entrepreneurship overall, whereas it increases longevity of businesses but not necessarily other self-employment. Providing a business subsidy as well as increasing entrepreneurship-specific human capital boosts the percentage of individuals in entrepreneurship, but slightly lowers the persistence of business owners over otherwise self-employed.

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Declaration of Authorship

I, Katharina Heike Wiesemeyer, hereby declare that this thesis and the work presented in it is entirely my own. Where I have consulted the work of others, this is always clearly stated.

Chapter 2 of this thesis is co-authored work with Robert M. Sauer, and presented as published in the Oxford Review of Economic Policy in September 2018. A link to the publication can be found here: `https://academic.oup.com/oxrep/article-abstract/34/4/584/5103416`.

‘A journey of a thousand miles begins with a single step.’

Lao Tzu

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Chapter 1

Female Entrepreneurship

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1.1 Introduction

While the percentage of women in the population of the self-employed has constantly been increasing in Germany, rising from 27.7% in 2010 to 32.2% in 2015, the figure of new businesses founded by women fluctuated around 37% with no obvious trend (Statistisches Bundesamt, 2017 and Wagner, 2007). This holds on a global scale too, where women are underrepresented amongst business owners in all but seven countries in the world (Global Entrepreneurship Monitor, 2017). The lack of growth of women-founded businesses led to economic and political debates, focusing on how to improve female participation rates in business ownership (Welter, 2004 and Bergmann & Sternberg, 2007). A recurring discussion point regards the access to finance for females. Intuitively, when starting a business an individual requires capital. Although some work has been done on the effect of finance on either business ownership or self-employment for women, showing the existence of liquidity constraints (Verheul and Thurik, 2001), limited work has been conducted with the focus on how these effects differ in size when comparing self-employed women and female business owners.

In the economics of entrepreneurship, the group studied and mostly used as a proxy for entrepreneurs are self-employed individuals. If there exists a difference in the impact of liquidity on self-employment compared to business ownership for females, previous research may not entirely capture how entrepreneurship is stimulated by capital and finance.

Defining the group of entrepreneurs correctly is important. In this paper, I aim to contribute to the existing literature by showing the difference in the effect of access to finance on the outcome for women to become a) self-employed and b) business owners. This will be achieved by outlining how the outcome variables are impacted by an individual's level of wealth. Exogenous income shocks will be used to show that an increase in wealth, which was not anticipated by the individual, has a positive effect on the decision to become self-employed or a business owner, and that liquidity constraints exist in accessing finance for females who are facing the decision of business ownership or self-employment.

The motivation to distinguish between individuals becoming self-employed and becoming business owners is driven by a recent study on that finds several types of self-employment over the life-cycle. John Eric Humphries (2019) finds that careers involving self-employment can be categories into a small number of economically distinct groups. Some individuals experience a short self-employment spell, with small capital investments and rapid return to paid employment, while others experience longer spells of self-employment and have larger capital dedicated to the business from the inception of the business.

To do so, I use data from the German Socio-Economics Panel provided by the Institute for Economic Research in Berlin (DIW). This is Germany's longest running longitudinal panel survey with a rich set of variables on the individual and household level. The empirical analysis follows the method employed in a paper by Sauer and Wilson (2017). I employ a linear probability model and conduct instrumental variable regressions to infer an external income shock to wealth. I use two instruments. Firstly, a dichotomous variable on receiving a form of windfall income (which are inheritances, gifts, and lottery winnings), and secondly the receipt of inheritance only. Using these instruments, I am able to capture the effect of an exogenous finance shock on the decision to become self-employed and the decision to become a business owner,

using a socio-economic panel dataset to show the existence of the impact of access to finance. I find that the effects of access to finance differ for the two groups of interest, self-employed and business owners.

Using the receipt of an inheritance as an instrument, I find that a one percent increase in the level of wealth leads to a 4.2 percentage point increase in the probability of becoming self-employed. This effect is 1.7 times the size for business owners, validating that a one percent increase in the level of wealth leads to a 7.09 percentage point increase in a woman starting a business and becoming a business owner. Therefore, when studying the economics of entrepreneurship and liquidity constraints for women, focusing on the group of self-employed individuals underestimates the role of finance. Self-employed women as a proxy for female entrepreneurs will not capture the true effect that wealth and finance have on the decision to leave wage employment.

The rest of this paper is organised as follows. Section 1.2 will review the literature on this topic. Section 1.3 will provide a description of the data. The empirical methodology and results will be presented in section 1.4, followed by the conclusion in section 1.5.

1.2 Literature

The economics of entrepreneurship has been studied for nearly one century. Schumpeter wrote one of the first papers addressing the phenomenon of entrepreneurs and their relevance for an economy's growth (1934). His ideas were built upon by Arrow (1962) who explained the process of how entrepreneurship and the distribution of technical information removes inefficiencies in an economy, underlining the importance of entrepreneurs. Increasing the number of individuals that become entrepreneurs will therefore benefit economic growth. Hence, there is an objective in trying to understand why an individual chooses to become an entrepreneur and how to increase and support the supply of entrepreneurs.

One area of interest in the entrepreneurship literature focuses on the financial aspect of entering entrepreneurship. To do so requires capital, and if access to such capital is constrained, the

individual will find it more difficult to become an entrepreneur. Evans and Leighton (1989) and Evans and Jovanovic (1989) argued that entrepreneurs face liquidity constraints. Using data on self-employment from the NLSY 1966 to 1981 and the CPS 1968 to 1987. They find that if assets increase, a move into self-employment becomes more likely.

Papers by Blanchflower and Oswald (1998), Meyer (1990) or Holtz-Eakin et al. (1999) built on this idea and designed binary choice models with the dependent variable capturing the dichotomous decision of becoming an entrepreneur or not becoming an entrepreneur. Blanchflower and Oswald outline the link between the aforementioned decision and finance by looking at the endogenous effect of receiving an inheritance or gift using a sample of self-employed British males (NCDS4 and NCDS5) in a probit estimation setting. The idea is that if this access to finance increases the probability of a positive outcome of the decision variable, a constraint to finance exists. They find that an unexpected windfall income of £4,692 is strongly correlated with a male being self-employed in the sample. Holtz-Eakin et al. find similar results in a probit estimation with inheritances using the US National Longitudinal Survey for Young Men (NLSY) between 1976 and 1981.

The logit estimation in Meyer's paper uses data on self-employment and wealth (measured by an individual's assets) from the 1984 US Survey of Income and Program Participation (SIPP). Meyer estimated the likelihood of entering self-employment depending on wealth of an individual, which too is endogenous here. Here too the author found that individuals are more likely to enter entrepreneurship (self-employment) if there is an increase in the level of wealth. Assets are shown to be significant, but the impact of an increase in the actual size of the wealth measure changed the transition rate by only 0.017 percentage points.

A paper by Imbens et al. (2001) uses lottery winnings as a different form of unexpected windfall income. The authors investigate the effect that unearned (windfall) income has on individual earnings, the consumption level and savings. The problem that arises with analysing the effect of this particular source of unexpected income is that playing the lottery is an endogenous choice. To identify exogenous lottery winnings, the authors assume that amongst people winning the lottery the size of the lottery winning is randomly assigned. Their results find that

the effect of a receipt of a lottery winning between 0 and 100,000 dollar has the same effect for males and females in terms of their savings rate and marginal propensity to consume, which is approximately 16 percent and 11 percent respectively. Schäfer and Tularik (2008) look at the effect of finance on becoming an entrepreneur from a different perspective, that is using bank loans instead of lottery winnings, inheritances, gifts, or wealth level. Their results describe how females in self-employment, recorded by the German Socio-Economic Panel (SOEP) between 1984 and 2004, are less likely to obtain bank loans and face higher interest rates when loan applications are approved. Furthermore, if a woman receives a bank loan, the amount and the access gained to finance is smaller than for men (Hundley, 2000).

The relationship between entrepreneurship and finance is also of interest in developing countries, where a lack of access to credit is one of the main reasons why individuals remain poor (Hermes and Lensink, 2007). Credit markets tend to be weak in developing countries and result in valuable entrepreneurial project going unfunded, thereby prohibiting economic development. To tackle this problem, Micro-finance schemes have been offered to people in need of small sums of funds where the person lacks collateral. The economics professor and Nobel Prize Winner Muhummad Yunus founded the "Grameen Scheme" in 1976 (Azevedo, 2006).

All these studies have to address the problem of endogeneity of wealth to the individual. If the set of regressors (X_i) is not independent of the random disturbance (u_i), then OLS does not provide consistent estimates of the vector of parameters to be estimated. There are several reason as to why endogeneity bias is especially problematic when studying the economics of entrepreneurship.

Firstly, performance is often assessed in terms of variables whose values the individual chooses themselves, such as education. However, if choices are decided by the individual's characteristics, then these variables will be likely correlated with unobserved variables, which will make them endogenous and lead to simultaneity bias. Secondly, the decision to become an entrepreneur is influenced by the individual being able to observe their own wealth level over the preceding and current period. Explanatory variables suggested to be the cause of entrepreneurship can in fact be consequences of it. This includes wealth, income and savings. Prior to

moving into business ownership, the individual might have accumulated savings to contribute to their wealth level. Therefore, a higher level of wealth is not necessarily the cause of entrepreneurship, but a consequence of it. To overcome the problem of endogeneity, Instrumental Variable (IV) estimators are used to estimate coefficients even when there are problematic variables in the set of regressors. I will use exogenous instrumental variables that influence the endogenous variable wealth. The variables used in the aforementioned studies, that is inheritances, gifts, and lottery winnings, can be used in an IV setting to instrument for wealth and infer exogeneity of the increase in wealth.

Across the aforementioned studies, even if the effect and the types of windfall income vary, the following observation can be drawn from them collectively: Windfall income and the level of wealth do matter when an individual decides to become an entrepreneur, and females experience larger constraints in accessing finance.

1.3 Data

The dataset used in this paper is the German Socio-Economic Panel (SOEP) from the German Institute for Economic Research (DIW) located in Berlin. It is Germany's longest running survey (since 1984) and comprises a rich set of demographic variables at the individual and at the household level, including sources of windfall income since 2001. It incorporates about 11,000 households and 30,000 individuals that are sampled annually. A particularly interesting and useful feature for this study is a wealth survey included in the dataset. The survey provides information on an individual's assets, such as property owned, financial assets and tangible assets, as well as information on whether an individual owns a business.

To better understand the data and empirical results I will define three variables: Self-employment, business ownership and unexpected windfall income. Alongside with the data, an individual is defined as being in self-employment, if the individual is recorded as being a self-employed farmer, a free-lancer, help in the family home or in other self-employment. The individuals in this group do not identify themselves as business owners in the wealth survey. The individuals

that do identify themselves as such are defined to be business owners in this study. Unexpected windfall income is defined by two questions. The first question is an indicator on whether a form of windfall income was received. The second question is an indicator on whether an inheritance, a gift, or a lottery winning was received. After identification of the three forms of unexpected windfall income received or not, an individual can state the amount obtained.

1.3.1 Descriptive Statistics

For my research, I am interested in the female sample only. Therefore, I entirely exclude males in my analysis and section 1.3.1 and 1.3.2 will solely focus on describing unexpected windfall income, self-employment and business ownership for females only. However, as a means of outlining how women differ from men and to use these differences to motivate the exclusion of males in my research, I will compare the genders in terms of demographic characteristics and business characteristics for the first part of section 1.3.1.

I include individuals between the age of 25 years and 65 years, due to the lack of female business owners under the age of 25 in the sample, and the retirement age in Germany being 65 years of age. The sample is a balanced panel, since I only include individuals that were sampled annually for the period 2001 to 2012. Differences in individual characteristics between the genders will be shown in the following paragraphs, and differences in the correlations of variables of interest will be presented in the first subsection of the empirical methodology in section 1.4.

The selected sample of males consists of 13,540 person-year observations, and the sample of females consists of 15,098 person-year observations. Table 1.1 summarizes sample characteristics of males and females, and Table 1.2 focuses solely on the sample of business-owning and self-employed females. The average age is 45 for men and nearly 46 for women. Women are more likely to be non-employed at 31.7% or part-time employed at 26.2%, whereas for men these figures are 18.1% and 5.1%. Men are 1.5 times more likely to be self-employed and twice as likely to be a business owner or in full-time employment compared to women. Men are found to be 12% less likely to be partnered than women and have fewer children than women, at 0.68 children per man compared to 0.99 children per woman. Both genders have on average 12

years of education. Income is reported in real Euros, and the base year is 2007. In the sample, a woman's individual income tends to be half of a male's income with earnings of 15,540€ compared to 32,141€[1], whereas household incomes are rather homogeneous. However, assets are again lower for females. Financial assets are on average 10,089€ for women and 12,441€ for men, and tangible assets are 4,947€ and 8,143€ respectively. Also, a quarter of males are found to have taken out a credit loan, compared to a fifth of females.

The amount of the credit loan does not differ much at 8,972€ for men compared to 8,602€ for women. The disparity in home ownership and home value is small. 38.4% of men in the sample tend to own a house with an average worth of 78,798€, compared to a home ownership rate of 34.7% for women and a slightly higher home value at 80,766€ on average. Table 1.2 shows that among the sample of female business owners and self-employed, women tend to have fewer children, are partnered less, and have higher values for all of the other variables.

In Table 1.3 I compare the value of businesses between male-headed businesses and female-headed businesses. In my sample of 13,540 men and 15,098 women, 65.4% of business owners are male and 34.6% of business owners are female. When comparing individuals that did not take out a credit loan, female-headed businesses tend to be on average worth half as much as male-headed businesses. After accounting for taking out a credit loan, the discrepancy decreases and female-headed businesses are around 12,000€ worth less at 72,752€ compared to male-headed businesses at an average worth of 84,823€. There are two observations to draw from this: women are underrepresented amongst business owners, and wealth seems to play a gender-equalising role.

When looking at the number of employees, individuals were given three options to provide this information. Either the individual has 0 employees, between 1 and 9 employees, or more than 9 employees. More than 9 employees is least likely for both gender groups, and men tend to have fewer one-person businesses than females.

[1]Incomes for females are more uniformly distributed at the lower end compared to the distribution being more concentrated around the average and higher end for males.

Table 1.1: Variable means

Variable	Males	Females
Age	45.052	45.989
	(11.155)	(10.934)
Non-employed	0.181	0.317
	(0.386)	(0.466)
Full-time employed	0.649	0.336
	(0.433)	(0.472)
Part-time employed	0.051	0.262
	(0.331)	(0.44)
Self-employed	0.062	0.048
	(0.291)	(0.209)
Business Owner	0.057	0.037
	(0.232)	(0.168)
Partnered	0.569	0.684
	(0.495)	(0.465)
Number of Children	0.688	0.988
	(0.976)	(1.03)
Years of Education	12.532	12.235
	(2.684)	(2.516)
Individual Income	32141.051	15539.874
	(27596.268)	(17214.569)
Household Income	37957.934	37925.488
	(22709.266)	(23085.264)
Credit	0.254	0.209
	(0.435)	(0.406)
Amount Credit	8972.63	8602.52
	(26191.31)	(30058.96)
Home Owner	0.384	0.347
	(0.486)	(0.476)
Value Home	78798.82	80766.38
	(132122.25)	(139964.61)
Amount Financial Assets	12441.51	10089.54
	(40774.56)	(38865.96)
Amount Tangible Assets	8143.69	4947.46
	(69645.38)	(43787.53)
NY	13,540	15,098

Note: Standard deviations in parentheses.

Table 1.2: Variable means of the female business owner and self-Employed sample

Variable	**Mean**
Age	45.35
	(9.746)
Partnered	0.505
	(0.5)
Number of Children	0.878
	(1.092)
Years of Education	13.615
	(2.857)
Individual Income	25813.159
	(29748.771)
Household Income	47375.544
	(35434.151)
Credit	0.25
	(0.433)
Amount Credit	14214.91
	(582.050)
Home Owner	0.469
	(0.499)
Value Home	110121.79
	(179892.617)
Amount Financial Assets	11657.90
	(34067.827)
Amount Tangible Assets	7040.53
	(5053.942)
NY	4,628

Note: Standard deviations in parentheses.

Table 1.3: Business characteristics by males and females

	Males	**Females**
Percentage of Business Owners	65.4%	34.6%
No Credit	137,589.70€	66,014.95€
	(354,931.80€)	(175,946.10€)
Credit	84,823.62€	72,752.29€
	(317,295.20€)	(480,505.20€)

Table 1.4: Number of employees

Variable	Males	Females
0 employees	37.28%	52.08%
up to 9 employees	54.68%	43.32%
more than 9 employees	8.04%	4.6%

These 4 tables provide an overview of the differences between the genders, especially in terms of financial characteristics. Females are less liquid with regards to their income and assets, fewer women have businesses compared to men, and females tend to have businesses of lower value and fewer employees than men. Hence, I argue that these differences motivate the split of the sample, to better understand how constraints to finance may impact the decision to enter self-employment or business ownership for women only.

1.3.1.1 Unexpected Windfall Income

In Table 1.5 and Table 1.6, I present summary statistics on my instrumental variables, the variables on unexpected windfall income. Table 1.5 shows that a form of windfall income is received by 3.4% of females in the sample, where inheritances and gifts are each obtained by 1.6%, and lottery winnings are received by 0.2%.

Table 1.5: Receipt of windfall income - females

Variable	Mean	Std. Dev.
Windfall Income	0.034	0.181
Inheritance	0.016	0.123
Gift	0.016	0.125
Lottery winning	0.002	0.047
NY 15,388		

Table 1.6 shows the average amount of unexpected windfall income and the breakdown of the amount into the three windfall income categories. The average windfall income received by a female in the sample is 32,496€, with the amount of inheritances to have an average of

46,897€, gifts to have an average of 17,457€ and lottery winnings to have an average of 45,187€.

Table 1.6: Amount of windfall income - females

Variable	Mean	Std. Dev.
Windfall Income	32496.76	76241.10
Inheritance	46897.54	84992.29
Gift	17457.94	34911.35
Lottery winning	45187.32	167012.31
NY 15,388		

Note: Windfall income is reported in real Euros. The base year is 2007.

1.3.1.2 Female Self-Employed and Business Owners

This section expands on Table 1.2, outlining the sample characteristics of females divided between five occupation states; non-employed, full-time employed, part-time employed, self-employed and business owners. The main focus will be on the two states of interest, which are self-employed and business owners.

Firstly, females in self-employment and business ownership are more likely to transition between occupation states. Table 1.7 portrays the transitions between occupation states of females in the sample. About a third of self-employed and business owners stay in their respective occupation state between year t and year t-5 compared to two thirds of full-time employed and two thirds of part-time employed. Hence, transitioning out of self-employment and business ownership is more likely than leaving full-time or part-time employment.

Table 1.7: Transition in percentages - females

	Occupation state in t				
Occupation state in t-5	1	2	3	4	5
Out of labour (1)	43.38	29.50	25.09	1.25	0.77
Full-time employed (2)	7.23	68.71	22.53	0.97	0.56
Part-time employed (3)	6.21	21.77	70.84	0.67	0.51
Self-employed (4)	6.11	36.94	19.17	36.39	1.39
Business Owner (5)	4.39	33.92	24.56	2.92	34.21

Secondly, female self-employed and business owners differ in terms of family characteristics, such as partnership status. When decomposing the partnership status of a female by her occupation state, it can be seen that around 75% of business owners are partnered, compared to only 55% of self-employed. Of those females that are partnered, 26.6% are in a partnership where the partner is also a business owner.

With regards to births of children, the majority of births happen before and after the age of 30 for all females in the sample. The distribution shifts to the right for women in self-employment, and even further to the right for female business owners. The respective average ages for giving birth are 32.67 years for all women, 34.08 years for self-employed women and 39.07 years for female business owners. These results differ when considering only the birth of the first child. Here, the averages of women in self-employment giving their first birth is closer to the mean of the whole sample, with 32.28 years for all women compared to 32.46 years for self-employed women. For female business owners, giving birth to the first child occurs at an average age of 37.75 years, more than five years later.

1.4 Empirical Methodology and Results

In this part of my paper I will present results of ordinary least square regressions in section 1.4.1, to show the existence of correlations between becoming a) self-employed or b) a business owner, and the level of net wealth. I take the logarithm of net wealth to achieve a uniform distribution. The main results are outlined in section 1.4.2, in which I use a linear probability model with instrumental variables. Instrumenting for the log of net wealth with unexpected windfall income allows me to observe the effect of an exogenous income shock to wealth. The effect of wealth on the outcome variable is endogenous to the individual, and with the individual knowing their wealth level the observation of an increase in wealth over preceding periods cannot explain a sudden move into business ownership of self-employment. In the final section, 1.4.3., I validate my results with the use of a variety of robustness checks.

1.4.1 OLS Regressions

In this section I present ordinary least square regression results to show that correlations differ between men and women, and that correlations also differ for self-employed and business owners. The OLS regression models are of the following form:

$$Y_{it} = \alpha + \beta log(NetWealth_{it}) + \gamma X_{it} + u_{it} \tag{1.1}$$

Y_{it} is the outcome variable. It is either a binary variable for self-employment or not, or a binary variable for business owner or not. X_{it} includes observable characteristics shown in the regression tables. The regressions in table 8 show the correlation between the log of net wealth and the binary dependent variable for the entire sample, males and females. When taking the log of net wealth, I drop the zero- and negative values as in Sauer & Wilson (2016). Therefore I use a truncated sample and distribution, sacrificing statistical significance for ease[2]. In the first column, the binary dependent variable combines both outcome variables to become a) self-employed and b) a business owner. I use a variety of control variables. These range from continuous variables such as age, years of education and work experience measured in years, as well as the number of children and the log of individual income, to binary variables such as being in a partnership, having given birth one year and five years ago, or working in the manufacturing and service sector. I find that a one percent increase in net wealth correlates with an increase of 2.78 percentage points in the probability of becoming either self-employed or a business owner. Being female correlates with a decrease of 7.2 percentage points of a positive outcome of the dependent variable.

In columns 2 and 3 I separate the outcome variable into becoming a) self-employed and b) a business owner. Here, the coefficient on the level of wealth is smaller on the dependent variable of becoming self-employed, with a positive correlation of 1.99 percentage points when net wealth

[2]The natural log transformations commonly applied to wealth for meeting the statistical assumptions may not always be the best solution in adjusting for skewness given wealth's unique properties. One solution to overcome this, would be to use the inverse hyperbolic sine (IHS), $\theta^{-1}\sinh^{-1}(\theta netwealth) = \theta^{-1}log(\theta netwealth + (\theta^2 netwealth^2 + 1)^{1/2})$ (Pence, 2006).

Table 1.8: OLS regressions - male and female sample

	(1) All	(2) Self-Employed	(3) Business Owner
Log of Net Wealth	0.0278***	0.0199***	0.0263***
	(0.00166)	(0.00149)	(0.00144)
Age	0.0104***	0.0098***	0.0040**
	(0.00234)	(0.00205)	(0.00192)
Age^2	-0.0001***	-0.0001***	-0.0001***
	(0.00003)	(0.00002)	(0.00002)
Years of Education	0.0048***	0.0044***	0.0023***
	(0.00107)	(0.00097)	(0.00088)
Work Experience FT	0.0005	0.0003	0.0012
	(0.00105)	(0.00093)	(0.00084)
Work Experience FT^2	-0.0000	-0.0000	-0.0000
	(0.00002)	(0.00002)	(0.00002)
Work Experience PT	0.0024*	-0.0003	0.0016
	(0.00122)	(0.00109)	(0.00098)
Work Experience PT^2	-0.0001***	-0.0000	-0.0001***
	(0.00004)	(0.00004)	(0.00003)
Working Partner	0.0148***	0.0178***	0.0112**
	(0.00534)	(0.00490)	(0.00449)
Number of Children	0.0100***	0.0049	0.0060**
	(0.00346)	(0.00313)	(0.00289)
Gave birth t-1	-0.0073	0.0006	-0.0008
	(0.01494)	(0.01386)	(0.01320)
Gave birth t-5	0.0701***	0.0462***	0.0647***
	(0.02015)	(0.01776)	(0.01842)
Log of Income	-0.0050*	-0.0009	-0.0008
	(0.00291)	(0.00263)	(0.00234)
Female	-0.0720***	-0.0569***	-0.0590***
	(0.00559)	(0.00517)	(0.00463)
Manufacturing Sector	-0.0696***	-0.0625***	-0.0547***
	(0.00656)	(0.00572)	(0.00576)
Service Sector	0.0189***	0.0228***	0.0019
	(0.00599)	(0.00553)	(0.00489)
Constant	-0.3968***	-0.3731***	-0.2695***
	(0.05296)	(0.04696)	(0.04399)
Observations	14929	14929	14929
R^2	0.054	0.043	0.056
F	47.4646	37.4956	42.5264

Note: Robust standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

increases by one percent. However, the coefficient on the level of net wealth is a third larger in size at 2.63 percentage points, when the dependent variable is the business owner outcome variable. Thus, the positive correlation between the outcome variable and the log of net wealth is larger for business owners than for self-employed. In Table 1.9, I replicate the OLS regression results for men and women to show the differences in correlations between the genders when entering self-employment or business ownership.

Columns 1 and 2 depict results of OLS regressions for the male sample and columns 3 and 4 outline the same for the female sample, each divided into becoming self-employed and becoming a business owner. The correlation of an increase in net wealth by one percent is smaller for men becoming self-employed than moving into business ownership, at 3.18 percentage points compared to 4.36 percentage points. The same holds for females, the correlations are higher for females entering business ownership than self-employment, with 2.61 percentage points compared to 4.36 percentage points. Other interesting coefficients on variables include the number of children, which shows a larger correlation for females than males when entering self-employment with an increase of 1.8 percentage points per extra child. I control for fertility choice, since self-employment as well as business ownership are occupation choices picked for their potential of combining household and work responsibilities. Worth noticing is, that the correlations are larger for males than females when deciding to enter into business ownership. Individual income on the other hand has a negative correlation for females becoming business owners as well as self-employed, whereas the correlations are positive for the male sample.

As outlined in the tables, an increase in net wealth will have a stronger positive correlation for the outcome variable of starting a business than deciding to become self-employed for both genders. This suggests that for both, men and women, access to finance plays a different role in self-employment compared to business ownership. Furthermore, differences in the correlations between men and women for the two outcome variables exist, underlining that the correlations are gender-specific. Along with the observed under-representation of women, I will focus on women in my analysis. Therefore, the regression output tables displayed in the rest of this section will include the observations from the female sample only.

Table 1.9: OLS regressions - split of male and female sample

	Male Sample		Female Sample	
	(1)	(2)	(3)	(4)
	Self-Employed	Business Owner	Self-Employed	Business Owner
Log of Net Wealth	0.0318***	0.0436***	0.0105***	0.0261***
	(0.00251)	(0.00250)	(0.00174)	(0.00156)
Age	0.0180***	0.0152***	0.0073***	0.0032**
	(0.00455)	(0.00439)	(0.00228)	(0.00182)
Age^2	-0.0002***	-0.0002***	-0.0001***	-0.0000**
	(0.00005)	(0.00004)	(0.00002)	(0.00002)
Years of Education	0.0011	0.0017	0.0061***	0.0037***
	(0.00171)	(0.00159)	(0.00124)	(0.00099)
Work Experience FT	-0.0062***	-0.0077***	0.0026**	0.0021**
	(0.00239)	(0.00225)	(0.00105)	(0.00095)
Work Experience FT^2	0.0001*	0.0001***	-0.0001***	-0.0000
	(0.00004)	(0.00004)	(0.00002)	(0.00002)
Work Experience PT	0.0015	0.0007	0.0009	0.0021**
	(0.00312)	(0.00294)	(0.00115)	(0.00097)
Work Experience PT^2	-0.0002*	-0.0001	0.0000	-0.0001***
	(0.00014)	(0.00013)	(0.00004)	(0.00003)
Working Partner	0.0349***	0.0350***	0.0044	0.0003
	(0.00788)	(0.00754)	(0.00605)	(0.00501)
Number of Children	0.0023	0.0106**	0.0178***	0.0050
	(0.00443)	(0.00468)	(0.00452)	(0.00330)
Gave birth t-1	-0.0133	-0.0126	0.0139	0.0109
	(0.02106)	(0.02031)	(0.01659)	(0.01573)
Gave birth t-5	0.0523*	0.0759***	0.0207	0.0271
	(0.02794)	(0.02879)	(0.01949)	(0.01978)
Log of Income	0.0085**	0.0064	-0.0082**	-0.0065**
	(0.00426)	(0.00402)	(0.00327)	(0.00264)
Manufacturing Sector	-0.0806***	-0.0665***	-0.0190**	-0.0262***
	(0.00782)	(0.00800)	(0.00739)	(0.00653)
Service Sector	0.0138	0.0072	0.0352***	0.0065
	(0.00930)	(0.00848)	(0.00644)	(0.00538)
Constant	-0.5872***	-0.6054***	-0.2935***	-0.1470***
	(0.09604)	(0.09432)	(0.05453)	(0.04261)
Observations	7546	7590	7303	7339
R^2	0.051	0.070	0.033	0.022
F	24.6784	29.1258	12.9472	10.3754

Note: Robust standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

1.4.2 IV Regressions

To capture the effect of unexpected external income on the decision to become self-employed and the decision to become a business owner, a linear probability model with two stage instrumental variables will be employed and estimated. I do so, since OLS estimates when compared to IV estimates, have been shown to be biased up- or downwards. A paper from 1995 by McKinley et al. pointed out that endogeneity bias and measurement error can exist in schooling and experience variables when using OLS compared to IV. In their paper, they find that OLS estimates are biased by roughly 40 percent. Vieira (1999) observes that the OLS estimates in his paper are also downwards biased when studying the returns to education. Using instruments for schooling resulted in the schooling variable not being correlated with other variables. Comparing my own OLS and IV estimates, I find that for wealth the OLS estimates are biased downwards as well when compared to estimates retrieved from a regression using an instrument.

The causal relationship of interest is the relationship between net wealth and the binary dependent variable as shown in equation 1.2. Using first-stage estimation, the effect of windfall income on net wealth is captured in equation 1.3. The log of net wealth is regressed on the windfall income variable along with other covariates, the same covariates as in section 1.4.1., making windfall income an exogenous instrument. This first-stage regression will then predict estimates to be replaced for net wealth as shown in equation 1.4. Net wealth along with other covariates will give estimates showing the effects on the binary dependent variable, using the statistics to calculate and determine probabilities in the case of a positive outcome.

$$Y_{it} = \alpha + \beta NetWealth_{it} + \gamma X_{it} + u_{it} \tag{1.2}$$

$$NetWealth_{it} = \alpha + \rho WindfallIncome + \gamma X_{it} + \nu_{it} \tag{1.3}$$

$$Y_{it} = \alpha + \delta \widehat{NetWealth} + \gamma X_{it} + \epsilon_{it} \tag{1.4}$$

Y_{it} is the binary outcome variable, X_{it} includes observable characteristics and u_{it}, ν_{it} and ϵ_{it}

capture unobservable characteristics of individuals in the dataset. The dichotomous dependent variable in the first and third column is the binary choice of a female deciding to become self-employed or not. In the second and fourth column the outcome variable is a female deciding to become a business owner or not. In column 1 and 2, net wealth is instrumented with the general receipt of unexpected windfall income. In column 3 and 4, the instrumental variable is the receipt of an inheritance. All regressions have an F-test and Chi^2 value above 10.

1.4.2.1 Main Results

The first-stage estimates as in equation 3 are presented in Table 1.10 of this section. The dependent variable is net wealth in logarithms. Columns 1 and 2 are the first-stage regressions that use receiving a windfall income as an instrument, and columns 3 and 4 use the receipt of an inheritance as an instrument. Receiving a source of unexpected windfall income increases net wealth by 76.92 percentage points in the first-stage regression using the self-employment outcome variable and by 76.98 percentage points in the first-stage regression using the business owner outcome variable. The receipt of an inheritance leads to an increase in net wealth by 99.9 percentage points in the first-stage regression using the self-employment outcome variable and by 99.73 percentage points in the first-stage regression using the business owner outcome variable. All estimates of the instruments used are statistically significant at the 1% significance level. With regards to other statistically significant estimates, the regression output shows that aging by one year increases the log of net wealth by 11.25 to 11.64 percentage points, and by 12.1 percentage points in the first-stage regression for the business owner outcome variable with inheritances as an instrument. Education has similar coefficients across the specifications, with an extra year spent in education increasing the log of net wealth by around 3.5 percentage points. Having a partner in full-time employment increases the log of net wealth by approximately 38 percentage points across all specifications. A one percent increase in individual income (measured in logarithms) will lead to an increase in the dependent variable by 22.51 to 23.77 percentage points. The second-stage results are presented in Table 1.11. As a reminder, columns 1 and 2 use the overall receipt of a source of windfall income as an instrument for the log of net wealth, and columns 3 and 4 use the specific receipt of an inheritance as an instrument for

the log of net wealth. The binary dependent variable is a female becoming a) self-employed in columns 1 and 3 and b) a business owner in columns 2 and 4.

The results show that an increase in the level of wealth by one percent increases the probability of becoming self-employed by 2.24 percentage points. For becoming a business owner, the effect of a one percent increase to wealth is 3.7 times larger than for the self-employed, at 8.38 percentage points. These results do not only give estimates for an increase in wealth as in the OLS regressions where the increase in wealth is known to the individual, but an exogenous increase in wealth that is unexpected to the individual. By using the instruments, we can infer a sudden increase in wealth and gain estimates that assess the shock of an unknown wealth increase and a move into entrepreneurship following this shock.

The same holds when using the receipt of an inheritance as the instrument. Columns 3 and 4 show that an increase in the level of net wealth by one percent improves the probability of a positive outcome, becoming self-employed, by 4.2 percentage points. The effect on entering business ownership is 1.7 times bigger for females, at 7.09 percentage points. Both estimates are statistically significant at the 1% significance level. Again, the effect of wealth and access to finance is smaller for self-employed women compared to female business owners.

Regarding further statistically significant estimates, the coefficients on having a working partner are attracting attention. Having a partner in full-time employment increases the probability of entering self-employment for women, but does not do so for women entering business ownership. Maybe access to finance gained by a partner's income is not a significant source for start-up capital. Furthermore, an increase in the number of children has a positive effect on becoming self-employed, but a statistically insignificant and negative effect for entering business ownership. A suggestion as to why this may be the case is that access to child care may be more difficult to attain, and it is more difficult to enter business ownership without child care than moving into self-employment. The flexibility gained from entering self-employment for balancing household and work responsibilities may also explain this trend. Unfortunately, the survey does not provide data on child care options that cover individuals in the wealth survey. Lastly, a 1% increase in income also has a negative effect on starting a business, but less so

Table 1.10: First stage regressions - female sample

	(1) Log of Net Wealth	(2) Log of Net Wealth	(3) Log of Net Wealth	(4) Log of Net Wealth
Receipt of	0.7692***	0.7698***		
Windfall Income	(0.08058)	(0.07734)		
Receipt of			0.9990***	0.9973***
Inheritance			(0.12628)	(0.12048)
Age	0.1125***	0.1164***	0.1158***	0.1210***
	(0.01934)	(0.01917)	(0.01937)	(0.01920)
Age^2	-0.0005***	-0.0005***	-0.0006***	-0.0006***
	(0.00021)	(0.00021)	(0.00021)	(0.00021)
Years of Education	0.0343***	0.0320***	0.0356***	0.0340***
	(0.00803)	(0.00788)	(0.00803)	(0.00788)
Work Experience FT	-0.0069	-0.0046	-0.0095	-0.0068
	(0.00781)	(0.00774)	(0.00783)	(0.00775)
Work Experience FT^2	-0.0001	-0.0002	-0.0000	-0.0001
	(0.00018)	(0.00017)	(0.00018)	(0.00018)
Work Experience PT	0.0041	0.0030	0.0058	0.0051
	(0.00836)	(0.00825)	(0.00837)	(0.00826)
Work Experience PT^2	0.0005*	0.0005*	0.0005	0.0004
	(0.00028)	(0.00028)	(0.00028)	(0.00028)
Working Partner	0.3834***	0.3930***	0.3746***	0.3855***
	(0.04138)	(0.04064)	(0.04138)	(0.04066)
Number of Children	0.2886***	0.2987***	0.2880***	0.2979***
	(0.02496)	(0.02436)	(0.02491)	(0.02431)
Gave birth t-1	0.2217*	0.2888**	0.3034**	0.3746***
	(0.12984)	(0.12640)	(0.13317)	(0.13052)
Gave birth t-5	-0.2275*	-0.2284*	-0.2027	-0.2112*
	(0.12940)	(0.12471)	(0.12898)	(0.12411)
Log of Income	0.2377***	0.2279***	0.2367***	0.2251***
	(0.02076)	(0.02022)	(0.02071)	(0.02019)
Manufacturing Sector	0.2455***	0.2232***	0.2603***	0.2326***
	(0.07358)	(0.07264)	(0.07435)	(0.07341)
Service Sector	-0.0443	-0.0352	-0.0278	-0.0250
	(0.04444)	(0.04394)	(0.04435)	(0.04385)
Constant	3.3223***	3.2968***	3.2811***	3.2409***
	(0.43306)	(0.42822)	(0.43327)	(0.42846)
Observations	6936	7242	6957	7263
R^2	0.0327	0.0267	0.0866	0.0299
F	91.12	99.07	62.58	68.52

Note: Robust standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Table 1.11: IV regressions - female sample

	(1) Self-Employed Windfall Income	(2) Business Owner Windfall Income	(3) Self-Employed Inheritance	(4) Business Owner Inheritance
Log of Net Wealth	0.0224	0.0838***	0.0420***	0.0709***
	(0.01536)	(0.02013)	(0.00670)	(0.02609)
Age	0.0025	0.0054	0.0102***	0.0037
	(0.00271)	(0.00341)	(0.00232)	(0.00400)
Age^2	-0.0000	-0.0000	-0.0001***	-0.0000
	(0.00002)	(0.00003)	(0.00002)	(0.00003)
Years of Education	0.0026**	0.0012	0.0051***	0.0018
	(0.00121)	(0.00132)	(0.00118)	(0.00144)
Work Experience FT	0.0012	0.0024**	0.0007	0.0023**
	(0.00089)	(0.00108)	(0.00094)	(0.00104)
Work Experience FT^2	-0.0000**	-0.0000	-0.0000**	-0.0000
	(0.00002)	(0.00002)	(0.00002)	(0.00002)
Work Experience PT	-0.0009	0.0016	-0.0006	0.0015
	(0.00095)	(0.00117)	(0.00102)	(0.00113)
Work Experience PT^2	0.0000	-0.0001***	0.0001	-0.0001***
	(0.00003)	(0.00004)	(0.00004)	(0.00004)
Working Partner	0.0065	-0.0268***	0.0178***	-0.0220*
	(0.00761)	(0.00957)	(0.00590)	(0.01149)
Number of Children	0.0091	-0.0158**	0.0273***	-0.0124
	(0.00564)	(0.00713)	(0.00473)	(0.00859)
Gave birth t-1	-0.0100	-0.0149	0.0089	-0.0099
	(0.01205)	(0.01938)	(0.01080)	(0.01962)
Gave birth t-5	0.0309*	0.0411*	0.0178	0.0370*
	(0.01879)	(0.02313)	(0.01943)	(0.02246)
Log of Income	-0.0138***	-0.0226***	0.0014	-0.0199***
	(0.00500)	(0.00545)	(0.00327)	(0.00644)
Manufacturing Sector	-0.0067	-0.0448***	0.0114	-0.0414***
	(0.00821)	(0.01052)	(0.00731)	(0.01043)
Service Sector	0.0277***	0.0081	0.0255***	0.0072
	(0.00543)	(0.00615)	(0.00575)	(0.00599)
Constant	-0.1862***	-0.3780***	-0.0214	-0.3372***
	(0.06512)	(0.08509)	(0.05365)	(0.09647)
Observations	6936	7242	6957	7263
R^2	0.1827	0.1847	0.1798	0.1816
Chi^2	117.1319	80.6301	118.1413	81.7543

Note: Robust standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

for becoming self-employed. This is consistent with findings by Boden (1999), showing that a female tends to stay in her job when she experiences an increase in her salary.

1.4.3 Robustness Checks

Tables of robustness checks are included in Appendix A, with all F-test and Chi^2 values being higher than 10. My first concern was that the unexpected exogenous income variables selected as instruments would not capture the true effect. Inheritances can be anticipated, and may not be as unexpected as suggested. Since the dataset also provides indicators for whether an individual received a gift and whether an individual received a lottery winning, I employed the linear probability model defined in section 1.4.2 using the receipt of a gift and the receipt of a lottery winning as instruments.

The results show similar statistically significant trends in the effects of wealth on the binary outcome variables. First-stage results are shown in Table 10 in Appendix A. The log of net wealth increases by 66.24 percentage points in the self-employment sample and by 62.58 percentage points in the business owner sample after the receipt of a gift by a female individual. When receiving a lottery winning, the log of net wealth rises by 60.49 percentage points and 82.09 percentage points respectively. Table 11 shows the results of the effect on the binary dependent variables. For self-employed the probability of a positive outcome is smaller compared to the probability of a positive outcome for business owners. Using the receipt of gifts as an instrument outlines that a one percent increase in the log of net wealth results in a 6.04 percentage point rise in the outcome of a woman becoming self-employed. For the business owner outcome this is 7.28 percentage points. The effect is even more pronounced when using the receipt of a lottery winning as an instrument. The impact on the entry into self-employment is 6.18 percentage points compared to a larger effect on the decision to become a business owner at 8.50 percentage points. Again, the effects of wealth and on access to finance are more noticeable for business owners than the self-employed. Therefore, my results are consistent with the ones retrieved by using other unexpected windfall income variables. Another concern was that using a binary variable as an instrument may incorrectly estimate the effect of an unexpected shock

in access to finance. By dichotomising the variable, I am assuming that the fitted line is linear throughout the outcome variable and variable of interest. More than two values may matter. Thus, I use the dataset's continuous variables on the amount of windfall income received by an individual.

Tables 12, 13, 14 and 15 use continuous windfall income variable instead of binary variables as an instrument. Table 12 shows first-stage regression results of using general windfall income and inheritances in 1,000€ as instruments. The estimates are statistically significant at the 5% significance level. An increase in the size of windfall income or specifically in the size of an inheritance by 1,000€ increases the log of net wealth by 0.8 percentage points and by 0.9 percentage points for the self-employment sample, and by 0.57 percentage points and by 0.54 percentage points for the business owner sample. These estimates are consistent with Meyer's findings in his 1990 paper, stating that the general receipt of assets has a larger impact on wealth than an increase in the amount of assets.

The effects in Table 13 show that an increase in the log of net wealth by one percent using an increase in windfall income by 1,000€ as an instrument result in an increase in the positive outcome by only 0.3 percentage points for self-employed, and by a larger 5.04 percentage point increase in the probability of entering into business ownership. Using an increase in inheritance by 1,000€ as the instrument depicts that a female is 2.33 percentage points more likely to become self-employed after a one percent increase in the log of net wealth, whereas choosing business ownership becomes 3.51 percentage points more probable for a woman. The results reflect the same trend, that is if windfall income or inheritance increases by 1,000€ the effect of access to finance and wealth is larger for business owners than for self-employed.

Table 14 and 15, as Table 12 and 13, also use a continuous variable as an instrument. There was too little data on the amount of lottery winnings recorded, and I could only use the amount recorded for gifts received for further robustness checks. First-stage results in Table 14 show that after an increase in gifts by 1,000€ the log of net wealth increases by 0.4 percentage points for the self-employment sample and by 0.47 percentage points for the business owner sample.

As shown in table 15, the effect of an increase in the log of net wealth by one percent results in

an increase in the probability of a positive outcome, becoming self-employed, by 2.75 percentage points and by 4.33 percentage points for the business owner outcome. Again, the effect of an increase in access to finance is larger for the outcome variable of becoming a business owner.

Additionally, I include different first stage regression results in table 18 to table 22. This is to justify the use of my instruments and the variable I am instrumenting for. The receipt of windfall income, inheritances, gifts and lottery winnings do have the largest effect on net wealth. Even if a form of windfall income may be anticipated by an individual, the estimates on net wealth exceed the estimates on home value, financial assets or tangible assets. Hence, instrumenting for net wealth using the receipt of either of the four types of unexpected windfall income is the best option.

1.4.3.1 Time of Business Entry and Survival

Does the effect of receiving an inheritance depend on the period it was received in, and does the receipt of an inheritance have the same effect for females that stay in business ownership for more than one period? In the following section I present results to firstly validate that my estimates hold when receiving an unexpected income shock in t-1, t-2 and t-5 periods before entering business ownership. Secondly, I present findings that show the robustness of access to finance for business owners of at least 2 consecutive periods.

To understand how crucial a role access to finance plays over time, I create lagged variables of the receipt of a windfall income and an inheritance. I do this to see whether an unexpected windfall income shock is only increasing the number of businesses created if received in the current period, or whether the effect rises if the time span between the income shock and the business start increases. In Table 16, I find that windfall income one year prior to the start of a business has the largest impact. It increases from 7.1 percentage points to 11.99 percentage points. For entering self-employment, this figure declines from 4.2 percentage points to 3.05 percentage points. However, this effect further decreases as we go beyond a one period lag for both outcome variables, becoming self-employed or not and becoming a business owner or not. These results suggest, that the impact of an unexpected income shock is the largest for women

who enter business ownership one year after receiving a form of windfall income.

Table 17 presents results on the effect of access to finance on a business that survives more than one period, hence has been recorded for at least two periods. The reason behind conducting these regressions is due to the different motivations of individuals entering self-employment or business ownership. For instance, a motivation behind self-employment can be a new mum's avoidance of entering inactivity or unemployment. On the other end of the spectrum, one may find a business owner that considers starting a business as a permanent job. It seems that the increase in wealth of one percent increases the probability of owning a business after at least one period of business ownership by 52 percentage points.

1.5 Conclusion

Previous work in the female entrepreneurship literature studied the effect of liquidity constraints and access to finance by using self-employed individuals as a proxy for entrepreneurs. Newest studies have recently begun to use data on business owners to account for entrepreneurs, but without a justification as to why using the group of self-employed may be critical and business owners may be preferred. This paper is one of the first to show the differing effects of access to finance through wealth by comparing the results for self-employed women and female business owners using a rich and balanced panel dataset. Women are more likely to enter business ownership after experiencing an unexpected income shock, than moving into self-employment.

Using the receipt of an inheritance to instrument for the log of net wealth in a linear probability model shows that the probability of a female becoming self-employed increases by 4.2 percentage points after a one percent increase in net wealth. This probability increases to 7.09 percentage points for a female becoming a business owner. I find similar results using different forms of windfall income as robustness checks, that is gifts and lottery winnings and binary and continuous variables. Therefore, increasing access to finance and thus wealth can result in an increase in the creation of female-headed businesses. How high an amount is needed to achieve a gender-equalising effect of loans is the scope of work I am currently conducting.

I further conclude, that research using self-employed individuals as a proxy for female entrepreneurs vastly underestimates the effect of access to finance by more than one third. Focusing on future policies to improve the business creation rate across an economy and across the female population should opt for using business owners as a proxy for entrepreneurs to capture the true effect that wealth and finance have on the decision to leave wage employment. These could include government programs that provide start-up loans to females, or a restructuring of bank loans offered to females starting a business.

Additionally, my results show that the number of children and working partners do not have a positive effect on becoming a business owner, contradictory to what has been shown in the literature analysing the self-employed. Business ownership is a great channel for women to combine domestic and work responsibilities, but it seems that having children is more likely to decrease the supply of female business owners. If entering business ownership were made easier by increasing access to finance, this may also make the option more attractive for women that consider having children, as well as increasing employment options for females and supporting employment creation.

The future use of this paper is to define entrepreneurs as business owners rather than self-employed individuals when studying the relationship between entrepreneurship and access to finance in a structural setting. To expand my results, I am planning on designing a discrete choice dynamic programming model, that will analyse how a change in the size of access to finance will incentivise an individual to start a business, and the amount needed for a gender-equalising loan towards entrepreneurs. Performing counterfactual policy evaluations will then help understand which policies and channels of access to finance can improve the level of business creations specifically for females.

Chapter 2

Entrepreneurship and Gender

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2.1 Introduction

In the economics of entrepreneurship, stark gender differences have been uncovered, but the study of their determinants is still in its infancy. According to the Global Entrepreneurship Monitor (2017), women are under-represented among business owners in all but seven countries throughout the world. The under-representation of women has persisted, even as the rate of entrepreneurship has increased substantially over time. For example, in Germany, the country of focus in this study, the rate of business ownership increased from 3 to 7 percent over the past decade. At the same time, the percentage of females in the pool of business owners declined from roughly 45 per cent to under 35 percent (Statistisches Bundesamt, 2017). A substantial gender gap among entrepreneurs also exists in terms of business value. Across OECD countries, female entrepreneurs tend to own businesses of considerably lower value than male entrepreneurs (OECD, 2016).

To try and understand why gender differences in entrepreneurial outcomes might arise, researchers have mostly focused on first identifying the determinants of female entrepreneurship.

One hypothesis is that marriage plays an important role. Surprisingly, it has been found that female entrepreneurs are more likely to be married than females in salaried employment. In Britain, roughly nine out of 10 female business owners with employees are married and have a spouse engaged in full-time employment (Cowling and Taylor, 2001). Bruce (1999) finds that having a spouse in full-time employment can increase the probability that a woman moves into entrepreneurship by as much as 50 percent. This is probably due to non-labour income acting as an important source of business finance.

The effect of children on female entrepreneurship is also not straightforward. In the US, an increase in the number of children has been shown to increase the number of self-employed women. This may be a consequence of the high costs of child care and lack of flexible work arrangements (Lombard, 2001). However, this correlation does not hold for the sub-group of self-employed women who are business owners. Female business owners also spend fewer hours on child care than even their salaried counterparts (Hildebrand and Williams, 2003).

Besides marital status and number of children, levels of human capital are likely to influence the decision to be a business owner. Coleman (2007) finds that the more education or the more work experience a female accumulates, the more likely she is to start a business. More curiously, it has been found that female entrepreneurs tend to have accumulated fewer years of work experience prior to starting a business than male entrepreneurs (Lee and Rendall, 2001). Moreover, Devine (1994) shows that selfemployed females earned 72 percent of what salaried females earned. Self-employed males, on the other hand, earned 107 percent of the earnings of salaried males. This suggests that there could be differential selection into entrepreneurship by gender, which may account for a portion of the business value gender gap.

Gender discrimination is another possible source of gender differentials in entrepreneurship. For example, wage discrimination in salaried employment can feed back into differences in human capital causing less female entrepreneurship and worse business performance (Baldwin and Johnson, 1992). However, Boden (1999) argues that wage discrimination in salaried employment leads to an increase rather than a decrease in female entrepreneurship.

Gender discrimination may also be present in the market for loanable funds. Kim (2006)

illustrates how start-up loan applications by female-owned businesses have the lowest success rate, whereas male-owned businesses have the highest, and mixed-gender headed businesses are intermediate between the two categories. Financing constraints could underlie the finding that female-headed businesses generate fewer sales (Loscocco and Robinson, 1991) and have fewer assets and lower profits than male-headed businesses. Even after controlling for sector, companies owned by men can reach twice as many sales and hold twice as many assets as companies owned by women (Coleman, 2007).

Public policy and private institutions have responded in a variety of ways to try and correct gender differentials in entrepreneurship. In Germany, there is a national agency (Bundesweite Gruenderinnenagentur, or BGA) that aids start-up activities with the aim of increasing the rate of female entrepreneurship. The BGA offers business counselling, entrepreneurship training, and mentoring schemes and facilitates access to finance.

There is also a non-governmental association (Goldrausch Frauennetzwerk, or GF) which offers small interest-free loans for female-headed business activity in Berlin. Between 2010 and 2013, only 70 women received loans from the GF, with a default rate as low as 1.3 percent (OECD, 2017). In collaboration with the government and federal ministries, Germany's third largest bank (Kreditanstalt fur Wiederaufbau) has developed a programme of subsidies for female entrepreneurs. However, these kinds of agencies and programmes that focus on female entrepreneurship are relatively rare and not widely established throughout the country.

In this paper, we contribute to the literature on gender differences in entrepreneurship, and emphasize the importance of developing better policy solutions, by examining unusually detailed data from the German Socio-Economic Panel (SOEP). The SOEP is particularly useful for studying the underlying determinants of gender differences in business ownership and business value because it is longitudinal and contains a comprehensive wealth survey. In particular, the SOEP contains information on windfall income, financial and tangible assets, and business ownership status, as well as a measure of total business value among entrepreneurs that own a business.

The usefulness of the information on windfall income in the SOEP can be understood as follows.

Individuals who wish to become business owners often acquire capital prior to starting their business. This can be from personal savings and other sources of non-labour income, such as spousal earnings. Hence, a positive relationship between individual net wealth and being a business owner is not necessarily a causal relationship, with those who have more personal assets being more likely to be business owners. There is also likely to be an element of reverse causation.

The lack of causation also means that a positive relationship between assets and business ownership does not indicate the existence of liquidity constraints, i.e. an inability to borrow which compels the use of one's own financial capital. But having a reliable measure of windfall income would allow one to measure the causal effect of personal wealth on the likelihood of being a business owner and infer the existence of liquidity constraints. This is because the windfall income would represent an unanticipated income 'shock' that was not acquired specifically for the use in the business.

We exploit the information on windfall income in the SOEP as a source of exogenous variation in net wealth within an instrumental variables (IV) regression framework. IV regressions run separately by gender indicate that the probability a woman reports being a business owner increases by 7.08 percentage points with a 1 percent increase in net wealth. Among males, the corresponding magnitude is 1.32 percentage points, and is not precisely estimated. The results suggest that access to finance may be a substantial impediment to business ownership in Germany only for females. This more restricted access to finance among female entrepreneurs may be an important explanation for the under-representation of women in business ownership.

The information provided by the SOEP also reveals sharp gender differences in the total business value of existing businesses. On average, male entrepreneurs own businesses that are worth 40 percent more than those of female entrepreneurs. In fixed effects regressions that use business value as a dependent variable, it is shown that owning a bank loan increases mean business value by €96,500 for men. The increase in mean business value among females is €174,545. Hence, obtaining a bank loan has a strong gender-equalizing effect on total business value. The results imply that whether or not one owns a bank loan is a key determinant of the business

value gender gap. The data also clearly indicate that women business owners in Germany are less likely to have secured a bank loan than men.

The rest of the paper is structured as follows. Section 2.2 surveys the previous literature most relevant for our study. Section 2.3 examines the relationship between personal wealth and business ownership. Section 2.4 studies the determinants of total business value. Section 2.5 summarizes and concludes.

2.2 Background

Entrepreneurs drive economic growth because they discover and exploit informational asymmetries, effectively removing static and dynamic inefficiencies in a market economy, thereby increasing social welfare (see, for example, Hayek (1945), Arrow (1962), and Kirzner (1973)). Entrepreneurs also introduce technological innovations in the economy which increase living standards for society via wealth generation and job creation (Birch, 1979). The widespread benefits of entrepreneurial activity have motivated economists to study the underlying factors leading individuals to become entrepreneurs, and how rates of entrepreneurship can be maintained or increased through public policy.

A main focus in this regard has been the role of liquidity constraints. Several studies suggest that liquidity constraints are an important obstacle to entrepreneurship. Blanchflower and Oswald (1998) studied the issue by using data on the receipt of an inheritance (windfall income) in a sample of British males. Since the receipt of an inheritance is found to increase the probability a male becomes self-employed, they infer the existence of liquidity constraints in Britain. Holtz-Eakin et al. (1994) find similar results using American data from the National Longitudinal Survey for Young Men. Liquidity constraints have also been found to differ by gender. Exploiting data on windfall income in an instrumental variables framework, Sauer and Wilson (2016) show that the positive effect of personal wealth on the propensity to be a business owner is stronger for women than for men in the UK. In this paper, we provide similar evidence for Germany.

Using data on bank loans in Germany, Schäfer and Talavera (2009) describe how females in self-employment are less likely to obtain funding than men and face higher interest rates when loan applications are approved. Hundley (2000) obtains comparable results with UK data. Using Dutch data, Verheul and Thurik (2001) find that men and women have the same proportion of equity and debt capital as start-up capital, but the amounts are lower among females. Thus, women may suffer from differentially stronger liquidity constraints than men, adversely affecting business creation, growth, and the chances of survival (see Alsos et al., 2006). Differential liquidity constraints by gender could possibly arise from discrimination. It has been claimed that discrimination may be the result of banks favouring certain male characteristics over female characteristics in loan decisions (Buttner and Rosen, 1988).

In this paper, we also study the differential performance of male and female entrepreneurs after businesses have been created. Performance can be measured in various ways, such as earnings, assets, and profits. Other measures include business growth, survival rates, and employment creation. For instance, in Germany, 63 percent of male entrepreneurs stay in the occupation 5 years after entering, compared to 42 percent for female entrepreneurs (Lohmann and Luber, 2004).

We focus instead on a relatively neglected measure of performance as total business value. For new businesses, the major source of finance stems from personal bank loans. On average, more than 50 percent of the early financial capital of a business comes from personal debt (Robb and Robinson, 2012). If women are more liquidity constrained than men, a female-headed business may be smaller, more at risk of bankruptcy, and have lower total business value (Hanspal, 2016)[1].

2.3 Access to Finance

In this section, we examine the relationship between personal wealth and business ownership with the aim of deducing whether females are more liquidity constrained than males. The

[1]See also Evans and Leighton (1989) and Evans and Jovanovic (1989) for seminal works on the link between liquidity constraints and entrepreneurship.

data are drawn from the German Socio-Economic Panel (SOEP) administered by the German Institute for Economic Research (DIW) in Berlin between the years 2001 and 2012.

The survey is Germany's longest running longitudinal study, starting in 1984. It includes a rich set of demographic characteristics at the individual level (about 30,000) and at the household level (about 11,000). One particularly relevant feature of the SOEP for our purposes is the wealth module. It includes data on assets and property owned by individuals as well as data on business owners and total business value.

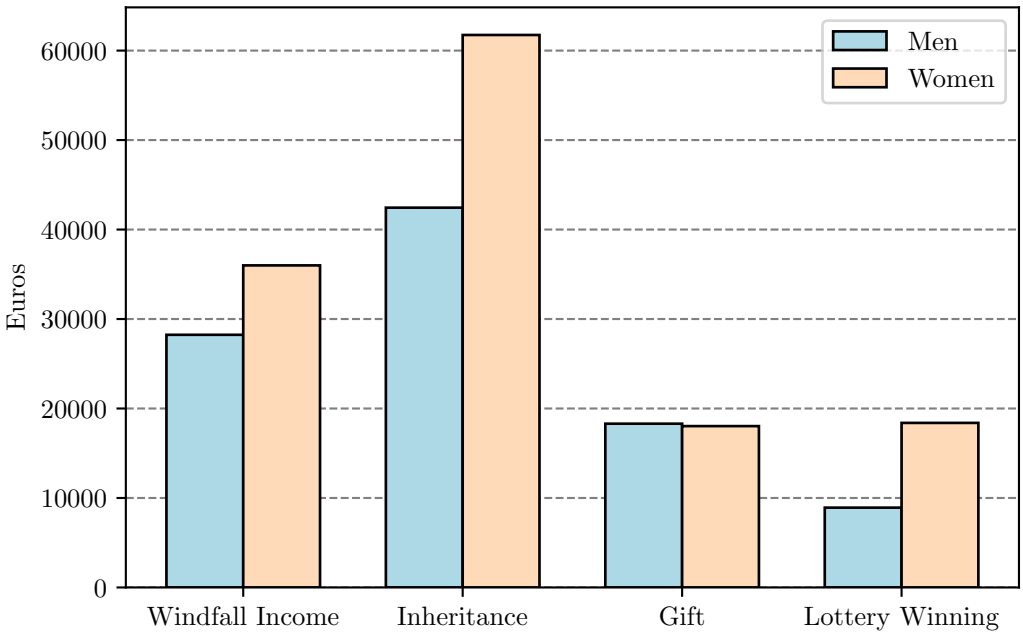
The sample used for this analysis includes 7,692 men and 7,311 women. Descriptive statistics reveal the following. Men included in our sample are on average 44.9 years of age whereas women are on average 47.8 years old. Both genders have on average 12 years of education, 0.66 children per person, and about 60 percent own a savings account with monthly payments. Fewer men have a partner in full-time employment than women, 22.8 percent compared to 31.2 percent. Men have more full-time work experience with 19.6 years compared to 13.3 years for women. Women have more part-time work experience, with 4.5 years of experience compared to 0.7 years for men. More males are home-owners compared to females (38.4 percent versus 34.7 percent). On average, men also have nearly twice as much individual income (€32,141), financial assets (€12,441), and tangible assets (€8,143) than females (€15,539, €10,089, and €4,947, respectively)[2].

In the following analysis, two variables are of key importance: business ownership and windfall (unexpected) income. Business owners are individuals who simply answered the question 'Are you a business owner?' with 'Yes' in the survey. Here we would like to point out that the SOEP also identifies self-employed individuals, of which business owners are a sub-group.

In this paper, we define entrepreneurs as business owners, in accordance with the definition by the Oxford English Dictionary (2018) that an entrepreneur is 'a person who sets up a business or businesses, taking on financial risk in the hope of profit'. Thus, business owners are properly distinguished from the 'merely' self-employed.

[2]Monetary figures are reported in real euros. The base year is 2007.

Figure 2.1: Average amount of windfall income



Note: Monetary values reported in real euros. The base year is 2007.

The second key variable, unexpected windfall income, is taken from the wealth survey and relates to receipt of an inheritance, a gift, or a lottery winning. The data allow us to create a binary variable for receipt of windfall income from a particular source, as well as exact windfall income amounts.

Of all business owners, 6.82 percent have received a form of windfall income. For female and male business owners, this number is 9.81 percent and 5.54 percent, respectively. Most sources of windfall income received are gifts (50 percent for women and 56.1 percent for men), followed by inheritances (32.4 percent for women and 39 per cent for men). As can be seen from Figure 2.1, the highest average value of any windfall income among both genders is that of inheritances. This is followed by gifts and lottery winnings.

As in Sauer and Wilson (2016), we use windfall income as an instrumental variable in a regression of business ownership on personal wealth. Windfall income is interpreted as an exogenous shock to personal wealth. IV regressions are run separately by gender and exploit the various sources of windfall income as instruments, i.e. inheritances, gifts, and lottery winnings. The

latter two sources of windfall income are used as robustness checks only. The causal relationship of interest is between the binary dependent variable of being a business owner (Y_{it}) and net personal wealth ($NetWealth_{it}$). The first-stage in the IV procedure correlates net personal wealth with windfall income ($WindfallIncome_{it}$). This is shown in equations (2.1) and (2.2),

$$Y_{it} = \alpha + \beta NetWealth_{it} + \gamma X_{it} + u_{it} \tag{2.1}$$

$$NetWealth_{it} = \alpha + \delta WindfallIncome_{it} + \gamma X_{it} + \epsilon_{it} \tag{2.2}$$

where X_{it} represents other observable characteristics, and u_{it} and ϵ_{it} capture unobservable characteristics of individuals.

In equation 2.2, we are conceiving of windfall income as an unanticipated source of wealth which can be used to help finance one's business. It does not derive from savings related to anticipated or actual business creation, maintenance, or growth. Windfall income is assumed to be randomly assigned conditional on other covariates in X_{it}. OLS estimation of equation (2.2), the first-stage in the IV procedure, reveals that receipt of any source of windfall income increases average male personal wealth by 48.4 percent. Average female personal wealth increases by 77.1 percent. Clearly, the relationship between receiving any form of windfall income (inheritances, gifts, or lottery winnings) is stronger for women in our sample than for males. The effects are highly statistically significant, at the 1 percent significance level.

IV estimation results for equation (2.1) are shown in Table 2.1. Column 1 reveals that a 1 percent increase in wealth (instrumented by the receipt of any form of windfall income) leads to a 2.92 percentage point rise in the probability a male becomes a business owner. The effect is not precisely estimated. Column (2) illustrates that the effect of a 1 percent increase in wealth among females results in an 8.37 percentage point increase in the probability of becoming a business owner. This result is statistically significant at the 1 percent significance level.

The same identification strategy with different instrumental variables results in similar findings. Regarding the first-stage regression, if we use the receipt of an inheritance as an instrument

Table 2.1: Linear probability model with instrumental variable regression results

	(1)	(2)	(3)	(4)
	Business Owner	Business Owner	Business Owner	Business Owner
	Male Sample	*Female Sample*	*Male Sample*	*Female Sample*
Instrument:	Windfall Income	Windfall Income	Inheritance	Inheritance
Log of net wealth	0.0292	0.0837***	0.0132	0.0708***
	(0.03457)	(0.02010)	(0.05776)	(0.02608)
Constant	–0.5914***	–0.3904***	–0.5303**	–0.3487***
	(0.16158)	(0.08690)	(0.23607)	(0.09993)
Observations	7,504	7,242	7,504	7,242
R^2	0.065	0.051	0.048	0.039
F	193.1859	80.3775	191.1778	81.3216
Controls	yes	yes	yes	yes

Note: Robust standard errors in parentheses. Controls include individual characteristics, i.e. age, age-squared, receipt of a loan, loan amount, years of education, presence of a working partner in full-time employment, number of children, a measure of risk-taking, possession of a savings account, full-time work experience, part-time work experience, employment in the manufacturing sector or service sector, and monetary characteristics, i.e. individual income, amount of financial assets, amount of tangible assets, and whether an individual is a home owner. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

for personal wealth, the effect is 1.32 percent for males and 7.08 per cent for females. Again, the effect among males is not statistically significant, whereas it is for females. When using the receipt of a gift as an instrument for wealth, the effect is 5.42 percent among males, and 7.26 percentage points for females. All first-stage regressions have an F-statistic well above 10. Using receipt of a lottery winning as an instrument, the IV estimate of the increase in the probability of being a business owner is 1.06 percentage points for men, and 18.4 percentage points for women. The result is not statistically significant among males but is for females.

Robustness checks show that the general conclusions are unchanged regardless of which instrument is used to represent windfall income. All sources of windfall income produce larger effects for females than for males. The male effects are not precisely estimated whereas the female effects are highly significant. Women in Germany appear to be more dependent on personal wealth for starting a business than are males. This is highly suggestive of females being differentially more liquidity constrained.

2.4 Total Business Value

In this section the analysis focuses on individuals who have become business owners. We investigate how male- and female-headed businesses might perform differently, expressed in terms of total business value. The main goal is to understand both the role that bank loans and gender play in determining the value of a business.

We continue with the German SOEP, using the same surveys, modules, and sample years. As mentioned earlier, business owners identify themselves by answering a question as to whether they are a business owner or not. After keeping business owners only and balancing the dataset, we obtain a sample with 1,511 person-year observations, of which 69.8 percent are male and 30.2 percent are female.

In this more restricted sample, 25 percent of male business owners and 20 percent of female business owners took out a bank loan. This is 5 percentage points larger for both genders than in the more comprehensive sample in section 2.3. Compared to the previous sample, both genders have on average 1 more year of education and are twice as likely to have a partner in full-time employment (44.3 percent of men and 56.4 percent of women). Both genders have a home ownership rate of 50 percent compared to the previous sample's rates of 38.4 percent for men and 34.7 percent for women. Men in the business ownership sample have a similar average income (€33,691), whereas female business owners have a higher average income than in the larger sample (€21,728). Another noticeable difference in demographic characteristics is in the number of children per person. For male business owners this number rises from 0.66 to 0.76, whereas for females the number declines from 0.66 to 0.56. Hence, female entrepreneurs have fewer children than female non-entrepreneurs. It is the reverse for men.

Figure 2.2 displays the average total value of businesses owned by men and women by whether a personal bank loan was held, averaged over the survey years. Without a bank loan means that the individual did not take out a bank loan in any of the 3 years. In both cases, male businesses have higher average value. However, holding a bank loan equalizes to a large extent the average business value between the genders.

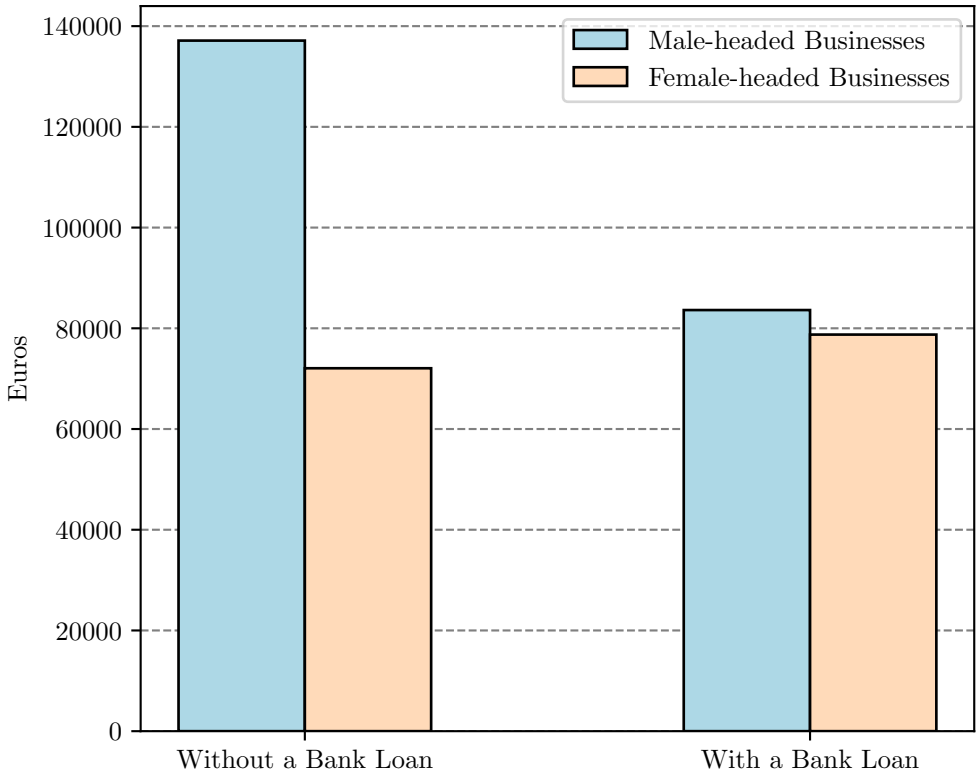
As a first step in better understanding the underlying determinants of the business value gender gap, we perform Blinder–Oaxaca decompositions (see Blinder (1973), Oaxaca (1973), and Neumark (1988)). The gap in business value between male- and female-owned businesses is 40.88 percent in total. The decomposition provides us with the following insights: 16.46 percentage points of the total difference result from differences in full-time work experience between men and women; 8.97 percentage points of the gap result from differences in the sector in which the business operates. Differences in taking out a bank loan between men and women account for 3.73 percentage points of the total gap. The unexplained component of the decomposition is 10.14 percentage points. This latter component is solely due to gender and is clearly non-negligible.

Due to the substantial equalizing effect of having a bank loan on the gender gap in total business value, as shown in Figure 2.2, it also instructive to perform a decomposition on differences in loan status by gender, because gender and the propensity to obtain a loan may strongly interact. This decomposition produces the following findings. Out of the 5 percent gender gap in the propensity to have a bank loan, only 1.53 percentage points can be explained by differences in observed characteristics between male and female business owners. The rest, 3.37 percentage points, is due to being female. This implies that there is also a substantial unexplained component of the 5 percent gender gap in bank loans, which is based solely on gender.

Focusing more precisely on the OLS regressions that underlie the first decomposition above, with the log of total business value as the dependent variable, we find the following in Table 2.2. There is a negative correlation between business value and an indicator for taking out a bank loan. The coefficient on the bank loan indicator is negative because loans are concentrated in the left tail of the business value distribution (smaller businesses). However, the coefficient on the amount of the loan is positive because business value increases with loan amount throughout the business value distribution.

Importantly, the amount of a bank loan has a stronger positive effect on mean business value among female business owners compared to male business owners.

Figure 2.2: Average total business value



Note: Business values are in 2007 constant euros.

This confirms the univariate correlations shown earlier where a loan bridges the gap in business value between the genders. The coefficients related to bank loans are precisely estimated. We also report the results of fixed-effects regressions which correct for biases due to time-invariant omitted variables. Fixed-effects regressions also help analyse the impact of having a bank loan on the growth in total business value rather than just the level. We estimate the following equation:

$$\Delta Y_{i,2012-2002} = \beta BankLoan_{i,2002} + \gamma \Delta X_{i,2012-2002} + \Delta u_{i,2012-2002} \tag{2.3}$$

where the dependent variable is the change (Δ) in total business value between 2002 and 2012. The bank loan variable indicates having received a loan in 2002. $X_{i,2012-2002}$ includes the change (Δ) in observable characteristics between the years 2002 and 2012. These variables are listed in the footnote to Table 2.2.

Table 2.2: OLS regression results

	(1)	(2)
	Δ Business Value	Δ Business Value
	Male Sample	*Female Sample*
Δ Loan	96,500.77***	174,545***
	(41,243.66)	(78,664.45)
Observations	998	412
R^2	0.213	0.101
F	11.83	7.76
Controls	yes	yes

Note: Robust standard errors in parentheses. The controls are: age, age-squared, years of education, having a partner in full-time employment, number of children, owning a savings account, work experience full-time, work experience part-time, working in the manufacturing sector, working in the service sector, individual income, the amount of financial assets, the amount of tangible assets, and a binary for home ownership. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

The results show that the effect of a bank loan is again larger for females than males. That is, women who took out a business loan in the year of starting a business experienced larger growth over the next 10 years than male-headed businesses.

More specifically, among male business owners a bank loan increases mean total business value

over the decade by €96,500. Among females, the change in total business value is €174,545. A female-owned business with a bank loan experiences an increase in mean business value that is nearly twice as large as comparable male-owned businesses. These findings illustrate the substantial value of obtaining bank loans and how it is differentially important for female business owners and closing the business value gender gap.

2.5 Conclusion

In this paper, we exploit longitudinal data from the German SOEP to study the determinants of gender differences in business ownership and business value. Information on windfall income is used as a source of exogenous variation in net wealth to determine the importance of liquidity constraints, or access to finance, in the ability to start or maintain an existing business. Instrumental variable regressions reveal that the probability that a female starts a business increases by 7.1 percentage points after experiencing a 1 percent increase in net wealth. The corresponding effect among males is only 1.32 percentage points and is not statistically significant. Thus, access to finance appears to be a substantial impediment for business ownership only for females.

In regressions that use total business value as a dependent variable, we found that bank loans are a key determinant in explaining differential business value by gender. The receipt of a bank loan has a strong effect on the performance and growth of a business measured by total business value. We find that the effect is larger in magnitude for women, for whom owning a bank loan leads to an increase in mean total business value of €174,545. For male-headed businesses, the estimate is half the size at €96,500. Thus, having a bank loan is an important determinant of the business value gender gap.

The results in this paper suggest that there are likely to be substantial frictions in the business loan market in Germany, especially with regard to the gender of the potential recipient. This is perhaps not surprising because the number of institutions in Germany that recognize and effectively address the special difficulties that female business owners face is relatively low.

This is likely to be the case in many other countries as well. Therefore, policy-makers should pay more careful attention to the proper functioning of the business loan market and explore new ways to further encourage the application and receipt of business loans among female entrepreneurs.

Chapter 3

A Structural Framework of Entrepreneurship

Katharina H. Wiesemeyer

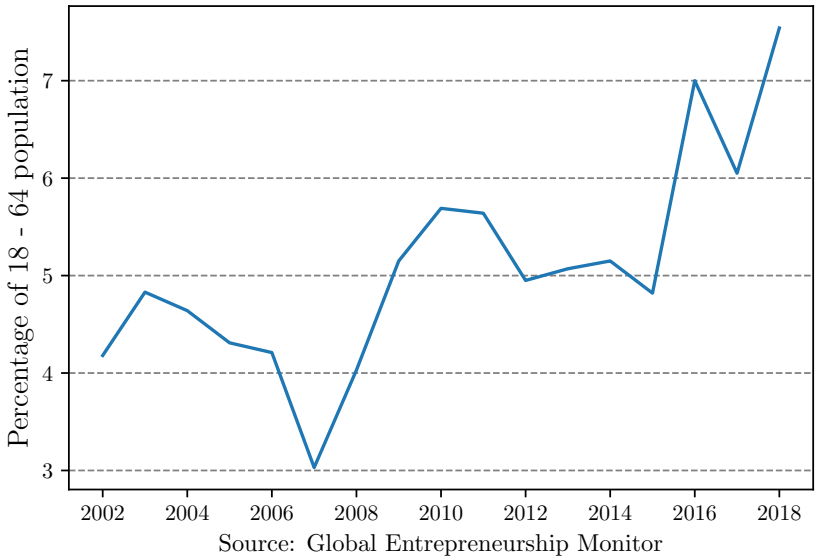
3.1 Introduction

Entrepreneurship has been increasingly covered by the media. Across the globe, policy implementations are put in place to nurture small businesses. Causes of this spike in enthusiasm for entrepreneurs extend from their ability to create jobs, innovate markets, and achieve higher productivity through specially designed products. Entrants incentivise competition as well as intensify economic development and growth. Yet the study of entrepreneurship could not be more multifaceted. As Baumol implied in his paper from 1968, "the entrepreneur is at the same time one of the most intriguing and one of the most elusive characters [...] in economic analysis".

One of the areas being investigated within economics centres around the question of why individuals choose entrepreneurship as an occupation. Over the years, the number of entrepreneurs has been rising in most countries. Figure 3.1 looks at data from the Global Entrepreneurship

Monitor (GEM). The level of entrepreneurship in Germany has been growing, and more than doubled over the period from 2007 to 2018. Therefore the question poses itself as to why it is that more individuals have chosen to enter entrepreneurship, along with what the defining factors are that determine and help the creation of small businesses. The National Expert Survey (NES) questions experts on a variety of components related to entrepreneurship. When the experts were asked to rank the availability of financing for entrepreneurs on a scale of 1 to 9 (with 9 being the maximum score), Germany received a score of 2.84. With regards to entrepreneurial education and training, Germany was given a score of 1.84. While the entrepreneurship rate has been rising, Germany still receives low ratings in terms of entrepreneurial support.

Figure 3.1: Entrepreneurship rate in Germany



In this paper, I study the area of economics that focuses on the entry into, and duration of entrepreneurship by calibrating a life-cycle model of entrepreneurship using a sample of white males from the German Socio-Economic Panel (SOEP). I build on a static model created by Evans and Jovanovic in 1989, and turn it into a model of labour supply and life-cycle decisions, with a choice set including the individual's occupation and accumulated wealth. My contribution to the literature lies in creating a discrete choice dynamic programming (DCDP) model that captures the impact of borrowing constraints, business capital and entrepreneurial human

capital. I evaluate the effect of improving each of these factors separately. More importantly, I include two types of entrepreneurs in the set of occupational choices for the individual's occupation decision, which has not been done in the framework of a labour supply model. I use my calibrated model to run three counterfactual policy evaluations, to resolve the question of how we can nurture small businesses and encourage individuals to enter entrepreneurship. For my counterfactual evaluations, I keep two key measurements in mind: How does the percentage of individuals in entrepreneurship change and how does the duration of entrepreneurship change. I measure these as responses to (i) relaxing borrowing constraints for all individuals, (ii) injecting business capital, and (iii) increasing entrepreneurship-specific human capital.

In my proposed model, individuals are defined in their heterogeneity by an exogenously determined discrete distribution of education type. In each period (a Gregorian calendar year), an individual makes a decision on their occupation choice after observing shocks to their employment preference and income potential. After having made this decision, the individual obtains income from the chosen option. Following from that, the individual makes a decision on how much to consume and how much to have as accrued wealth. The individual gains utility from consumption, utility from being in wage-employment, and utility from being "your own boss". The goal is to maximise the expected present discounted value of utility from the first period to the last period, over a finite horizon. To correctly grasp the expansion of income from wage-employment and being-your-own-boss, I not only incorporate heterogeneous education but also full-time and part-time work experience. I include unobservable residuals instead of explicitly modelling frictions to the labour market (e.g. job search). I further include borrowing constraints as a type of financial market friction, since the model framework is that of a partial equilibrium one and I do not incorporate changes in market prices.

Given the affluence of the structural framework, the solution for the optimal path of the individual's choice set is not a closed-form solution and the framework is first solved numerically. After simulating the data, I use the method of simulated method of moments (SMM) to calibrate the model's parameters. The resulting parameters fit well, and the simulated data fits the patterns observed in the empirical data. The model results outline how non-pecuniary benefits from "being your own boss" drive the entry into entrepreneurship. I follow up on this by evaluating

my counterfactual proposals and using my model's calibrated parameters to define changes in the three key measurements of impact mentioned above (the percentage of individuals choosing entrepreneurship, age at first entry, and the transition rates of entrepreneurship).

The first counterfactual evaluation of reducing borrowing constraints for all individuals leads to a lower percentage of individuals choosing entrepreneurship but a higher period-to-period transition rate for individuals in entrepreneurship, for both business owners and otherwise self-employed. These findings might be the cause of two effects often observed when relaxing borrowing constraints. One is the direct effect of consumption smoothing, and the other is the indirect effect of individuals choosing non-employment.

The second and third counterfactual evaluations led to contrasting results. The injection of business capital, by providing individuals with a subsidy of 20,000 Euros when continuing entrepreneurship, leads to a larger percentage of individuals in entrepreneurship. In the final counterfactual evaluation, I increase entrepreneurship-specific human capital. German programs such as 'Exist' or 'Go!' aim to educate people on the occupational choice of entering entrepreneurship and provide appropriate training, which offers individuals an indirect incentive compared to the two previous counterfactual evaluations. The outcome of the two key measurements are similar to the second counterfactual evaluation. A higher percentage of individuals are in entrepreneurship in the second and third counterfactual experiment. However, this only holds for business owners in the second counterfactual evaluation, since the percentage of otherwise self-employed decreases. To conclude, the relaxation of borrowing constraints results in longer duration of entrepreneurship, whereas a subsidy and entrepreneurship-specific training increase the percentage of entrepreneurs observed.

The rest of this chapter is structured as follows. The coming section reviews the literature related to the topic, which is succeeded by a description of the empirical data in section 3.3. Section 3.4 presents the structural model, followed by section 3.5 explaining how the model is solved. Section 3.6 lays out the calibration method, with section 3.7 discussing the calibration results and section 3.8 listing the findings from the counterfactual evaluations. Section 3.9 concludes.

3.2 Literature Review

The existing literature on entrepreneurship is vast and multifaceted. The following section will focus on studies most relevant to this paper. In the first half, I will discuss theories on occupational choice models of entrepreneurship, followed by theories on wealth and entrepreneurship. In the second half, I will examine empirical methods used in entrepreneurship research.

Among the first researchers to outline the economic significance of 'entrepreneurial ability' was Robert E. Lucas. In his paper from 1978, he endows individuals with a single-dimensional quantity, x. Whether the ability in entrepreneurship might derive from human capital, idiosyncratic leadership skills or other sources, x keeps the illustration of entrepreneurial ability simple. Abilities are constrained, fixed, and known by every individual with certainty. This addition of heterogeneity had a profound effect on the economics literature, helping to distinguish entrepreneurs from employees as well as showing how abler entrepreneurs create more successful businesses. Nevertheless, Lucas' model predicted that entrepreneurship was bound to decline as economies develop, which proved to be incorrect when the total number of entrepreneurs continued to increase in the last decades of the twentieth century while capital and real wages were both rising. In the following years, this criticism of the Lucas model prompted researchers to question if other determinants are at work, and whether these may be missing in Lucas' mechanism.

One of these factors is wealth. The relationship between entrepreneurship and wealth is one of the most researched areas in the study of entrepreneurship. Economic theory has been asking whether an individual requires personal wealth in order to become an entrepreneur. If this is the case, then those individuals with lower levels of personal wealth may not be able to recognise entrepreneurship as an occupation choice within possibility. Across the literature on the connection between wealth and entrepreneurship, researchers disagree on the meaning of the relationship. In fact, academics quarrel over its mere existence. Evans and Jovanovic (1989) pioneered the discussion on wealth and entrepreneurship. The pair introduced the idea of a positive correlation between entrepreneurship and wealth as being evidential credit constraints,

which might prevent able individuals from entering entrepreneurship. The Evans and Jovanovic model is a static model with limited liability constraints. A set of individuals can borrow a multiple (γ) of their initial assets B to start a business, where γ is the same for each individual and capital $k \in (0, \gamma B)$. Banks are inclined to provide a loan to individuals as a proportion of their assets, known as Type I credit rationing. Entrepreneurial ability x enters the production function, where income $y = xk^{\alpha}$ with $\alpha \in (0, 1)$. Two predictions can be derived from the Evans and Jovanovic model. First, there is a positive correlation between assets before entering entrepreneurship and the likelihood of entering entrepreneurship. Secondly, those entrepreneurs with higher levels of wealth will create larger businesses and receive higher income than those with lower levels of wealth. The model fails in its prediction that individuals with the highest entrepreneurial ability x are the most constrained individuals as shown by Astebro & Bernhardt (2003, 2005) and Parker & van Praag (2006)[1]. In my model, I include entrepreneurial ability as human capital in the wealth function. The intuition being that banks use human capital as a variable in determining loan size, removing the problem of individuals with higher ability being more constrained.

A paper by Aghion and Bolton (1997) extends the Evans and Jovanovic structure, and proposes to rectify the aforementioned issue by creating a model in which less wealthy individuals are cut off by a credit threshold. This credit threshold is imposed by competitive banks, since poorer individuals will have to share a larger proportion of their marginal returns from effort with the bank, meaning that they will have a lower incentive to supply effort. The outcome transpiring that poor individuals are more constrained and will be refused access to finance, therefore being denied entry into entrepreneurship. However, this approach does not capture observed and unobserved characteristics such as the level of human capital. Thus, it disregards the effect of human capital on borrowing potential which enters the wealth function of the structural model outlined in this chapter.

Empirical methods in entrepreneurship research have battled their own issues. With data

[1]The three studies identify a positive relationship between human capital and access to finance. E.g., Parker & van Praag (2006) use an instrumental variable estimator to evaluate the return of human capital on capital constraints. They find that an extra year of schooling lowers capital constraints by 1.18 percentage points, ceteris paribus.

being prone to self-serving bias or 'cheap talk', economists had to arm themselves with economic methods that disregard 'revealed preferences' and infer preferences from factual behaviour. One such battle in studying the relationship of entrepreneurship and wealth is endogeneity. It is notably an issue, since on the one hand researchers work with observable variables chosen by the entrepreneur, which tend to be correlated with unobservable variables ceding them endogenous. On the other hand, explanatory variables causing an individual to become an entrepreneur might also be a result of it, leading to spurious estimates. For instance, wealth could increase the probability of an individual becoming an entrepreneur, but being an entrepreneur could also increase the individual's level of wealth.

A cure against endogeneity is Instrumental Variable (IV) estimation. Studies such as the one by Hurst and Lusardi in 2004 were among the first to use a robust estimator by instrumenting their wealth variable. Using the Panel Study of Income Dynamics (PSID), their instrument of choice was the appreciation of house prices. Their findings suggest that there is not relationship between becoming an entrepreneur and personal wealth for the majority of people. Their estimates are positive at and after the 95^{th} percentile of the wealth distribution, claiming that only very wealthy individuals are liquidity constrained. They furthermore documented this non-monotonic relationship by considering a polynomial of wealth in a probit equation and argue that there is little evidence of a positive relationship between entrepreneurship and wealth. A variety of papers have confronted these results. One such paper is a study by Fairlie and Krashinsky (2006), in which the authors used data from the PSID and enriched it by adding data from the Current Population Survey (CPS). They found that Hurst and Lusardi aggregated heterogeneous groups in their paper, leading to their surprising findings. Fairlie and Krashinsky separated out individuals who had lost their job from individuals that had not lost their job. It emerges that the positive relationship between wealth and entrepreneurship at the top of the personal wealth distribution was caused by wealthy individuals from an older generation that had lost their job. These individuals experienced difficulties when reattempting to enter wage-employment, and thus chose the path of entrepreneurship. When separating out the two groups of individuals, becoming an entrepreneur is observed to be an increasing positive rate across the personal wealth distribution. Sauer and Wiesemeyer (2018) published a paper,

employing the method of IV estimation using a sample of females from the SOEP. The aim was to distinguish between different *categories* of entrepreneurs. As the quote by Baumol at the beginning of this chapter pointed out, entrepreneurs are one of the most elusive characters. By separating out different archetypes, we were able to predict in more detail the impact of an exogenous shock to wealth. We instrumented wealth by using the receipt of an inheritance, gift and lottery winnings. Our results underline that the relationship between entrepreneurship and wealth is strongest for those individuals that are registered business owners, whereas the effect was only half the size for individuals that freelance. In this paper, I build on these findings by incorporating two types of entrepreneurship alternatives in the set of occupation choice.

3.3 Data

The data for the calibration of the life-cycle model is gathered from the German Socio-Economic Panel (SOEP), Germany's longest running longitudinal panel study. A wealth module was incorporated into the main survey in 2002. The sample includes individuals surveyed in the years 2002-2016. To reduce heterogeneity among agents, I keep male respondents only. This results in a representative sample of 29,348 male person-year observations, including male business owners at 9.57 percent and self-employed males at 3.04 percent of the sample size.

3.3.1 Descriptive Statistics

All statistics reported include males only. This section reports summary statistics of variables used for sample X. Sample X includes N observations of individual i's data X_i. Elements of X_i will be discussed in the following subsections and consists of:

$$X_i = \{educ_i,\ exp_i, t,\ age_{i,t},\ d_{i,t},\ a_{i,t},\ y_{i,t},\ v_{i,t}\}$$

3.3.1.1 Initial Conditions *(Education and Type)*

Education $educ_i$ is divided into 3 categories within the SOEP survey. Individuals can discretely report whether they are educated to high school level, below high school level, or above high school level[2]. Values are reported in percentages in Table 3.1 for the full sample, and separately for the 9.57 percent of business owners and the 3.04 percent of other self-employed. The three categories of education level reported are recorded as binary variables. The majority of males have completed their high school education. Business-owning males are characterized by having a lower proportion of individuals educated below high school level and a higher proportion educated above high school level. Self-employed males are closer to the full sample than business-owning males in their distribution of education levels.

Table 3.1: Educational levels (%)

Variable	Full Sample	Business Owners	Self-Employed
< High School	8.57	3.37	6.86
High School	63.10	56.74	62.52
> High School	28.34	39.90	30.61
Total	100.00	100.00	100.00

Notes: Values are reported in percentages. Individuals between the age of 25 and 65 are included in the summary statistic.

3.3.1.2 Occupation Choice *(Labor Supply Decisions and Transitions)*

The occupation choice profile $d_{i,t}$ is derived from four independent survey questions in the SOEP. Firstly, surveyed individuals provide information on whether they are full-time employed, part-time employed or non-employed. Secondly, individuals are surveyed on whether they earn any income from secondary employment. Thirdly, I retrieve knowledge on whether

[2]The data is from Germany, and receiving a high school diploma is the attainment of the German Abitur.

an individual is wage-employed or not. Lastly, details are given on whether an individual is a business owner or otherwise self-employed (freelancer, help in the household, agriculture, other). Along with these four items of information, I can construct the occupation choices in the full sample. The majority of males are full-time employed, followed by non-employment and part-time employment, where non-employment is inactivity. Business owners make up 9.57 percent of the sample, followed by 0.17 percent of individuals that are wage-employed and business owners contemporaneously. More detailed information on occupation choices by age can be found in Table 23 in Appendix B[3].

Table 3.2: Labor supply decisions (%)

Variable	Labor Supply State
Full-Time Employed	61.60
Part-Time Employed	11.11
Business Owner	9.57
Other Self-Employed	3.04
Non-Employed	14.52
Wage-Employed & Business-Owning	0.17
NY	29,348

Notes: Values are reported in percentages. Individuals between the age of 25 and 65 are included in the summary statistic.

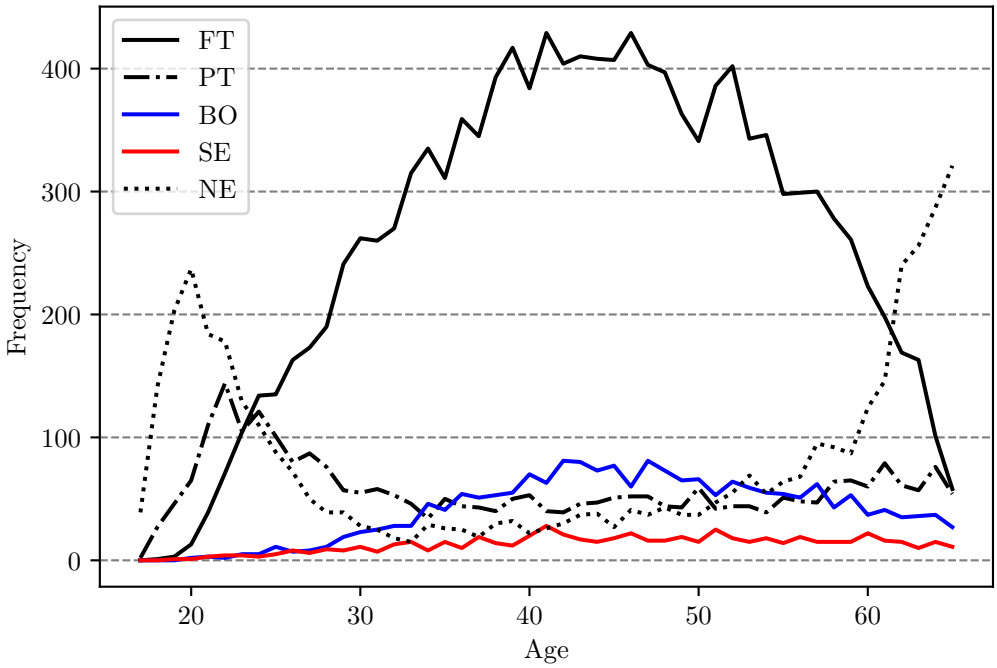
A graph on the marginal distributions of occupation choices over age is shown in Figure 3.2. Values found on the y-axis are the count of individuals in each respective state as outlined in Table 3.3 except for the final category[4]. Full-time wage-employment participation increases throughout the lifetime, and then starts declining halfway, with part-time wage-employment

[3]Table 4 shows that business ownership as an occupation choice is too small in the male sample before the age of 25. Therefore, the individuals included in the summary statistics are 25 to 65 years of age.

[4]Given that the number of individuals that are both simultaneously in wage-employment and own a business are represented by 0.17 % of the sample, this state will not be included as an occupation choice in the life-cycle model, reducing the state space and simplifying the computation of the model.

peaking in the early 20s and then declining to stay at approximately the same level. Non-employment increases drastically when individuals leave school, declining in the early 20s and then increasing again in the 60s. Business ownership exhibits a trend comparable to full-time wage-employment at a smaller scale. Other self-employment does not show high variation over the lifetime of individuals.

Figure 3.2: Labour Supply Distributions over Age



Note: FT = full-time wage-employed, PT = part-time wage-employed, BO = business owner, SE = other self-employed and NE = non-employed.

Table 3.4 includes transition rates between the occupation states. I exclude the occupation state where individuals are in wage-employment and business ownership at the same time. The dexter diagonal (upper left to lower right in bold) provides information on the percentage of males that did not change their occupation state. Four fifths of full-time wage-employed men stay within full-time wage-employment (81.5 percent), followed by 75.0 percent and 68.9 percent of men staying in business ownership and non-employment respectively. Nearly every second self-employed men continues self-employment (45.4 percent). This number drops to less than one third for wage-employed individuals (22.8 percent). With regards to transitions between states, the highest transition rate occurs at 43.0 percent where part-time wage-employed

Table 3.3: Occupation choice transition rates

	State t+1					
State t	FT	PT	SE	BO	NE	Total
FT	**0.815**	0.069	0.013	0.029	0.074	1.00
PT	0.430	**0.298**	0.031	0.032	0.209	1.00
SE	0.138	0.104	**0.454**	0.258	0.046	1.00
BO	0.114	0.028	0.077	**0.750**	0.031	1.00
NE	0.141	0.138	0.013	0.019	**0.689**	1.00

Note: FT = full-time wage-employed, PT = part-time wage-employed, SE = other self-employed, BO = business owner and NE = non-employed.

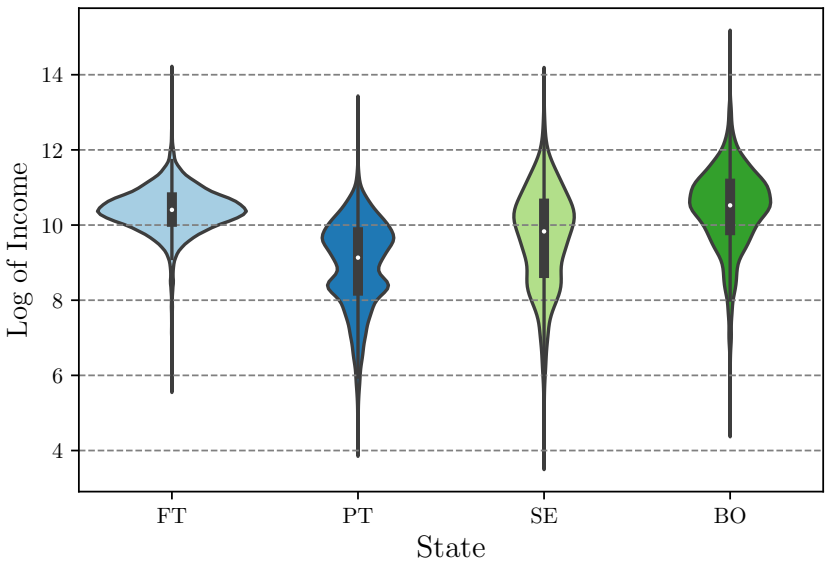
males move to full-time wage-employment. This is followed by the move from self-employment into business ownership (25.8 percent), and the switch from part-time wage-employment to non-employment (20.9 percent). Of equal size are the move from non-employment into full-time wage-employment (14.1 percent), self-employment into full-time wage-employment (13.8 percent) and business ownership into full-time wage-employment (11.4 percent).

3.3.1.3 Monetary components (*Wealth and Income*)

Monetary variables in this paper are income $y_{i,t}$, and wealth $a_{i,t}$. Values are reported in real Euros and the base year is 2007. To understand the distribution of mean income across the sample, I plot the average log of income for occupations that receive an income in Figure 3.3. The occupation with the tightest distribution of incomes is full-time wage-employment. Part-time wage-employment exhibits a bi-modal distribution. Business ownership does not only have the highest median, but also the highest upper adjacent value. The widest inter-quartile range of incomes is found for self-employment, showing that self-employment has the broadest spread of incomes in the mid 50 percent of observed incomes. Figure 3.4 shows mean income distributions in the sample over age and by state. It is worth noting, that there are heavy fluctuations in the income values of business owners and other self-employed, the cause of which is the proportional small number of business owners and self-employed in the sample (9.57

percent of the individuals in the sample are business owners and 3.04 percent are otherwise self-employed). Throughout their lifetime, business owners earn on average more than full-time wage-employed individuals. Part-time wage-employed males earn roughly half of the amount full-time wage-employed men earn. Otherwise self-employed males earn less than full-time wage-employed individuals. Mean incomes rise with age (except for non-employment). Otherwise self-employed males earn less than full-time wage-employed individuals. Mean incomes rise with age (except for non-employment). Table 24 in Appendix B provides details on mean labor incomes by state at each age. Figure 3.5 shows the mean and median net wealth distributions over age. Mean net wealth growths faster than median net wealth, and remains about twice as large across age. Table 25 in Appendix B provides details on mean and median net wealth for each age category.

Figure 3.3: Individual mean income across occupation states

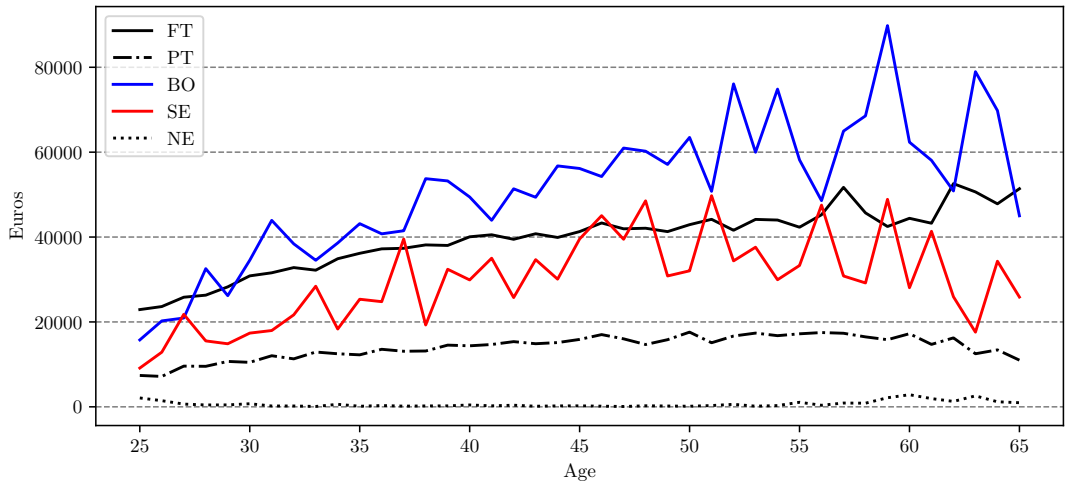


Note: FT = full-time wage-employed, PT = part-time wage-employed, BO = business owner, and SE = other self-employed.

3.3.1.4 Reduced-form Regressions

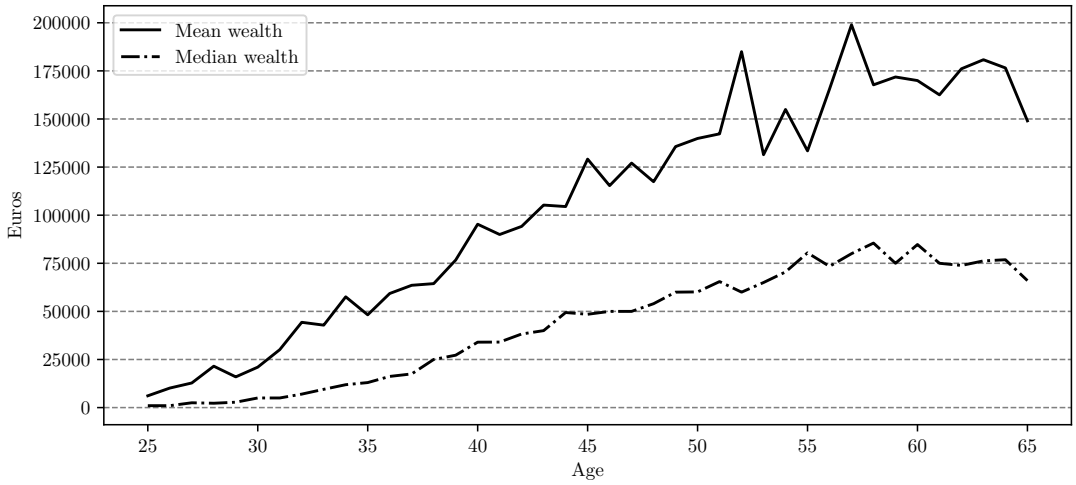
The following two tables include regression output providing estimates to better understand the relationship between the individual's characteristics and occupation choices, and the relation-

Figure 3.4: Individual mean and median wealth distribution over age



Note: FT = full-time wage-employed, PT = part-time wage-employed, BO = business owner, SE = other self-employed and NE = non-employed.

Figure 3.5: Individual Labor income distributions over age by state



Note: Values are in 2007 constant euros.

ship between the individual's characteristics and monetary outcome variables. Observations used are restricted to individuals that are between 25 and 65 years of age in the SOEP data. The first table outlines the results of a multinomial logit regression as average marginal effects. The four columns show the four outcome categories and compares each to the base outcome (non-employment). Education does not have an effect on the 4 occupation choices. The only significant effect is the negative impact of being educated above high school level on working in part-time wage-employment compared to non-employment. Age significantly increases the probability of working in full-time wage employment by 1.48 percent, whereas it decreases the probability of working in part-time employment by 1.8 percent compared to non-employment.

Table 3.4: Average Marginal Effects - Multinomial Logit

	(1) FT	(2) PT	(3) SE	(4) BO
I(High school)	0.0039	-0.0123	0.0033	0.0026
	(0.01463)	(0.00788)	(0.00706)	(0.01252)
I(> High school)	0.0167	-0.0180**	0.0136*	-0.0136
	(0.01571)	(0.00883)	(0.00732)	(0.01316)
Age	0.0148***	-0.0075***	0.0022	-0.0014
	(0.00309)	(0.00173)	(0.00136)	(0.00258)
Age^2	-0.0002***	0.0001***	-0.0000	0.0000
	(0.00003)	(0.00002)	(0.00001)	(0.00003)
Full-time work experience	0.0062***	-0.0024***	-0.0012***	-0.0021***
	(0.00059)	(0.00037)	(0.00020)	(0.00044)
Full-time work $experience^2$	0.0000	0.0000**	-0.0000	-0.0000
	(0.00003)	(0.00002)	(0.00001)	(0.00003)
Part-time work experience	-0.0196***	0.0109***	0.0033***	0.0066***
	(0.00195)	(0.00091)	(0.00053)	(0.00149)
Part-time work $experience^2$	0.0013***	-0.0007***	-0.0006***	-0.0001
	(0.00020)	(0.00010)	(0.00013)	(0.00015)
Log of income	0.1490***	-0.0957***	-0.0140***	-0.0274***
	(0.00518)	(0.00276)	(0.00200)	(0.00405)
Log of net wealth	-0.0895***	-0.0040***	0.0033***	0.0908***
	(0.00258)	(0.00135)	(0.00104)	(0.00237)
Observations	29,159	29,159	29,159	29,159
Pseudo R^2	0.2217	0.2217	0.2217	0.2217
LR χ^2	5791.53	5791.53	5791.53	5791.53

Note: FT = full-time wage-employed, PT = part-time wage-employed, SE = other self-employed, and BO = business owner. Robust standard errors in parentheses. The base outcome is non-employment. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Furthermore, full-time work experience decreases the likelihood of being part-time wage-employed, or becoming a business owner or otherwise self-employed, whereas part-time work experience increases the probability of entering all of these. Another year of part-time work increases the probability of entering business ownership by 6.6. percent compared to non-employment. This effect is halved for otherwise self-employed at 3.3 percent. The logarithms of income and net wealth have differing effects on the outcomes. A one percent in crease in income improves the probability to stay in full-time employment. For the other outcomes this decreases. The impact of a one percent increase in wealth has a high positive effect on entering business ownership at 9.08 percent, whereas this percentage is only 0.33 percent for otherwise self-employed and negative for wage-employment. Net wealth has the highest increase in the probability of entering business ownership compared to non-employment. Table 3.6 outlines two reduced-form regressions. In the first column the outcome variable is the logarithm of individual income, whereas the second column uses the logarithm of net wealth as the dependent variable.

Table 3.5: Reduced-form regressions

	(1) Log of Income	(2) Log of Wealth
High school	0.2021***	0.3659***
	(0.01637)	(0.05615)
I(> High school)	0.6271***	0.9977***
	(0.01805)	(0.06043)
Age	0.0426***	0.2082***
	(0.00544)	(0.01694)
Age^2	-0.0003***	-0.0017***
	(0.00006)	(0.00019)
Full-time work experience	0.0101***	0.0212***
	(0.00213)	(0.00650)
Full-time work $experience^2$	-0.0004***	-0.0005***
	(0.00005)	(0.00016)
Part-time work experience	-0.0460***	-0.0822***
	(0.00524)	(0.01605)
Part-time work $experience^2$	0.0019***	0.0027**
	(0.00040)	(0.00118)
Constant	8.9146***	4.2473***
	(0.10477)	(0.33233)
Observations	29,159	29,159
R^2	0.239	0.213
F	491.4909	351.0491

Note: Robust standard errors in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Having a high school diploma increases income by 20.21 percent and net wealth by 36.59 percent. The impact of education increases as the individual is educated beyond high school, which leads to an increase in wages by 62.71 percent and doubles net wealth. Age has a positive impact as well. Being one year older increases income by 4.26 percent, and net wealth improves by 20.82 percent. The increase continues at a decreasing rate. Full-time work experience has a positive effect on income and net wealth, whereas part-time work experience decreases the return to wages and net wealth. Full-time work experience increases at a decreasing rate, whereas part-time work experience decreases at an increasing rate.

3.4 Model Structure

The discrete choice time period is denoted by t, where one period is a Gregorian calendar year. The sequential decision-making of the agent starts at age $\underline{age} = 25$ in period $t = 1$, and finishes in the terminal period $t = T$ at age $\overline{age} = 65$.[5] The occupation state variable is denoted by d_t^k, $k \in K$. The variable $d_t^k = 1$ if occupation state alternative k is chosen, and 0 otherwise. An agent decides among these k alternatives in each of T finite discrete periods of time. Each choice has an outcome on wages and utility, and the agent's information on the current and future rewards at time t is contained in the state space $\Omega(t)$.

The state space contains the education level of the agent, which joins the wage functions as an exogenous variable. This variable defines the agent's permanent heterogeneity. It is questionable to condition the agent's optimal path on the education level, since it is exogenous and therefore not non-stochastic (Keane and Wolpin, 1997). This lack of persistent unobserved heterogeneity could be rectified by starting the optimization problem at the age of the agent when education was zero for every agent in the model. However, defining a model in such a way would be computationally burdensome, since decisions made by parents with regards to schooling and fertility would be adding further dimensions to the state space. Another possible

[5]The starting age is derived from the data. No significant business ownership activity is observed before the age of 25 as shown in Appendix B. The terminal age is the retirement age in Germany as of the time this paper was written.

solution would be to have as many types as agents (types = number of agents), which would also be computationally unfeasible[6].

At the beginning of every decision period t the agent observes shocks to occupation preferences $\epsilon^u_{i,t} \in \mathbb{R}^k$ where $\epsilon^u_{i,t} \sim \mathcal{N}(0,\, \Sigma^u)$, income $\epsilon^y_{i,t} \in \mathbb{R}^k$ where $\epsilon^y_{i,t} \sim \mathcal{N}(0,\, \Sigma^y)$, and business value shock $\epsilon^v_{i,t} \in \mathbb{R}^k$ where $\epsilon^v_{i,t} \sim \mathcal{N}(0,\, \Sigma^v)$. I assume that the preference shock $\epsilon^u_{i,t}$, the income shock $\epsilon^y_{i,t}$ and the business value shock $\epsilon^v_{i,t}$ are serially uncorrelated and distributed independently. If the agent chooses one of the four employment alternatives, he will observe income from working. If he chooses non-employment, the individual is given a non-working compensation benefit. The income is calculated using a Mincer wage equation as shown in section 3.4.1. Additionally, the agent must decide on an amount to save and not consume which is denoted as Δa_{t+1}, the change in the agents net wealth, which is $a_{t-1} - a_t$. Changes in net wealth are discretized for computational reasons related to the payoff matrix. Δa_{t+1} is defined as $\Delta a_{t+1} \in \{\Delta \underline{a} \; ... \; \overline{a}\}$. This amount will become part of the agent's assets and thus net wealth in the next period *t+1*. The difference between future additional net wealth and current period's earnings is the agent's consumption.

The objective of this exercise is for the individual to find the optimal expected present discounted value of their life-time utility from the starting period to the final decision period, a finite horizon problem. There are several moving state variables. These represent the work experiences gained for full-time work experience and part-time work experience throughout the model periods, as well as periods spent in non-employment and net wealth a_t. Two more binary moving variables are added, incorporating whether the individual ever experienced being self-employed or a business owner.

The discrete choice dynamic programming task goes as follows. An individual makes decisions in each period t that are assumed to maximize the discounted value of lifetime utility. The discount factor is $\beta \in (0, 1)$. Therefore:

[6] In future work, it would be attractive to assume that initial education levels are exogenous conditional on the age of entry in the model and its endowment vector.

$$\max_{d_t^k,\, \Delta a_{t+1}^k} E\left[\sum_{t=1}^{T} \beta^t u_t\right] \tag{3.1}$$

where u_t is subject to a budget constraint and subject to a consumption and a borrowing constraint. The utility function is an isoelastic function as follows:

$$u_t = \frac{c_t^{1-\lambda}}{1-\lambda} + \Phi_t^{we} d_t^k + \Phi_t^{ob} d_t^k + \epsilon_t^u d_t^k \tag{3.2}$$

where the first additive part is the utility derived from consumption, followed by the utility derived from being wage-employed ($k = 1, k = 2$) and the utility derived from being your own boss ($k = 3, k = 4$). The last additive part is a preference shock ($k = 5$). The budget constraint is expressed as:

$$c_t + a_{t+1} = y_t + (1-\delta)v_t + (1+r)(a_t - v_t) \tag{3.3}$$

where c_t is consumption in period t, a_{t+1} is wealth not consumed in period t, y_t is income in period t, v_t is the business value in period t if $k = 4$. $\delta \in (0,1)$ is the depreciation rate of the business, $r > 0$ is the interest rate, and a_t is the individual's net wealth in period t. There is an opportunity cost of v_t in not having put the amount towards the individual's net wealth.[7]

Consumption c_t is constrained by a lower bound, which is the period-independent consumption floor c_{min}, and an upper bound, which is the individual's sum of income, net wealth, and the business's value minus the minimum net wealth an individual is able to have in the next period as shown in equation 3.4.

$$c_{min} \leq c_t \leq y_t + (1-\delta)v_t + (1+r)(a_t - v_t) - \underline{a}_{t+1} \tag{3.4}$$

[7] I assume no further adjustment costs. If the individual decides to leave business ownership, v_t becomes a_t.

The borrowing constraint has a lower bound, which is the minimum savings an individual can have which would be comparable to a minimum bound given by banks to save.[8] The individual cannot have more savings than income plus net wealth plus business assets minus the what is needed for consumption. This borrowing constraint will prohibit consumption that is perfectly smoothed.

$$\underline{a}_{t+1} \leq a_{t+1} \leq y_t + (1-\delta)v_t + (1+r)(a_t - v_t) - c_{min} \tag{3.5}$$

3.4.1 Wage Functions

The model requires further parameterisation as outlined in the following subsections. One such addition to the model characterises wage offer functions. These wage functions are modelled as Mincer-style wage equations capturing individual skills as identified by the wage offer functions for wage-employed wage in equation 3.6 and 'own boss' wage in equation 3.7 below,

$$\begin{aligned} w_t^{we} = exp\Big[&\beta_{0we} + \beta_{1we} I(highschool) + \beta_{2we} I(> highschool) + \beta_{3we}(age) \\ &+ \beta_{4we}\frac{(age)^2}{100} + \beta_{5we} x_t^{ft} + \beta_{6we}\frac{(x_t^{ft})^2}{100} + \beta_{7we} x_t^{pt} + \beta_{8we}\frac{(x_t^{pt})^2}{100} \\ &+ \beta_{9we} I(x_{t-1}^{ft}) + \beta_{10we} I(x_{t-1}^{pt}) + \epsilon_t^{we}\Big] \end{aligned} \tag{3.6}$$

$$\begin{aligned} w_t^{ob} = exp\Big[&\beta_{0ob} + \beta_{1ob} I(highschool) + \beta_{2ob} I(> highschool) + \beta_{3ob}(age) \\ &+ \beta_{4ob}\frac{(age)^2}{100} + \beta_{5ob} x_t^{ft} + \beta_{6ob}\frac{(x_t^{ft})^2}{100} + \beta_{7ob} x_t^{pt} + \beta_{8ob}\frac{(x_t^{pt})^2}{100} \\ &+ \beta_{9ob} I(x_{t-1}^{ob}) + \beta_{11} v_t + \epsilon_t^{ob}\Big] \end{aligned} \tag{3.7}$$

where $I(highschool)$ and $I(> highschool)$ are education dummies for an individual having gained the equivalent of a high school qualification, and for the individual having gained a

[8] Assuming unmodeled imperfect financial markets, where the unmodeled lender sets a lower bound.

qualification above high school. The individual's age is found in *age*, and full-time work experience as well as part-time work experience are observed in x_t^{ft} and x_t^{pt}. Two indicators for whether an individual was in full-time wage-employment or part-time wage-employment in the previous period are added to 3.6, x_{t-1}^{ft} and x_{t-1}^{pt} respectively. Equation 3.7 includes an indicator on whether the individual has experience of being their 'own boss' from the previous period, x_{t-1}^{ob}. Additionally, 3.7 further incorporates the individual's business value v_t, since business value correlates positively with the individual's wage. Lastly, both functions include transitory productivity shocks, ϵ_t^{we} and ϵ_t^{ob}. Where for both wage-employment options, i.e. full-time wage employment and part-time wage employment, ϵ_t^{we} is drawn *individually* from the same distribution. Meaning I will draw two shocks for each wage employment option from the same distribution. I will also draw two shocks for each "own boss" option from the same distribution, i.e. ϵ_t^{ob} is also drawn *individually* from the same distribution.

$$y_t = \begin{cases} w_t^{we} * ft & \text{if } k = 1 \\ w_t^{we} * pt & \text{if } k = 2 \\ w_t^{ob} * ft & \text{if } k = 3 \\ w_t^{ob} * ft & \text{if } k = 4 \\ b & \text{if } k = 5 \end{cases} \tag{3.8}$$

It follows that each individual receives per period income y as demonstrated in equation 3.8, which can be expressed as the following income y_t, where ft and pt correspond to the annual hours worked in full-time or part-time mode. When the individual enters the model, full-time and part-time work experience along with experience of "being your own boss" are set to 0. Initial net wealth a_1 can be positive, negative or zero. The laws of motion for accumulating experience are as follows:

$$x_{t+1}^{ft} = x_t^{ft} + d_t^1 \tag{3.9}$$

$$x_{t+1}^{pt} = x_t^{pt} + d_t^2 \tag{3.10}$$

$$x_{t+1}^{ob} = d_t^3 \tag{3.11}$$

$$x_{t+1}^{ob} = d_t^4 \tag{3.12}$$

where the individual can only have previous period experience or no previous experience in entrepreneurship.

3.4.2 Business value and the lower bound for net wealth

In each period t, the individual is subject to a borrowing constraint from unmodeled financial market imperfections. Unmodeled banks set a lower bound so that net wealth does not go below $\underline{a_t}$, where $\underline{a_t}$ can be negative. Therefore, the individual is not able to smooth consumption perfectly. The lower bound borrowing constraint progresses as a function of the individual's eduaction, age, and work experience for $t = 2, \ldots, T$ as shown in 3.13. First period netwealth a_1 has to further satisfy the condition where $a_1 > \underline{a_1}$. Initial net wealth is taken from the first period observations from the data. Equation 3.14 determines the value of the business v, if the individual is a business owner ($k = 4$) in period t. Business value evolves as a function of education, age and work experience, as well as a business value shock. This is done to forecast future business value potential from human capital.

$$\begin{aligned}\underline{a}_t = exp\Big[&\gamma_0 + \gamma_1 I(highschool) + \gamma_2 I(> highschool) + \gamma_3(age) \\ &+ \gamma_4 \frac{(age)^2}{100} + \gamma_5 x_t^{ft} + \gamma_6 \frac{(x_t^{ft})^2}{100} + \gamma_7 x_t^{pt} + \gamma_8 \frac{(x_t^{pt})^2}{100} \\ &+ \gamma_9 I(x_{t-1}^{ob})\Big]\end{aligned} \tag{3.13}$$

$$
\begin{aligned}
v_t = exp\Big[&\zeta_0 + \zeta_1 I(highschool) + \zeta_2 I(> highschool) + \zeta_3(age) \\
&+ \zeta_4 \frac{(age)^2}{100} + \zeta_5 x_t^{ft} + \zeta_6 \frac{(x_t^{ft})^2}{100} + \zeta_7 x_t^{pt} + \zeta_8 \frac{(x_t^{pt})^2}{100} \\
&+ \zeta_9 I(x_{t-1}^{ob}) + \epsilon_t^v\Big]
\end{aligned} \tag{3.14}
$$

3.5 Solution Method

In this section, I portray how to computationally solve my life-cycle model. The structural model is a discrete choice problem. It is a dynamic problem with a finite horizon, which can be solved backwards from the final decision period T. The choice set contains 100 elements (5×20) made up of the following 2 choice variables: an occupation state variable with 5 mutually exclusive alternatives, and a savings choice with 20 mutually exclusive alternatives. Variables used to define an individual's heterogeneity, i.e. the level of education, are also discretized as described in the data section. The agent, after observing shocks to their occupation preferences and income, decides on the choice variables and obtains utility. Agents are forward looking and try to maximize expected lifetime rewards instead of choosing the largest immediate reward, where β captures the agent's preferences of immediate over future rewards.

The dynamic program is solved by the agent choosing the *optimal* sequence of alternatives. The model being formulated recursively and the horizon being finite, allows for solving the model by backward recursion starting in the final period T. The terminal value of discounted lifetime utility is calculated as a function by the state variables of the final period. We denote the *j-th* element of the choice set as follows:

$$
d_t^j \in \{\text{FT, PT, SE, BO, NE}\} \times \{\Delta a_{t=1}, ...\Delta a_T\} \tag{3.15}
$$

and the utility from a given choice set as u_t^j. The state space $\Omega(t)$ incorporates states points $\omega(t) \in \Omega(t)$ which include moving state variables, heterogeneity defining variables, and shocks.

$$\omega(t) = \{(exp_t^{FT}, exp_t^{PT}, exp_t^{SE}, exp_t^{BO}, d_{t-1}^k, a_t), (educ, \underline{age}), (\epsilon_t^u, \epsilon_t^{we}, \epsilon_t^{se}, \epsilon_t^{bo})\} \tag{3.16}$$

The first part of equation 3.16, $(exp_t^{FT}, exp_t^{PT}, exp_t^{SE}, exp_t^{BO}, d_{t-1}^k, a_t)$, is a generic element that results from past decisions up to *t-1*. The second element $(educ, \underline{age})$ is fixed permanently. Shocks and age_t form the exogenous part that moves across decision periods, t. The Bellman equation takes the following form, where V_t is written recursively with E_t being the expectation operator at the start of t:

$$\begin{aligned} V_t(\omega_t) &= \max_{d_t^j} u_t^j + \beta E_t \left[V_{t+1}(\omega_{t+1}) | \omega_t \right] \\ &= \max_{d_t^j} u_t^j \left[V_t(\omega_t)^1, V_t(\omega_t)^2, V_t(\omega_t)^3, ..., V_t(\omega_t)^J \right] \end{aligned} \tag{3.17}$$

where t denotes the period, ω_t denotes the state space in period t, and j denotes the choice combination. The discounted lifetime utility at each choice combination j is expressed as:

$$V_t^j(\omega_t) = u_t^j + \beta E_t \left[V_{t+1}(\omega_{t+1}) | d_t^j = 1, \omega_t \right] \tag{3.18}$$

where the expectation is taken over the joint distribution of the next period's stochastic shocks. Choices and choice combinations are assumed to be made optimally in any given period for the alternative-specific value functions. From hereon we will call the second additive part of equation (3.18) $Emax_t$. Each $Emax_t$ is a function mapping the predetermined state space ω_t and the choice combination j to a value. Shocks are observed and used to make a decision in period t, but since ϵ_t and ϵ_{t+1} are uncorrelated and independent, the information gained from observing the shocks does not affect $Emax_t$. The individual in the model compares the alternative-specific value functions to follow on a discounted lifetime utility maximizing path.

To solve the dynamic programming problem by backward recursion, we have to consider the value functions $V_t^j(\omega_t)$ or rather the $Emax_T$ functions in the final period T, where the individual

has the following J equations system for $\omega_T \in \Omega_T$:

$$\begin{cases} V_T^1(\omega_T) & = u_T^1 + \beta V_{T+1}(d_T^1 = 1, \omega_T) \\ \dots & \\ V_T^J(\omega_T) & = u_T^J + \beta V_{T+1}(d_T^J = 1, \omega_T) \end{cases} \tag{3.19}$$

We know the functions of each choice combination j in the final period T. Knowing $Emax_T$, we can take expectations of $V_T(\omega_T) = \max[V_T^1(\omega_T), \dots, V_T^J(\omega_T)]$ to calculate $Emax_{T-1}$ and so on, until all $Emax_t$ for all t have been calculated recursively. In the last period, no expectations are taken over the next period's shocks.

After all $Emax_t$ have been computed, we can solve for the optimal decision path and choice combinations j at each period t. I do this by calculating the probabilities that an individual chooses choice combination j, which is an integral over the space of the errors, so that choice combination j is the preferred choice combination. The calculated probabilities are conditional on the deterministic part of state space Ω_t. Since this method becomes computationally burdensome as the dimension of the state space increases, I use an approximation method by interpolation as applied in papers by Keane and Wolpin (1994, 1997, 2001). This way I retrieve approximated expected values of maxima alternative-specific value functions at each state point $Emax_t$. To implement this solution method, I made assumptions on functional form of the parameters and model distributions. The data used for calibration is outlined in the previous section.

3.6 Calibration Method

To calibrate the parameters for my life-cycle model of entrepreneurship, I use the observations of the data described in section 3.4. Using the approximated $Emax_t$ values calculated by the solution method in section 3.5, I simulate a dataset of 2000 agents from the first model period (where the agent enters the model at age 25) to the final model period (where "retirement"

occurs at age 65). The moments used for comparing the actual and simulated data are the occupation state rates, the one-period transition rates, and the occupation choice distribution by age as well as the distribution of mean income by occupation state and age. Educational level and initial wealth are exogenous. I simulate the dataset by defining a trial vector of parameters $\theta \in \Theta$. A period-by-period shock is randomly generated for every decision period t, in every m^{th} simulation (where $m = 1, \ldots$ M). I calculate outcomes of choice realisations, and the succeeding income realisations along with next period's wealth realisations. The m^{th} simulated data for individual i is denoted by:

$$X_i^m = (\{d_{i,t}^{j^m}, y_{i,t}^{j^m}, a_{i,t+1}^m, v_{i,t}^m, age_{i,t}^m\}_{t=1}^T, a_{i,1}^m, educ_i) \tag{3.20}$$

where I make the assumption that $educ_i$ and $\underline{age_i}$ are observed without error for each individual i, thus $age_{i,t}^m$ is given by t and $\underline{age}$.The solution of the dynamic programming model provides the conditional probabilities that an individual chooses choice occupation d. Given that part of the endogenous state variables in Ω_t are not observed, I would have to calculate conditional probabilities of unobserved state variables by integrating out all choices over the unobserved elements' distribution. To overcome this, McFadden (1989) proposes to use a method known as Simulated Method of Moments (SMM) to estimate models that are solved using numerical integration. The SMM moment estimator is:

$$argmin\ g(\theta)'Wg(\theta) \tag{3.21}$$

where θ is a vector of all unknown parameters that minimises the distance between the moments calculated from the actual data and the moments calculated from the simulated data. In the SMM criterion function, W is the optimal weighting matrix for the SMM estimates, which is the inverse of the estimated variances from the actual data divided by the number of individuals that add to each moment[9].

[9]In my calibration, I set the weighting matrix equal to the identity matrix to set the moment conditions equally.

The estimate of the model moments $g(\theta)$ is defined as:

$$g(\theta) = \frac{1}{N}\sum_{i=1}^{N} g_i(\theta) = [\overline{m_1} - \mu_1(\theta)...\overline{m_n} - \mu_n(\theta)] \tag{3.22}$$

where $(\overline{m}_1, \ldots, \overline{m}_n)$ are the data moments and $(\overline{\mu}_1, \ldots, \overline{\mu}_n)$ are the model moments from our m^{th} simulation.[10] Following this, I provide the model with the first period parameters (the 'trial' parameters), period-by-period shocks, and probabilities on educational level. The result is a file of simulated data which includes agent and period identifiers, education level, choice histories, wage outcomes, wealth, and the cumulative years of experience gained in each occupation choice. Then, the moments of my simulated data are computed and compared to the actual data.

3.7 Calibration Results

In the following section, I describe the identification of parameters, the fit of the calibrated model, as well as interpret the calibrated parameters and outline the most important moments. The following subsection compares the simulated empirical data moments to the observed empirical data moments.

3.7.1 Identification

Various moments, which are conditional on the individual's age as well as transition matrices, are used to identify the calibrated parameters in my life-cycle model. In the modelling of discrete choice dynamic programming models, all of the elements of the state space are represented in the alternative-specific value functions. However, wage functions are created by using a subset of state variables. Skills such as education level and work experience are controlled for in the

[10]The errors that are drawn for the m^{th} simulations of the model must be drawn only once so that the minimisation problem does not have the underlying sampling changing for each guess of a value of θ. The random draws for all simulations must be held constant so that the only changing element in the minimisation problem is the value of the vector of parameters θ.

wage functions, since wages are informed by the human capital acquired from schooling and experience gained from previous employment. I use full-time and part-time work experience, dummies for education level, as well as age and previous employment states for both "being your own boss" and wage-employment states. Wages seem to be less influenced by marriage and the number of children, which is the reason as to why I do not control for these in my wage functions. Variations in wages explain the productivity shocks.

The CRRA parameter is informed by transitions between occupation states. Choices of occupation states create shifts in consumption, because it can be optimal to choose different occupations at different ages to create optimal life-cycle paths from a life-cycle consumption point of view. The parameters of the functions on asset and business value are identified by education, work experience, previous asset levels and business values, because they are closely tied to the data on wages, and the occupation choice distributions.

3.7.2 Model Fit

To evaluate the model and the fit of its calibration results, I use the calibrated parameters to create a set of 10,000 (5 times 2,000) individual life-cycle paths from age 25 to age 65. Table 27 in Appendix C.1 outlines the percentage of individuals in the sample choosing each occupational choice, and comparing the simulated data moments to the actual data moments (where the actual data moments are in parentheses). The model seems to predict these proportions relatively well, with non-employment being minimally underpredicted and the entrepreneurship states slightly overpredicted. Table 3.7 below lists the one-period transition rates for the simulated data, and the actual data in parentheses. Row totals sum to 1, or alternatively 100 percent. The model does a good job at replicating the transition rates. However, moves from a non non-employment state into non-employment is higher in the simulated data than in the actual data. This also holds for other self-employment to other self-employment and full-time wage-employment to both entrepreneurship alternatives. The five transition rates of staying the same mode are reasonably reflected in the simulated transition rate moments.

Table 3.6: Occupation choice transition rates - *Simulated data*

	State t+1					
State t	FT	PT	SE	BO	NE	Total
FT	0.792	0.048	0.022	0.034	0.103	1.00
	(0.815)	(0.069)	(0.013)	(0.029)	(0.074)	(1.00)
PT	0.380	0.264	0.052	0.061	0.241	1.00
	(0.430)	(0.298)	(0.031)	(0.032)	(0.209)	(1.00)
SE	0.152	0.084	0.501	0.209	0.052	1.00
	(0.138)	(0.104)	(0.454)	(0.258)	(0.046)	(1.00)
BO	0.120	0.043	0.019	0.716	0.100	1.00
	(0.114)	(0.028)	(0.077)	(0.750)	(0.031)	(1.00)
NE	0.185	0.101	0.018	0.021	0.675	1.00
	(0.141)	(0.138)	(0.013)	(0.019)	(0.689)	(1.00)

Note: Actual data in parentheses.

3.7.3 Calibrated parameters

Table 3.7 provides calibrated values of the model parameters. Individuals discount expected utility by 97.51 percent a year ahead. Looking at the CRRA coefficient, it is just below the calibrated values in studies by Keane and Wolpin (2001), Keane and Imai (2004) and Sauer (2015), where it ranges between 0.5 and 2. The lower value calibrated for the risk aversion parameter in this chapter (implying that individuals are less risky) will impact the likelihood of becoming an entrepreneur, since the variance from income y_t from 'own boss' income is greatly higher than the variance from wage-employment income.

There is a positive improvement stemming from continuing entrepreneurship, at 0.0801 the calibrated value is close to a third of returns from being more than high school educated (0.2873). However, the utility gained from 'being your own boss' is two thirds the size of the utility gained form wage-employment. It is also interesting to point out that in Appendix C.3, the earnings potential of those in business ownership becomes larger faster than those in full-time wage-employment and particularly in other self-employment. Calibrated values on the return from high school education suggest that high school education is not as important for

'own boss' income compared to wage-employment income, and that a qualification beyond high school has a positive impact on the entrepreneur's returns. The opposite holds for full-time work experience, which has twice as large an estimate on the wage-employment wage than the wage for entrepreneurs.

Table 3.7: Model parameters

Function	Parameter	Variable (Returns to)	Calibrated Value
u_t	β	Time discount factor	0.9751
	λ	CRRA constant	0.4627
	Φ_t^{we}	Utility from being wage-employed	310.1635
	Φ_t^{ob}	Utility form being your own boss	250.2311
	ϵ_t^u	Non-employment preference shock	136.7126
w_t^{we}	β_{0we}	Constant	8.7283
	β_{1we}	Indicator - High school educated	0.2274
	β_{2we}	Indicator - More than high school educated	0.6116
	β_{3we}	Age	0.0459
	β_{4we}	Age squared	-0.0002
	β_{5we}	Full-time work experience	0.0094
	β_{6we}	Full-time work experience squared	-0.0003
	β_{7we}	Part-time work experience	-0.0366
	β_{8we}	Part-time work experience squared	0.0013
	β_{9we}	Indicator - Full-time wage-employed in $t-1$	0.0052
	β_{10we}	Indicator - Part-time wage-employed in $t-1$	-0.0011
	ϵ_t^{we}	Idiosyncratic productivity shock	0.2131
w_t^{ob}	β_{0ob}	Constant	6.9653
	β_{1ob}	Indicator - High school educated	-0.7866
	β_{2ob}	Indicator - More than high school educated	0.2873
	β_{3ob}	Age	0.1015
	β_{4ob}	Age squared	-0.0009
	β_{5ob}	Full-time work experience	0.0056
	β_{6ob}	Full-time work experience squared	-0.0001
	β_{7ob}	Part-time work experience	-0.1122
	β_{8ob}	Part-time work experience squared	0.0036
	β_{9ob}	Indicator - Own boss in $t-1$	0.0801
	β_{10ob}	Business value	0.0082
	ϵ_t^{ob}	Idiosyncratic productivity shock	0.6365
$\underline{a_t}$	γ_0	Constant	-9.635
	γ_1	Indicator - High school educated	0.2740
	γ_2	Indicator - More than high school educated	0.6312
...	...	...	...

...	...	...	...
	γ_3	Age	1.2421
	γ_4	Age squared	-0.021
	γ_5	Full-time work experience	0.1206
	γ_6	Full-time work experience squared	-0.0022
	γ_7	Part-time work experience	-0.0564
	γ_8	Part-time work experience squared	0.0091
	γ_9	Indicator - Own boss in $t-1$	0.0002
v_t	ζ_0	Constant	7.4435
	ζ_1	Indicator - High school educated	0.1065
	ζ_2	Indicator - More than high school educated	0.4427
	ζ_3	Age	0.1375
	ζ_4	Age squared	-0.0013
	ζ_5	Full-time work experience	-0.0189
	ζ_6	Full-time work experience squared	0.008
	ζ_7	Part-time work experience	-0.1466
	ζ_8	Part-time work experience squared	0.0037
	ζ_9	Indicator - Own boss in $t-1$	0.0352
	ϵ_t^v	Idiosyncratic business value shock	0.5891
	c_{min}	Consumption floor	129.3629

For the lower bound of net wealth, age plays a significant positive factor, as well as education and full-time work experience. More part-time work experience results in lower returns to the lower bound net wealth value. These results further differ for the business value function. Where the returns from education and age are positive, the returns from full-time work experience and the returns from part-time work experience are negative, suggesting that business value does not benefit from an individual's work experience. However, having had entrepreneurship experience in the previous period impacts the business's value positively.

3.8 Counterfactual Analysis

Having calibrated a dynamic structural model provides the opportunity to conduct counterfactual evaluations on changes in exogenous variables. It is a great tool in empirical research, and I use it to predict the effects of three different ex ante counterfactual policies. Using my cali-

brated model, I simulate agents' decisions according to each counterfactual, and then contrast those to the baseline agent decisions.

Table 3.9 uses the key measurement of population percentages in each occupational category, and compares the baseline to the three policies used for counterfactual evaluations. *Policy I* relaxes the borrowing constraint by making the net wealth floor negatively larger and setting $\underline{a_t} = -20,000$ Euros for any state and all individuals.[11] *Policy II* focuses on providing business owners with business capital in form of a subsidy. Therefore, business value v_t will be adjusted by including a subsidy, such that $v_t + subsidy$ where $subsidy = 20,000$ Euros. The last counterfactual evaluation, *Policy III*, is providing indirect incentives by educating the labour force through the supply of training to increase entrepreneurial human capital. I do this by increasing β_{0ob}, by raising it to the value of the constant in the wage-employment wage function, β_{0we}. Table 3.9 outlines how the counterfactual policies compared to the baseline population percentages in each occupation state.

Table 3.8: Counterfactual outcomes on occupation state rates

Variable	Baseline	Policy I	Policy II	Policy III
Full-Time Employed	59.32	60.31	59.30	58.91
Part-Time Employed	10.58	9.56	9.15	9.48
Business Owner	13.71	11.22	16.38	15.41
Other Self-Employed	5.69	5.13	4.98	6.27
Non-Employed	10.67	13.75	10.19	9.93

Policy I significantly reduces the percentage of individuals in business ownership from 13.71 percent to 11.22 percent, and only slightly affects the percentage of individuals in other self-employment. At the same time, the percentage of individuals in non-employment has climbed by 3.08 percentage points. Policy III and in particular Policy II move in the opposite direction, where the percentage of the population in business ownership increased. Policy III also leads to an increase in other self-employed individuals, and seems to be reducing the percentage of non-employed individuals.

[11] Compared to the calibrated lower bound in the range of -1,800 Euros to -11,250 Euros.

Table 3.9 highlights changes in one-period transition rates that are key to this study. Policy I causes an increase in the number of individuals that stay in business ownership, whereas Policy II and III lead to a decline in the persistence of individuals within business ownership. Policy III further increases the transitioning from full-time wage-employment to business ownership, as well as full-time wage-employment to other self-employment. Lastly, under Policy I there exists an increase in the number of business owners and other self-employed moving into non-employment.

Table 3.9: Key changes in transition rates

Variable	Baseline	Policy I	Policy II	Policy III
FT to BO	0.029	0.025	0.029	0.031
BO to BO	0.750	0.796	0.746	0.730
BO to NE	0.031	0.033	0.027	0.030
FT to SE	0.013	0.013	0.011	0.021
SE to SE	0.454	0.452	0.456	0.501
SE to NE	0.013	0.015	0.012	0.009

To summarise, it depends on what the aim is of a policy to tackle entrepreneurship. If the goal is to *increase the number of entrepreneurs* within an economy, then policy II and III are most effective. This means that the number of entrepreneurs rises when business subsidies are provided at the point of becoming an entrepreneur (policy II). The number of entrepreneurs also increases when individuals are better educated on entrepreneurship (policy III).

However, if the aim is not to increase the number of entrepreneurs, but to *increase the duration of entrepreneurship* after individuals entered entrepreneurship, policy I is the better choice. Under policy I, the borrowing constraint is relaxed. Every individual has access to a bank loan of up 20,000 Euros, which makes it easier for already existing entrepreneurs to stay in entrepreneurship for longer.

3.9 Conclusion

In this chapter, I calibrated a discrete choice dynamic programming model of entrepreneurship with data from the German Socio-Economic Panel. The life-cycle model captures the impact of borrowing constraints, business capital, and entrepreneurial human capital. I evaluated the effect of improving each of these factors separately in three counterfactual evaluations, while also including two types of entrepreneurs in the set of occupational choices for the individual's occupation decision.

My results outline how each counterfactual evaluation affects two key measurements, which are (a) the percentage of individuals in each occupation state, and (b) the transition rates in entrepreneurship. I show that the relaxation of borrowing constraints can enhance the longevity of entrepreneurship, and in particular the total lifetime of a registered business. Providing entrepreneurship-specific training or a subsidy towards the business does not have the same impact on the persistence of individuals in business ownership. However, these latter two counterfactual evaluations have a larger impact on individuals entering into entrepreneurship, particularly for those entering into business ownership.

This portrays how differing types of support for entrepreneurs have varying impacts on the two key measurements used in this study. Depending on whether an increase in the duration of the entrepreneur's endeavor or an increase in the overall number of entrepreneurs is desired, policies will have to be implemented accordingly. If aiming for longer lasting businesses and self-employment, then policies should aim at relaxing borrowing constraints. If an increase in the number of individuals entering into entrepreneurship is the target, then policies should be focusing on providing entrepreneurship-specific training or providing an injection of business capital.

The findings hold for Germany, and are dependent on that. They will likely vary for different countries and different model frameworks and setups, such as including both genders and/or other ethnicities. This might be of particular interest, since programs are being created that are aiming at underrepresented groups within entrepreneurship or providing an alternative to

unemployment. Additionally, it would be interesting for future research to extend the study to include not only a single agent's wealth and occupation choices, but also the choices of other household members, the cost of children in the household, and risk preferences.

Appendices

A Further Regressions

Table 10: First Stage Regressions - Female Sample

	(1) Log Net Wealth	(2) Log Net Wealth	(3) Log Net Wealth	(4) Log Net Wealth
Receipt of **Gift**	0.6624***	0.6258***		
	(0.10748)	(0.10454)		
Receipt of **Lottery Winning**			0.6049**	0.8209***
			(0.30147)	(0.25654)
Age	0.1132***	0.1170***	0.1169***	0.1207***
	(0.01942)	(0.01926)	(0.01950)	(0.01933)
Age^2	-0.0005**	-0.0006***	-0.0006***	-0.0006***
	(0.00021)	(0.00021)	(0.00021)	(0.00021)
Years of Education	0.0355***	0.0338***	0.0366***	0.0345***
	(0.00803)	(0.00789)	(0.00804)	(0.00789)
Work Experience FT	-0.0074	-0.0051	-0.0089	-0.0064
	(0.00784)	(0.00777)	(0.00786)	(0.00779)
Work Experience FT^2	-0.0001	-0.0002	-0.0001	-0.0001
	(0.00018)	(0.00018)	(0.00018)	(0.00018)
Work Experience PT	0.0056	0.0048	0.0066	0.0056
	(0.00839)	(0.00828)	(0.00841)	(0.00830)
Work Experience PT^2	0.0005*	0.0005	0.0004	0.0004
	(0.00028)	(0.00028)	(0.00028)	(0.00028)
Working Partner	0.3879***	0.3987***	0.3813***	0.3919***
	(0.04149)	(0.04076)	(0.04161)	(0.04084)
Number of Children	0.2891***	0.2992***	0.2873***	0.2960***
	(0.02497)	(0.02438)	(0.02496)	(0.02436)
Gave birth t-1	0.2277*	0.2985**	0.2945**	0.3671***
	(0.13066)	(0.12739)	(0.13329)	(0.13056)
Gave birth t-5	-0.2044	-0.2028	-0.1750	-0.1782
	(0.12836)	(0.12424)	(0.13006)	(0.12566)
Log of Income	0.2384***	0.2283***	0.2375***	0.2275***
	(0.02080)	(0.02027)	(0.02079)	(0.02027)
Manufacturing Sector	0.2608***	0.2386***	0.2833***	0.2594***
	(0.07396)	(0.07312)	(0.07471)	(0.07383)
Service Sector	-0.0377	-0.0287	-0.0283	-0.0198
	(0.04450)	(0.04405)	(0.04456)	(0.04409)
Constant	3.2925***	3.2640***	3.2357***	3.2095***
	(0.43427)	(0.42947)	(0.43576)	(0.43074)
Observations	6957	7263	6957	7263
R^2	0.0551	0.0225	0.0303	0.0347
F	38.03	35.94	16.38	10.33

Robust standard errors in parentheses.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 11: IV Regressions - Female Sample

	(1) Self-Employed Gift	(2) Business Owner Gift	(3) Self-Employed Lottery Winning	(4) Business Owner Lottery Winning
Log of Net Wealth	0.0604***	0.0728**	0.0618*	0.0850**
	(0.03316)	(0.03076)	(0.03330)	(0.08202)
Age	0.0053	0.0040	0.0125***	-0.0175
	(0.00461)	(0.00425)	(0.00459)	(0.01067)
Age^2	0.0000	0.0000	0.0001**	0.0001
	(0.00003)	(0.00003)	(0.00003)	(0.00006)
Years of Education	0.0002	0.0017	0.0058***	0.0023
	(0.00174)	(0.00152)	(0.00177)	(0.00333)
Work Experience FT	0.0018	0.0023**	0.0005	0.0030*
	(0.00114)	(0.00106)	(0.00106)	(0.00169)
Work Experience FT^2	-0.0000	-0.0000	-0.0000**	-0.0000
	(0.00002)	(0.00002)	(0.00002)	(0.00004)
Work Experience PT	-0.0014	0.0015	-0.0005	0.0009
	(0.00120)	(0.00113)	(0.00111)	(0.00184)
Work Experience PT^2	-0.0000	-0.0001***	0.0001	-0.0001**
	(0.00004)	(0.00004)	(0.00004)	(0.00007)
Working Partner	0.0325**	-0.0228*	0.0254*	-0.0667**
	(0.01398)	(0.01325)	(0.01365)	(0.03303)
Number of Children	-0.0106	-0.0130	0.0330***	-0.0461*
	(0.01013)	(0.01006)	(0.01045)	(0.02482)
Gave birth t-1	-0.0295	-0.0106	0.0147	-0.0511
	(0.01977)	(0.02045)	(0.01514)	(0.03979)
Gave birth t-5	0.0415*	0.0374*	0.0142	0.0580*
	(0.02183)	(0.02237)	(0.02145)	(0.03400)
Log of Income	-0.0300***	-0.0204***	0.0061	-0.0457**
	(0.00902)	(0.00761)	(0.00837)	(0.01918)
Manufacturing Sector	-0.0258*	-0.0419***	-0.0170	-0.0704***
	(0.01350)	(0.01196)	(0.01206)	(0.02564)
Service Sector	0.0293***	0.0073	0.0249***	0.0098
	(0.00661)	(0.00588)	(0.00619)	(0.00934)
Constant	-0.4079***	-0.3435***	-0.0857	-0.7039**
	(0.12090)	(0.11267)	(0.12029)	(0.27761)
Observations	6957	7263	6957	7263
R^2	0.1780	0.1790	0.1740	0.1759
Chi^2	82.1519	77.3549	93.4804	33.0016

Robust standard errors in parentheses.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 12: First Stage Regressions - Female Sample

	(1) Log Net Wealth	(2) Log Net Wealth	(3) Log Net Wealth	(4) Log Net Wealth
Windfall Income in 1,000s	0.0088***	0.0090***		
	(0.00065)	(0.00066)		
Inheritance in 1,000s			0.0057**	0.0054**
			(0.00241)	(0.00250)
Age	0.1208***	0.1258***	0.1053	0.0896
	(0.01940)	(0.01922)	(0.14178)	(0.14069)
Age^2	-0.0006***	-0.0007***	-0.0006	-0.0004
	(0.00021)	(0.00021)	(0.00153)	(0.00152)
Years of Education	0.0365***	0.0346***	0.1456***	0.1479***
	(0.00798)	(0.00783)	(0.05313)	(0.05372)
Work Experience Full-Time	-0.0101	-0.0074	-0.0862**	-0.0588
	(0.00782)	(0.00772)	(0.04298)	(0.04135)
Work Experience FT^2	-0.0000	-0.0001	0.0025***	0.0016**
	(0.00018)	(0.00017)	(0.00084)	(0.00078)
Work Experience Part-Time	0.0047	0.0041	-0.0433	-0.0469
	(0.00834)	(0.00823)	(0.04657)	(0.04731)
Work Experience PT^2	0.0005*	0.0005*	0.0011	0.0012
	(0.00028)	(0.00028)	(0.00146)	(0.00148)
Working Partner	0.3823***	0.3940***	0.7231**	0.6454**
	(0.04124)	(0.04051)	(0.29014)	(0.27851)
Number of Children	0.2903***	0.3006***	-0.0473	-0.0407
	(0.02485)	(0.02425)	(0.14893)	(0.14980)
Gave birth t-1	0.2712**	0.3255**	0.2507*	0.2121*
	(0.13117)	(0.12698)	(0.71163)	(0.69166)
Gave birth t-5	-0.1604	-0.1614	-0.8366**	-0.8840**
	(0.12958)	(0.12519)	(0.39953)	(0.40006)
Log of Income	0.2332***	0.2215***	0.0011	0.0252
	(0.02069)	(0.02017)	(0.17154)	(0.17011)
Manufacturing Sector	0.2818***	0.2545***	0.3991	0.5524
	(0.07433)	(0.07343)	(0.34678)	(0.33504)
Service Sector	-0.0440	-0.0420	-0.4163	-0.3729
	(0.04431)	(0.04378)	(0.31125)	(0.31040)
Constant	3.1425***	3.1102***	3.8099	3.8186
	(0.43359)	(0.42872)	(3.74039)	(3.75192)
Observations	6957	7263	140	143
R^2	0.0592	0.0323	0.0484	0.0483
F	174.36	175.67	10.02	11.05

Robust standard errors in parentheses.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 13: IV Regressions - Female Sample

	(1) Self-Employed Windfall Income	(2) Business Owner Windfall Income	(3) Self-Employed Inheritance	(4) Business Owner Inheritance
Log of Net Wealth	0.0030	0.0504***	0.0233	0.0351
	(0.00844)	(0.01712)	(0.14074)	(0.03833)
Age	0.0049**	0.0012	0.0097	0.0070
	(0.00228)	(0.00299)	(0.04673)	(0.00807)
Age^2	-0.0000*	-0.0000	-0.0000	-0.0001
	(0.00002)	(0.00002)	(0.00050)	(0.00009)
Years of Education	0.0034***	0.0025**	0.0540**	0.0068
	(0.00108)	(0.00119)	(0.02673)	(0.00693)
Work Experience Full-Time	0.0011	0.0022**	-0.0277	-0.0142**
	(0.00087)	(0.00098)	(0.02086)	(0.00579)
Work Experience FT^2	-0.0000**	-0.0000	0.0007	0.0005***
	(0.00002)	(0.00002)	(0.00043)	(0.00018)
Work Experience Part-Time	-0.0009	0.0017	-0.0070	0.0039
	(0.00092)	(0.00105)	(0.01681)	(0.00334)
Work Experience PT^2	0.0000	-0.0001***	0.0001	-0.0001
	(0.00003)	(0.00003)	(0.00043)	(0.00010)
Working Partner	0.0007	0.0140	0.2169	0.0122
	(0.00581)	(0.00851)	(0.13503)	(0.03440)
Number of Children	0.0144***	-0.0063	0.0670	-0.0024
	(0.00472)	(0.00626)	(0.05196)	(0.00843)
Gave birth t-1	-0.0041	-0.0025	0.1685	-0.0185
	(0.01060)	(0.01685)	(0.22970)	(0.05126)
Gave birth t-5	0.0259	0.0332	-0.1334	0.0553
	(0.01839)	(0.02113)	(0.19340)	(0.04744)
Log of Income	-0.0093**	-0.0153***	-0.0327	-0.0143
	(0.00361)	(0.00463)	(0.05536)	(0.00977)
Manufacturing Sector	-0.0012	-0.0361***	-0.0909	-0.1077*
	(0.00685)	(0.00856)	(0.13862)	(0.05663)
Service Sector	0.0268***	0.0068	-0.0533	-0.0095
	(0.00534)	(0.00564)	(0.11614)	(0.02022)
Constant	-0.1245**	-0.2713***	-0.0145	-0.1586
	(0.05072)	(0.07163)	(1.36981)	(0.23412)
Observations	6957	7263	140	143
R^2	0.0231	0.1873	0.2529	0.2941
Chi^2	120.8603	95.0091	20.2591	8.6768

Robust standard errors in parentheses.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 14: First Stage Regressions - Female Sample

	(1) Log of Net Wealth	(2) Log of Net Wealth
Gift in 1,000s	0.0040**	0.0047**
	(0.00201)	(0.00195)
Age	0.1282	0.1285
	(0.15999)	(0.15174)
Age^2	-0.0018	-0.0018
	(0.00198)	(0.00188)
Years of Education	0.0520	0.0255
	(0.05028)	(0.05021)
Work Experience Full-Time	-0.0085	0.0066
	(0.08296)	(0.07557)
Work Experience FT^2	0.0019	0.0018
	(0.00230)	(0.00215)
Work Experience Part-Time	0.0433	0.0578
	(0.05604)	(0.05362)
Work Experience PT^2	0.0046	0.0038
	(0.00347)	(0.00306)
Working Partner	0.3820	0.2922
	(0.26780)	(0.26165)
Number of Children	0.0994	0.1130
	(0.20825)	(0.17892)
Gave birth t-1	-0.7261	-0.0879
	(0.61492)	(0.55527)
Gave birth t-5	0.7200	0.4456
	(0.55082)	(0.61769)
Log of Income	0.6551***	0.4821***
	(0.14509)	(0.13285)
Manufacturing Sector	-0.6884	-0.6900
	(0.51256)	(0.51729)
Service Sector	0.6547**	0.6708**
	(0.28803)	(0.27719)
Constant	3.2368	4.1384
	(3.24954)	(3.04123)
Observations	146	161
R^2	0.3286	0.4357
F	10.58	13.72

Robust standard errors in parentheses.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 15: IV Regressions - Female Sample

	(1) Self-Employed Gift	(2) Business Owner Gift
Log of Net Wealth	0.0275	0.0433*
	(0.07306)	(0.02175)
Age	0.0360	0.0646**
	(0.02636)	(0.03288)
Age^2	-0.0005	-0.0007*
	(0.00030)	(0.00039)
Years of Education	0.0002	0.0008
	(0.00978)	(0.01268)
Work Experience Full-Time	0.0000	0.0163
	(0.00815)	(0.01396)
Work Experience FT^2	0.0003	0.0001
	(0.00024)	(0.00040)
Work Experience Part-Time	0.0063	-0.0175
	(0.00955)	(0.01558)
Work Experience PT^2	-0.0002	-0.0001
	(0.00060)	(0.00071)
Working Partner	0.0529	0.0150
	(0.04538)	(0.05663)
Number of Children	0.0454	-0.0788*
	(0.02829)	(0.04683)
Gave birth t-1	-0.0610	0.1260
	(0.08485)	(0.10144)
Gave birth t-5	-0.2354**	-0.2132**
	(0.10945)	(0.10676)
Log of Income	-0.1440**	-0.1231**
	(0.06266)	(0.05844)
Manufacturing Sector	0.0030	0.0639
	(0.06217)	(0.07951)
Service Sector	0.1548*	-0.1145
	(0.08196)	(0.10577)
Constant	0.4246	0.6290**
	(0.52535)	(0.80554)
Observations	146	161
R^2	0.3775	0. 3312
Chi^2	46.8473	17.3321

Robust standard errors in parentheses.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 16: First Stage Regressions - Net Wealth

	(1) Log Net Wealth	(2) Log Net Wealth	(3) Log Net Wealth	(4) Log Net Wealth
Receipt of Windfall Income	0.7698***			
	(0.07734)			
Receipt of Inheritance		0.9973***		
		(0.12048)		
Receipt of Gift			0.6258***	
			(0.10454)	
Receipt of Lottery Winning				0.8209***
				(0.25654)
Constant	3.2968***	3.2409***	3.2640***	3.2095***
	(0.42822)	(0.42846)	(0.42947)	(0.43074)
Observations	7242	7263	7263	7263
R^2	0.185	0.182	0.179	0.176
F	104.3256	103.1583	100.7793	99.1815

Robust standard errors in parentheses.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 17: First Stage Regressions - Home Value

	(1) Log Home Value	(2) Log Home Value	(3) Log Home Value	(4) Log Home Value
Receipt of Windfall Income	0.2184***			
	(0.04037)			
Receipt of Inheritance		0.2469***		
		(0.05105)		
Receipt of Gift			0.2188***	
			(0.05814)	
Receipt of Lottery Winning				0.1176**
				(0.06349)
Constant	10.6339***	10.6221***	10.6534***	10.6354***
	(0.28301)	(0.28242)	(0.28339)	(0.28308)
Observations	3632	3646	3646	3646
R^2	0.064	0.061	0.062	0.058
F	14.7376	14.2910	13.5865	13.3313

Robust standard errors in parentheses.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 18: First Stage Regressions - Years of Education

	(1) Years of Educa	(2) Years of Educa	(3) Years of Educa	(4) Years of Educa
Receipt of Windfall Income	0.6298***			
	(0.05612)			
Receipt of Inheritance		0.4313***		
		(0.08312)		
Receipt of Gift			0.7969***	
			(0.07734)	
Receipt of Lottery Winning				0.4063
				(0.24752)
Constant	8.7987***	8.8012***	8.7993***	8.8099***
	(0.23529)	(0.23509)	(0.23484)	(0.23515)
Observations	47020	47150	47150	47150
R^2	0.144	0.142	0.144	0.142
F	573.2823	567.0130	575.2477	564.7040

Robust standard errors in parentheses.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 19: First Stage Regressions - Financial Assets

	(1) Log Fin. Assets	(2) Log Fin. Assets	(3) Log Fin. Assets	(4) Log Fin. Assets
Receipt of Windfall Income	0.4975***			
	(0.06800)			
Receipt of Inheritance		0.5769***		
		(0.12015)		
Receipt of Gift			0.4869***	
			(0.08211)	
Receipt of Lottery Winning				0.1666
				(0.22660)
Constant	5.4220***	5.4235***	5.3892***	5.3752***
	(0.40951)	(0.40947)	(0.40911)	(0.41068)
Observations	4660	4667	4667	4667
R^2	0.133	0.129	0.130	0.125
F	43.9490	42.7840	43.0761	41.2427

Robust standard errors in parentheses.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 20: First Stage Regressions - Tangible Assets

	(1) Log Tan. Assets	(2) Log Tan. Assets	(3) lLog Tan. Assets	(4) Log Tan. Assets
Receipt of Windfall Income	0.2017			
	(0.22752)			
Receipt of Inheritance		0.5129**		
		(0.25992)		
Receipt of Gift			0.4129	
			(0.44739)	
Receipt of Lottery Winning				0.5559**
				(0.21632)
Constant	6.7169***	6.7491***	6.8175***	6.7752***
	(1.41827)	(1.42094)	(1.41741)	(1.42154)
Observations	519	519	519	519
R^2	0.183	0.188	0.183	0.182
F	7.5382	7.7672	7.7806	9.5577

Robust standard errors in parentheses.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 21: IV Regressions for periods t-1, t-2 and t-5.

	(1) Self-Employed *t-1*	(2) Business Owner *t-1*	(3) Self-Employed *t-2*	(4) Business Owner *t-2*	(5) Self-Employed *t-5*	(6) Business Owner *t-5*
Log of Net Wealth	0.0305	0.1199**	0.0044	0.0280	0.0239	0.0122
	(0.03226)	(0.04688)	(0.02720)	(0.03583)	(0.02784)	(0.02641)
Age	0.0079*	-0.0095	0.0042	0.0046	0.0028	0.0055*
	(0.00448)	(0.00656)	(0.00294)	(0.00350)	(0.00312)	(0.00295)
Age^2	-0.0000	0.0000	-0.0000	-0.0001***	-0.0000	-0.0001***
	(0.00003)	(0.00004)	(0.00003)	(0.00002)	(0.00003)	(0.00002)
Years of Education	0.0052***	-0.0003	0.0055***	0.0026	0.0042**	0.0033*
	(0.00175)	(0.00245)	(0.00192)	(0.00221)	(0.00182)	(0.00188)
Work Experience Full-Time	0.0014	0.0034**	0.0037***	0.0029**	0.0035***	0.0030**
	(0.00109)	(0.00139)	(0.00115)	(0.00136)	(0.00117)	(0.00136)
Work Experience FT^2	-0.0001***	-0.0000	-0.0001***	-0.0000	-0.0001***	-0.0001*
	(0.00002)	(0.00003)	(0.00002)	(0.00003)	(0.00002)	(0.00003)
Work Experience Part-Time	-0.0006	0.0010	-0.0011	0.0001	-0.0017	0.0003
	(0.00112)	(0.00156)	(0.00129)	(0.00148)	(0.00128)	(0.00135)
Work Experience PT^2	0.0001	-0.0001**	0.0001**	-0.0000	0.0001*	-0.0000
	(0.00004)	(0.00005)	(0.00004)	(0.00003)	(0.00004)	(0.00004)
Working Partner	0.0099	-0.0413**	-0.0013	-0.0009	-0.0113	0.0052
	(0.01307)	(0.01896)	(0.01195)	(0.01556)	(0.01128)	(0.01236)
Number of Children	0.0252**	-0.0275*	0.0220**	0.0032	0.0115	0.0097
	(0.01012)	(0.01445)	(0.01078)	(0.01315)	(0.01070)	(0.01039)
Gave birth t-1	0.0100	-0.0364	0.0072	0.0012	-0.0094	0.0132
	(0.01615)	(0.02951)	(0.02248)	(0.03223)	(0.02300)	(0.02683)
Gave birth t-5	0.0220	0.0379	0.0308	0.0078	0.0344	0.0070
	(0.02188)	(0.02706)	(0.02268)	(0.02066)	(0.02245)	(0.01984)
Log of Income	-0.0043	-0.0325***	-0.0185**	-0.0126	-0.0256***	-0.0071
	(0.00855)	(0.01185)	(0.00775)	(0.00968)	(0.00804)	(0.00722)
Manufacturing Sector	0.0031	-0.0603***	-0.0099	-0.0500***	-0.0195*	-0.0420***
	(0.01192)	(0.01725)	(0.01023)	(0.01202)	(0.01069)	(0.00984)
Service Sector	0.0244***	0.0084	0.0228***	0.0043	0.0228***	0.0033
	(0.00570)	(0.00756)	(0.00599)	(0.00668)	(0.00599)	(0.00647)
Constant	0.0448	-0.4998***	0.0166	-0.2448*	-0.1053	-0.1938*
	(0.11358)	(0.16126)	(0.12301)	(0.14669)	(0.12516)	(0.11697)
Observations	6253	6532	4961	5193	4949	5179
R^2	0.032	0.026	0.028	0.011	0.037	0.025
chi2	96.2411	54.2890	102.0136	123.1498	100.3572	113.2123

Standard errors in parentheses.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 22: Business Owners with more than one period of Business Ownership

	(1) Business Owner ≥ two periods Windfall Income	(2) Business Owner ≥ two periods Inheritance
Log of Net Wealth	0.0120	0.5261
	(0.42857)	(1.45203)
Age	0.0837**	0.0620
	(0.03362)	(0.08791)
Age^2	-0.0009*	-0.0015
	(0.00054)	(0.00169)
Years of Education	-0.0047	0.0243
	(0.02509)	(0.08381)
Work Experience Full-Time	-0.0079	-0.0194
	(0.01194)	(0.03917)
Work Experience FT^2	0.0002	0.0011
	(0.00081)	(0.00282)
Work Experience Part-Time	-0.0237	0.0260
	(0.04493)	(0.14271)
Work Experience PT^2	0.0008	-0.0011
	(0.00181)	(0.00578)
Working Partner	-0.0661	-0.2568
	(0.16810)	(0.55124)
Number of Children	0.0360	-0.1315
	(0.14472)	(0.47623)
Gave birth t-1	0.0199	-0.6410
	(0.55990)	(1.88588)
Gave birth t-5	-0.1647	0.5792
	(0.62490)	(2.11241)
Log of Income	0.0226	-0.0191
	(0.04103)	(0.12583)
Manufacturing Sector	0.1573	0.5808
	(0.37290)	(1.28359)
Service Sector	0.0019	0.0605
	(0.07364)	(0.20656)
Constant	-1.7089	-5.5491
	(3.26064)	(11.00754)
Observations	306	306
R^2	0.106	0.093
chi2	50.0362	10.6790

Standard errors in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

B Constructing the Data

The sample X selected from the SOEP data and used for calibration is constructed by the following criteria:

1. The first exclusion restriction is on gender. Since this paper is interested in providing a model on male entrepreneurship, females are removed from the sample.

2. After observing that there is no significant amount of business ownership before the age of 25 years, I keep observations of individuals from age 25 to 65 only.

3. Widowed individuals are excluded, since the death of a partner can provide financial means that are not identified by the data.

4. To reduce heterogeneity within the sample, I exclude ethnic minorities.

The rest of Appendix B lists the tables concerning section 3.3 in Chapter 3, and provides detailed age profiles of labour supply states, individual income and net wealth.

Table 23: Occupation States (%)

Age	FT	PT	BO	SE	NE	Total
20	3.29	22.30	0.23	0.47	73.71	100.00
21	9.95	31.84	0.75	0.75	56.72	100.00
22	17.12	34.25	1.14	0.68	46.80	100.00
23	28.09	29.38	1.55	1.29	39.69	100.00
24	34.16	33.17	0.75	1.25	30.67	100.00
25	38.50	30.19	1.66	3.60	26.04	100.00
26	47.83	24.93	2.61	2.03	22.61	100.00
27	53.06	27.11	1.75	2.33	15.74	100.00
28	57.96	24.02	2.70	3.30	12.01	100.00
29	65.96	15.96	2.39	5.05	10.64	100.00
30	69.29	14.44	2.89	6.04	7.35	100.00
31	69.23	15.65	1.86	6.63	6.63	100.00
32	70.54	13.70	3.36	7.49	4.91	100.00
33	75.00	11.32	3.54	6.60	3.54	100.00
34	74.12	7.68	1.75	10.09	6.36	100.00
35	69.96	11.66	3.36	9.19	5.83	100.00
36	72.93	8.89	2.02	11.11	5.05	100.00
37	72.02	9.05	4.12	10.70	4.12	100.00
38	73.88	7.46	2.80	10.26	5.60	100.00
39	73.77	8.80	2.11	9.68	5.63	100.00
40	69.78	9.53	3.78	12.77	4.14	100.00
41	73.19	6.75	4.89	10.79	4.38	100.00
42	70.09	7.01	3.59	14.19	5.13	100.00
43	69.62	7.68	2.84	13.69	6.18	100.00
44	70.15	8.23	2.57	12.52	6.52	100.00
45	69.91	9.06	3.08	13.16	4.79	100.00
46	70.94	8.54	3.78	9.85	6.90	100.00
47	68.39	9.03	2.68	13.55	6.35	100.00
48	69.19	7.75	2.75	12.91	7.40	100.00
49	68.93	8.10	3.58	12.43	6.97	100.00
50	65.58	11.47	2.87	12.81	7.27	100.00
51	69.60	7.91	4.50	9.53	8.45	100.00
52	68.88	7.82	3.06	10.88	9.35	100.00
53	64.62	8.38	2.79	11.17	13.04	100.00
54	67.37	7.53	3.47	10.81	10.81	100.00
55	62.14	10.70	2.88	11.11	13.17	100.00
56	61.71	10.18	3.87	10.39	13.85	100.00
57	57.77	9.02	2.88	12.09	18.23	100.00
58	57.09	12.77	2.99	8.58	18.56	100.00
59	53.91	13.37	3.09	10.91	18.72	100.00
60	47.57	13.11	4.65	7.82	26.85	100.00
61	41.12	16.32	3.31	8.47	30.79	100.00
62	32.25	12.02	2.86	7.06	45.80	100.00
63	30.99	10.84	1.90	6.84	49.43	100.00
64	19.31	14.53	2.87	7.07	56.21	100.00
65	12.16	11.32	2.31	5.87	68.34	100.00
Total	43.99	11.50	2.50	7.44	34.57	100.00

Note 1: FT = full-time wage-employed, PT = part-time wage-employed, BO = business owner, SE = other self-employed and NE = non-employed. Note 2: The total percentages differ to Table 3.3, since I include individuals aged 17 to 65 in the above table to motivate the initial age at which an individual enters the model. There is no significant amount of male business ownership before the age of 25. Thus, the sequential decision-making of the agent starts at age $\underline{a} = 25$. I exclude the option of being wage-employed and self-employed, since I show in Table 3.3 that this percentage is below 1 percent overall.

Table 24: Average Individual Income by Age and State

	State				
Age	FT	PT	SE	BO	NE
20	13725.08	5010.864	2995.572	2750.00	3057.98700
21	17093.48	7381.696	29886.400	18987.67	3354.59900
22	19297.72	7913.580	4702.500	14274.40	3346.49800
23	20514.52	7402.801	6537.273	35084.00	3127.52400
24	21888.15	8182.589	3234.750	13276.86	2635.55200
25	22909.80	7392.375	9133.167	15759.36	2088.61400
26	23623.85	7163.162	12872.830	20243.45	1447.14300
27	25823.80	9589.394	21789.230	20922.91	642.91610
28	26308.35	9543.079	15529.680	32553.45	439.32370
29	28265.81	10695.720	14853.600	26191.88	451.88810
30	30852.19	10480.160	17367.840	34536.87	725.57380
31	31579.60	12034.730	17977.230	43930.43	195.31750
32	32806.16	11301.010	21670.570	38396.83	201.97540
33	32191.95	12909.760	28415.000	34532.86	84.47482
34	34889.91	12501.650	18330.350	38604.20	590.65560
35	36169.14	12248.790	25349.320	43156.39	134.80790
36	37218.34	13554.510	24775.190	40756.38	299.44850
37	37352.27	13092.810	39548.630	41484.73	165.93710
38	38149.62	13153.120	19279.150	53752.34	212.16670
39	38022.31	14537.330	32411.530	53222.46	223.50340
40	40057.48	14375.980	29897.000	49438.57	439.06920
41	40535.06	14685.090	35015.760	43944.52	236.97940
42	39470.61	15359.940	25744.330	51365.79	378.80880
43	40776.29	14867.140	34677.790	49374.64	143.43540
44	39903.21	15137.460	30077.230	56762.26	218.68670
45	41287.59	15882.530	39547.180	56153.08	228.32650
46	43319.65	17017.710	45040.890	54256.46	153.61840
47	41942.02	16018.790	39477.270	60968.27	79.03226
48	42077.56	14679.540	48531.410	60225.11	247.19600
49	41280.84	15818.220	30829.590	57109.89	192.03030
50	42917.66	17600.590	32044.720	63472.56	136.18250
51	44177.91	15094.740	49747.090	50763.57	300.52470
52	41598.10	16678.670	34381.150	76089.41	589.18650
53	44157.58	17370.690	37608.450	59975.16	154.84920
54	44007.13	16764.220	29941.900	74858.98	295.51350
55	42315.74	17203.180	33297.870	58173.60	1070.10900
56	45251.18	17499.170	47527.050	48576.58	368.96190
57	51712.75	17332.890	30824.450	64961.01	890.88360
58	45691.90	16479.570	29184.810	68558.77	855.58940
59	42483.70	15817.330	48890.310	89815.96	2141.71100
60	44415.85	17227.940	28055.120	62350.47	2848.66300
61	43256.08	14710.090	41360.760	58070.58	1939.55000
62	52579.36	16242.900	25924.040	50856.85	1277.08300
63	50632.89	12502.480	17592.130	78960.11	2580.54400
64	47828.27	13416.730	34305.000	69797.35	1189.63300
65	51385.93	10994.380	25862.320	45004.97	968.74010

Note 1: FT = full-time wage-employed, PT = part-time wage-employed, BO = business owner, SE = other self-employed and NE = non-employed.

Table 25: Average Individual Net Wealth by Age

Age	Mean	Median
25	6123.84	1000
26	10145.83	1000
27	12791.66	2500
28	21515.83	2260
29	15961.98	2800
30	21021.50	5000
31	30105.94	5000
32	44328.29	7000
33	42848.50	9500
34	57569.90	11900
35	48218.73	13000
36	59297.77	16200
37	63562.49	17500
38	64424.34	25000
39	76673.95	27234
40	95296.27	34000
41	89955.73	34050
42	94170.88	38250
43	105254.90	40000
44	104482.60	49408
45	129147.00	48500
46	115353.10	50000
47	127071.40	50000
48	117395.90	54000
49	135652.10	60000
50	139875.50	60125
51	142270.50	65500
52	184986.40	60000
53	131428.10	65000
54	154940.00	70500
55	133432.40	80422
56	165547.20	73400
57	198954.70	80000
58	167746.00	85503
59	171830.90	75000
60	169965.80	84750
61	162540.40	75000
62	176093.30	73875
63	180799.90	76250
64	176524.70	76847
65	149030.20	66000

C Model Fit

C.1 Occupation state percentages - simulated data

Table 26: Labor supply decisions (%)

Variable	Labor Supply State
Full-Time Employed	59.33
	(61.64)
Part-Time Employed	10.58
	(11.14)
Business Owner	13.71
	(9.57)
Other Self-Employed	5.69
	(3.11)
Non-Employed	10.67
	(14.52)

Notes: Actual data in parentheses.

C.2 Occupation levels by age

Figure 6: Full-time wage-employment

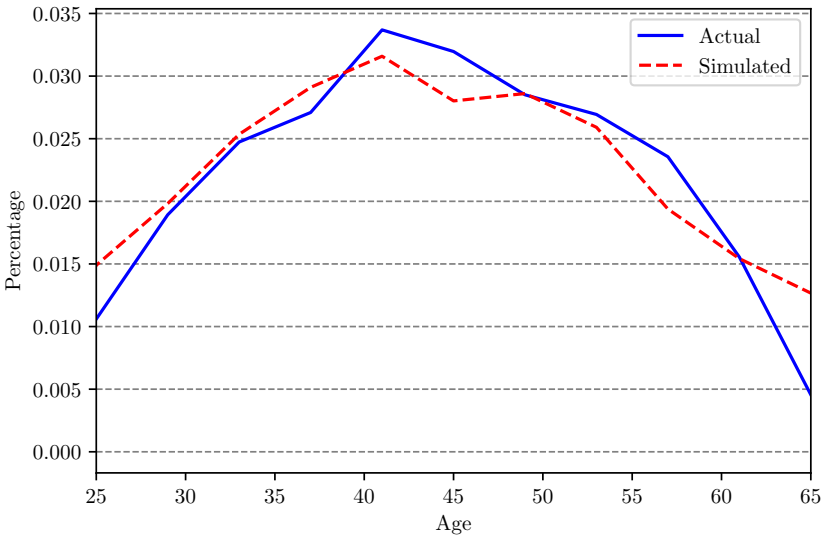


Figure 7: Part-time wage-employment

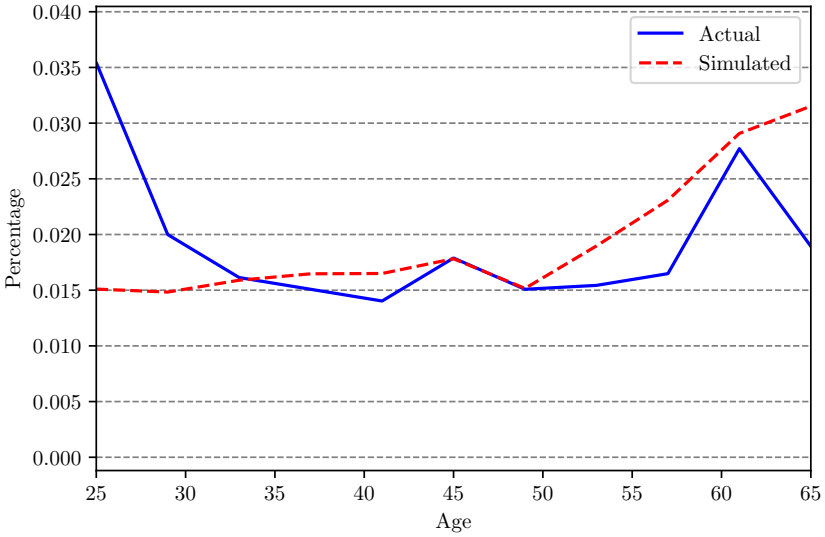


Figure 8: Self-employed

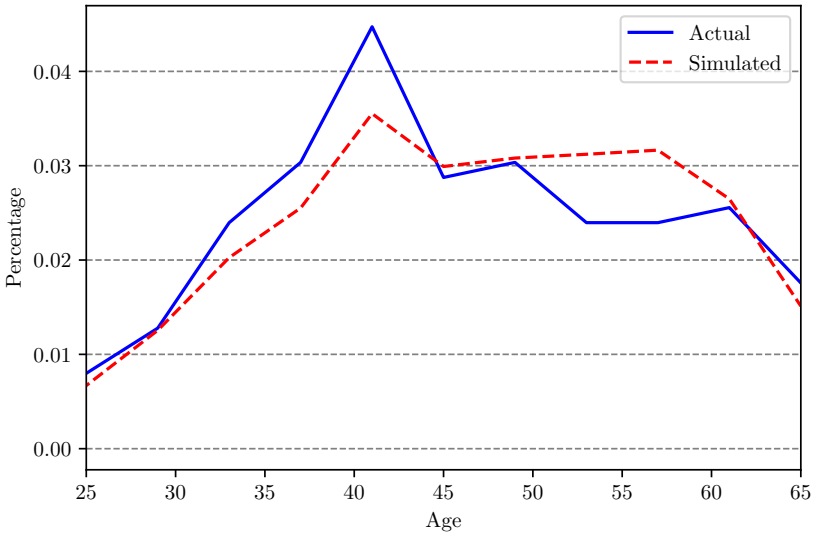


Figure 9: Business owners

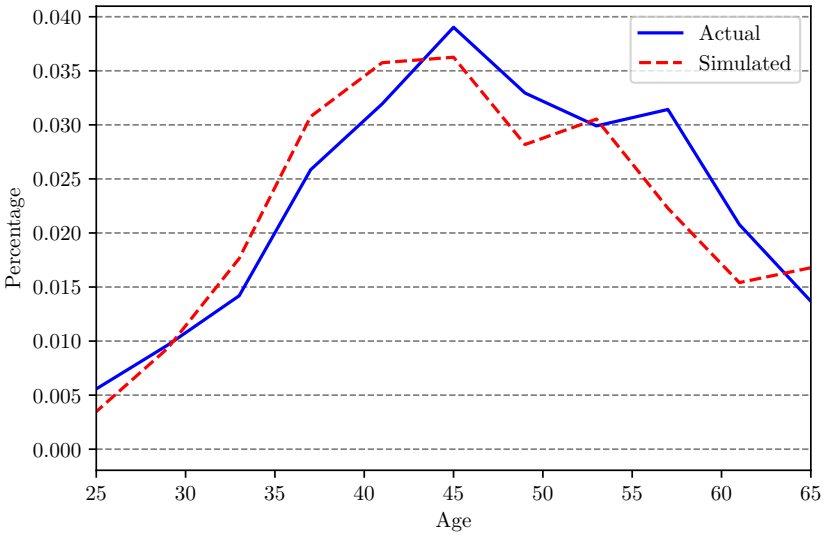
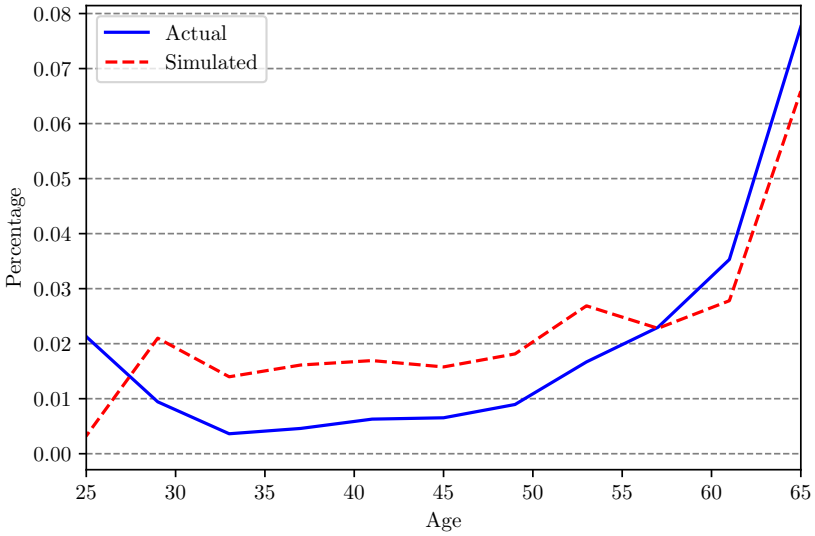


Figure 10: Non-employment



C.3 Mean income by occupation and by age

Figure 11: Mean income for full-time wage-employment by age

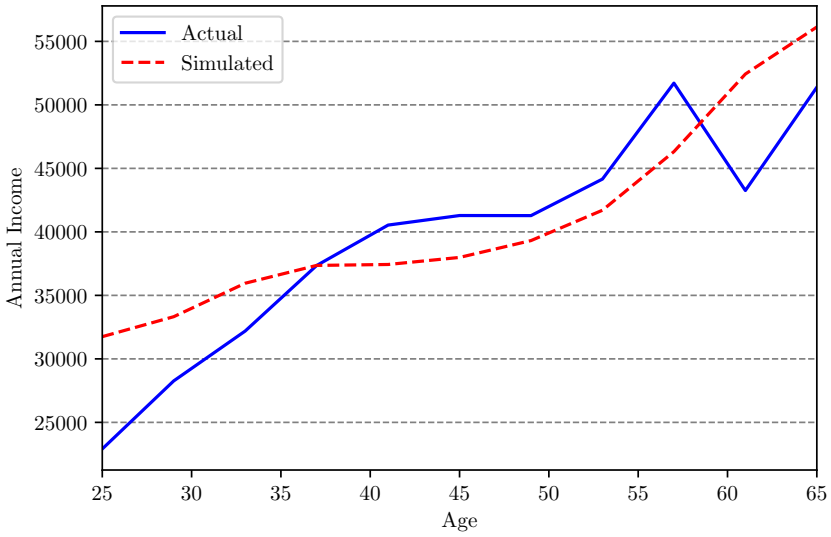


Figure 12: Mean income for part-time wage-employment by age

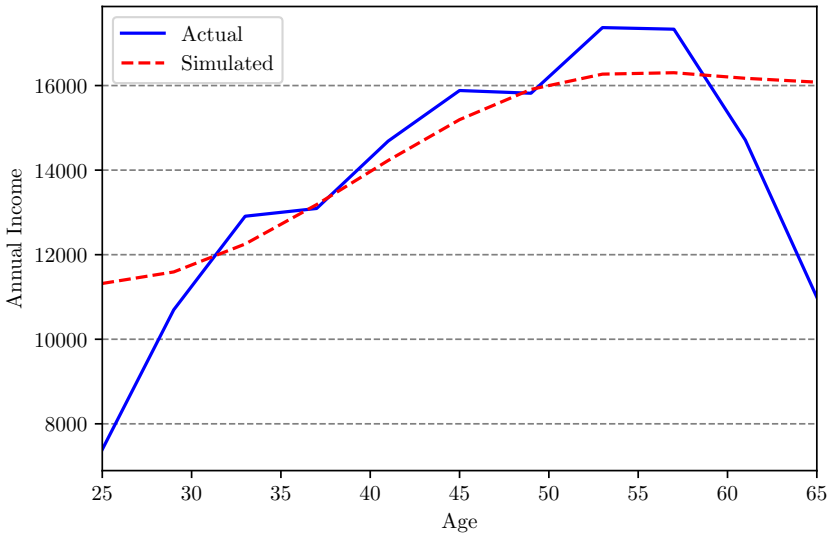


Figure 13: Mean income for self-employment by age

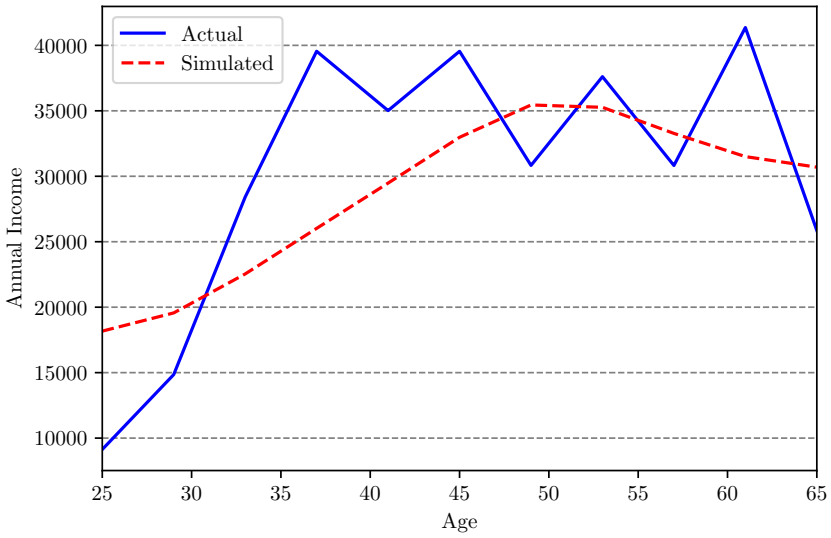
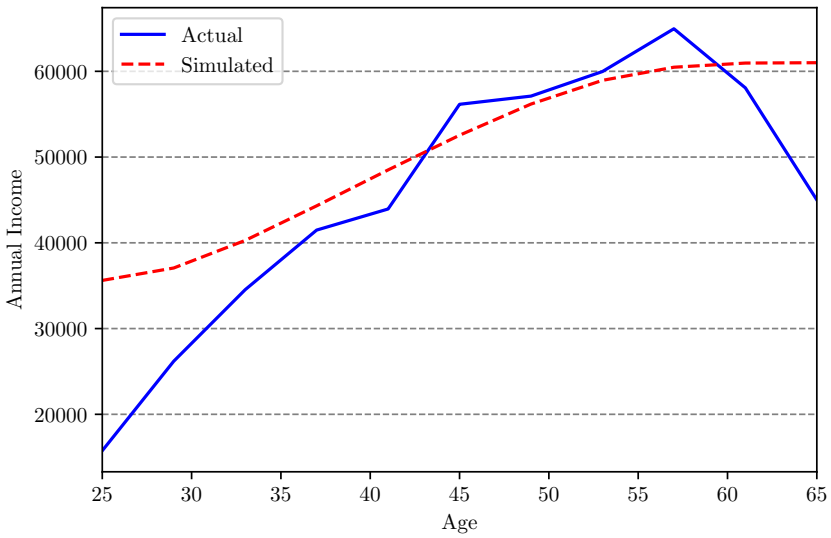


Figure 14: Mean income for business ownership by age



C.4 Net wealth levels by age

Figure 15: Mean wealth by age

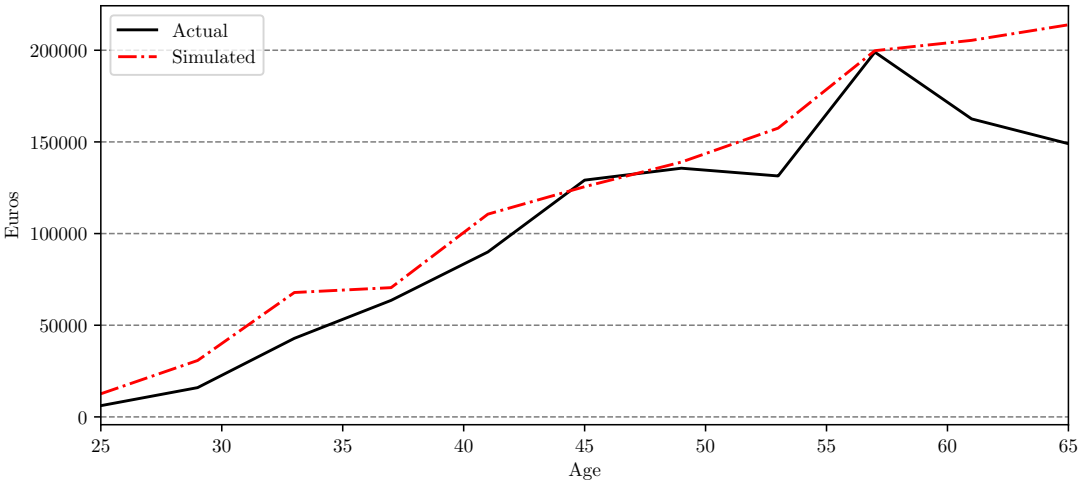
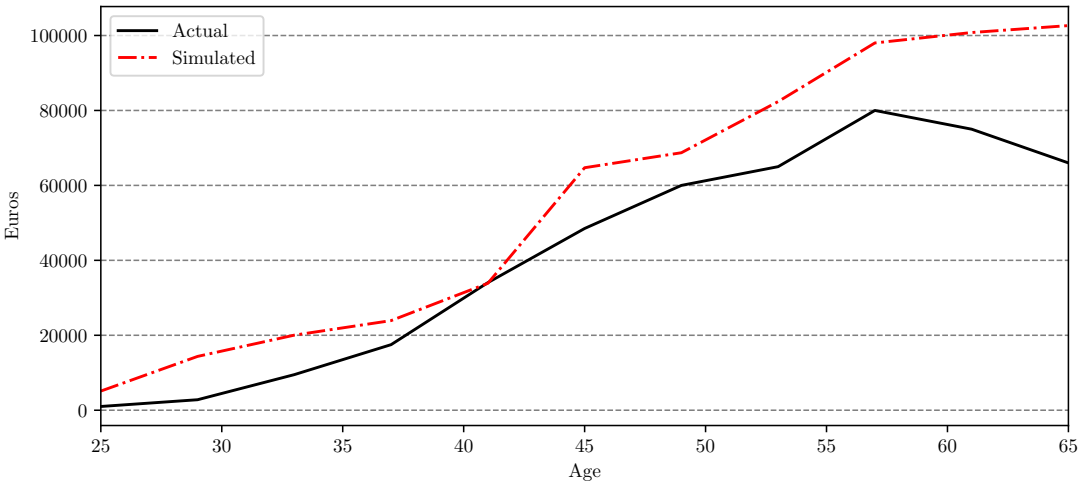


Figure 16: Median wealth by age



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