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"Examining the Gender Wealth Gap"

Sierminska, E., Frick, J. and Grabka, M. (2010)

Empirical Labour Economics and the German Socio-Economic Panel (SOEP)

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Introduction

The wealth gap between men and women has not received the attention that the corresponding pay gap has, though it is closely related. The stock of wealth also includes investment, inheritance, and savings rates, and these factors also vary between genders, sometimes even within the same couple. This paper endeavors to examine the overall wealth gap, as well as the factors that go into wealth accumulation. It is a replication of "Examining the gender wealth gap" by Eva Sierminska, Joachim R. Frick, Markus M. Grabka, as published by the Oxford University Press in 2010.

Wealth is important both for its direct and indirect effects on an individual. The direct effects are self-evident. When a person has more wealth, he or she can increase consumption with fewer constraints, retire earlier, and handle personal income shocks such as a temporary job loss. Some wealth is usable, such as a primary residence or items such as jewelry that convey status. Indirectly, there are significant psychological effects. Simply thinking of difficult financial problems can cause people to perform worse on cognitive tests (Mani et al., 2013). Wealth can also increase social status and influence, even between spouses. Given the significant influence of wealth on multiple levels, it is important to understand how gender affects wealth accumulation.

The interesting question of the gender wealth gap is whether or not the difference between men's and women's wealth is due to intrinsic differences between the genders, perhaps due to genetics or socialization, or whether or not there has been discrimination. To this end, we use a semi-parametric decomposition to create a counterfactual framework for how much wealth a man would have if he were a woman with the same characteristics. This will give a breakdown of the wealth gap and its factors. For this analysis we use the German Socio-Economic Panel (SOEP), a multi-year study that collects information on a panel of German residents. The SOEP includes both household and individual data, which is critical to our analysis due to the wealth gap within married couples (Grabka et al., 2015). Our replication uses data from 2002, and the extension uses the most recently available wealth information, from 2012.

In the next section we will review the literature concerning pay and wealth differences due to gender. The section that follows examines the data and methods we use for the analysis, after which we discuss our results. The final section concludes and considers avenues for further research.

Literature Review

As Sierminska et al. (2010) point out, wealth accumulation can be simply modeled by stating

$$W_t = (1 + r)(W_{t-1} + Y_t - C_t)$$

where W, Y, C, and r denote wealth, income, consumption, and the return on investments, respectively. This simple model is sufficient to indicate the intuitive source of the gender wealth gap. Women and men do not have the same wealth because they do not start with the same amount of wealth from the previous period, do not earn the same, and differ in the rates of investment return that they receive. This review summarizes literature findings on these topics.

Warren et al. (2001) find that the persistence of gender differences on wealth accumulation in Britain is mainly due to the lower female labour force participation. These income differences lead to gender wealth inequality over time since there is a restricted ability to build up assets such as pension assets or general financial savings. Moreover, a study from the United States (Brush et al., 2002) shows how women are excluded from the wealth creation process. Specifically, women's participation in the venture capital industry is extremely small. Only 28% of women in the venture capital industry worked for their own venture in 2001, and only 5% received funding for their own projects.

Some studies in Germany have exhibited a structural gender issue that couples face after divorce (Leopold, 2018), where there is evidence of disproportionate losses in household income and associated increases in the risk of poverty and single parenting for women. Additionally, a paper from the United States (Schmidt and Sevak, 2006) shows how family structure, specifically whether a person is married, highly influences gender wealth accumulation. The authors claim that wealth inequality seems to emerge later in life, when households are already settled, and is more evident in households headed by single women. They illustrate that even when controlling for education, family earnings, and position in life cycle, single women hold significantly less wealth than single men. These differences are present across the wealth distribution. Furthermore, they find no evidence of a wealth gap in the early stages of life. The reason that the younger cohorts seem to be more equal in comparison might be due to higher savings rates for younger workers, more aggressive investment, or that differences in attainment of job prestige emerge later in life, often due to childbearing. Similarly, Ruel and Hauser (2013) find that never-married couples accumulate less wealth than currently married couples.

In a New Zealand study (Gibson et al., 2006), the authors show how intrahousehold bargaining can affect wealth. They find that when the women's bargaining power is higher, the net worth for a sample of pre-retirement couples is lower. Although women tend to marry at at younger age and must finance a longer retirement period, the authors demonstrate that this does not have a significant impact on women's wealth accumulation. This is because countries with more generous pension systems tend shape women's bargaining power toward increasing their own current consumption instead of ensuring adequate retirement incomes.

Furthermore, most of the research evidence highlights the importance of the difference of magnitudes of the wealth gap, which is not accurately represented by an OLS regression or mean-based analysis. Hence, it is important to use tools that are sensitive to non-normal distributions. One of the weaknesses that the above-mentioned literature has is that these studies were mostly conducted at a household level. Other authors, such as Warren (2006), Ludwig-Mayerhofer et al. (2006), and Deere and Doss (2006) have investigated intra-household inequality and focused on individual wealth components, such as pension endowments. These authors highlight the fact that low levels of pensions for women lead to a much lower level of accumulation of wealth. Men tend to work longer, whereas women are more likely to stop working at early ages or seek employment in lower-quality or part-time positions. This perpetuates a cycle of poverty in advanced ages that is much more visible for women.

Households with one male adult have more net wealth than households with one female adult. This wealth gap is driven mostly by labor force participation and wages differences (Schneebaum et al., 2014). Additionally, men tend to invest in riskier assets than women, therefore men's higher wealth is due to higher risk premia paid by these investment strategies. Austen et al. (2015) find that women in Australia are excluded from the investment industry. Ruel and Hauser (2013) find that never-married couples accumulate less wealth than currently married couples.

Lastly, Grabka et al. (2015) find that when women manage the household budget, the gender wealth gap is significantly smaller. They use data collected not at the household level but at the individual level. This enables them to analyze the distribution of assets and liabilities between spouses or partners. They study the true degree of inequality within households and examine the role of intra-partnership financial decision-making. Moreover, they restrict the sample to cohabiting couples. Their results showed that in 52% of all couples the male partner has more wealth accumulation and that the wealth gap was about 33,000 euros in 2007.

It is important to emphasise the findings on the last-mentioned paper, since it provides further insight into wealth within couples. Grabka et al. (2015) find that business assets strongly contribute to the intra-partnership wealth gap. Women only have 13% of the corresponding business assets of men and for all other wealth components, this proportion is higher, with exception of house ownership, which is more equally distributed.

With these studies in mind, some stylized facts could be drawn from the literature available on wealth gap. First, women and men differ in their attachment to the labor market. This difference has reduced in magnitude but still persists, contributing to uneven wealth accumulation through income differentials. Second, gender wealth inequality persists within married couples. Third, women often have limited influence over important household decisions, including how their own personal income is spent and how they manage their future wealth. Fourth, men are more likely to own productive assets than women, influencing the rate of return for existing wealth.

In summary, the literature shows that there seems to be an important wealth accumulation gap between women and men. This gap is more significant when controlled by observable factors related to gender and wealth: education, work experience, family income, position in the life cycle and asset possessions. This indicates that the gap could be the result of intrinsic characteristics of gender, making the study of the gender gap in wealth extremely important for understanding the factors that lead to this inequality. This question becomes even more relevant when we consider that women are increasingly being more integrated into the labor market, are employed in higher and better positions, and have increased their hours of work and education. But even with these shifts, there is strong empirical evidence that women still accumulate less wealth than the men during their lifetime.

Analysis

Data

The approach to examining the gender wealth gap on an individual level was achieved by using the German Socio-Economic Panel, a wide-ranging longitudinal study of private households with available data since 1984. This study is considered representative as its survey consists of collected data from Germans living in West and East Germany, foreigners, and immigrants. Every five years, the SOEP includes a section in the questionnaire regarding individual wealth, which

inspired the addition of a high-income sample in 2002. Where only household level comparisons had been done in the past, the availability of this data made analyzing the gender wealth gap possible at the individual level. Therefore, this paper uses data collected from the 2002 survey and finds that decomposition analyses reveal that the gap is largely driven by individuals' characteristics.

The SOEP provides weighting data for each wave. We used these weights to obtain all descriptive statistics, and any analysis with standard deviation used sampling weights. As a further precaution against outliers, we drop the bottom and top percentile of wealth observations, dropping all observations below -19,200 euros and above 973,000 euros in 2002, and keeping wealth observations from -25,000 to 980,000 euros in 2012. These precautions should provide a representative and unskewed sample.

Since wealth-related questions are typically more complex and require more effort on behalf of the individual, this section of the survey is only included every five years. We look into extending this research paper by analyzing 2012 data and comparing it to the 2002 results.

Our dataset has a sample size of 11,565 for 2002, and 9,260 for 2012, almost evenly split by gender, and approximately 50% of the sample size considered for Sierminska, et al. (2010) for the year 2002.

Comparisons of descriptive and wealth statistics in 2002 for both genders (see Table 1 and Table 2 in appendix) show that means regarding demographics, income, education, labor market status, among others, are very similar. Since our sample is broken down by gender and marital status, means vary from the original paper when marital status is single-divorced, single-widowed or single-never married, mainly attributed to low sample size.

An important inconsistency in the male sample is that our 2002 replication is below the average by more than 10,000 euros. However, a wealth median comparison indicates that both samples are within the same range, which underscores another potential setback from a lower sample size. On the other hand, our female sample has lower average annual post-government income, with almost a €10,000 difference when married, but other income and wealth indicators are somewhat similar. Our 2012 sample descriptive statistics are not particularly different from our 2002 replication, mainly due to population weights, and therefore are also close to the Sierminska, et al. (2010) results.

Wealth, the variable of interest, is the market value of seven different components: owner-occupied property (and associated debt); other property (and associated debt); financial assets;

private pensions (include life insurance and building savings contracts); business assets; tangible assets (include gold, jewelry, coins or valuable collections); and consumer credits, as defined by Sierminska, et al. (2010). Overall wealth estimation was based on the formula of imputed and edited variables to correct measurement errors derived by Frick, Grabka and Marcus (2007). Additionally, minor wealth components such as cars and household durables as well as financial and tangible assets below €2,500 are not collected by the SOEP and are therefore not considered in the wealth variable.

Table 3.a captures wealth ratios from all 2002 wealth components, where all ratio totals with regards to marital status are statistically significant and all but tangible assets and debts are statistically significant as well. Notably the highest ratios are in the business asset category, where the intuition behind the research paper (Grabka et al. 2015) is evident, implying that women are at a clear disadvantage in business settings. Ratios appear to be lower than 1 when marital status is widowed, in large part because women live longer. The only other exception is non-residential property for divorced individuals.

	Replication 2002					
Wealth Component	**Total**	**Married**	**Cohabitating**	**Divorced**	**Widowed**	**Single**
Housing	1.12*	1.18*	1.21*	1.52*	1.14*	1.07
Other Property	1.42*	1.35*	3.31*	0.98	1.04	1.64
Financial Assets	1.25*	1.45*	1.19	2.13*	0.94	1.39
Insurance/Private Pensions	1.97*	1.87*	1.80*	2.75*	1.78*	1.71*
Business Assets	3.31*	3.03*	9.87	1.33	0.00	5.65*
Tangible Assets	1.04	1.02	3.47*	1.06	0.81	1.41
Debt	1.35	1.15*	1.87*	1.72*	1.08	1.83*
Total	1.28*	1.37*	1.62*	1.64*	1.10*	1.28*

Table 3.a. Wealth ratios by marital status and wealth components, 2002 replication.

In 2012, wealth ratios (Table 3.b) appear to be lower than 1 when marital status is cohabitating (housing and tangible assets), divorced (financial assets), widowed (other property and debt) and single (housing). Likely due to the Financial crisis, ratios for business assets have generally become more equal, particularly among cohabiting couples. The ratio of non-residential property has increased dramatically in divorced individuals, though it has decreased for most other groups. Reasons for this are unclear. Overall, the wealth ratios are closer to parity in 2012, indicating that wealth has been more evenly accumulated in the intervening decade.

Replication 2012						
Wealth Component	**Total**	**Married**	**Cohabitating**	**Divorced**	**Widowed**	**Single**
Housing	1.09*	1.18*	0.91	1.74*	1.18*	0.95
Other Property	1.36*	1.14*	3.92*	8.23*	0.70*	1.64*
Financial Assets	1.24*	1.41*	1.80*	0.94	1.36*	1.29*
Insurance/Private Pensions	1.43*	1.46*	1.11	1.45*	1.22	1.28*
Business Assets	3.20*	2.83*	2.48*	4.28*	0.00	6.49*
Tangible Assets	1.17	1.37	0.48*	1.36	1.06	1.54
Debt	1.43*	1.27*	1.40*	3.50*	0.71	1.29
Total	1.19*	1.26*	1.41	1.62*	1.18	1.18

Table 3.b. Wealth ratios by marital status and wealth components, 2012 replication.

In line with the original paper, the decomposition analysis includes four groups of determining variables. The first group is labor market experience, which includes labor force experience, permanent income, lifetime work experience, job autonomy and years over 65 years old. Second is the education level, which is split into four binary variables indicating increasing education levels. The third considers intergenerational components, specifically the parents' higher education status both together and separately, as well as binary variables indicating a recent or older inheritance. Finally, the last set of variables indicates demographic characteristics. These include whether the person was born in Germany, the length and number of marriages, whether there are children under the age of five in the household, and whether they lived in East Germany in 1989. It should be noted that these groups are ordered deliberately, as the DFL decomposition depends on the order of components.

The wealth variable is largely determined by permanent income, defined by the paper as the sum of income (consisting of labor income, pensions, unemployment benefits, alimony, other private transfers received, maternity benefits and student grants) in the last five-year period, divided by the number of years with data availability. Compared to Sierminska, et al. (2010), our replication shows that the mean net worth of female individuals seem to be somewhat similar but is slightly below the mean for our male sample.

Method

The method of this paper first appeared in the 1995 paper "Labor Market Institutions and the Distribution of Wages, 1973-1992: A Semiparametric Approach" by John DiNardo, Nicole M. Fortin, and Thomas Lemieux. Their method, known as the DFL decomposition, is an extension of the Blinder-Oaxaca decomposition. Since the Blinder-Oaxaca uses mean data in its decomposition,

the nuance of the data is lost. DiNardo, Fortin, and Lemieux manage to preserve this information by using a technique that their original paper calls "weighted kernel density estimation". This allows for an appropriate probability density function for the study at hand by the use of reweighting techniques.

The kernel, in this case, is the probability distribution of the function *F(w,z,g)*, where *w* is the wealth of an individual, *z* is a vector of individual characteristics, and *g* is a binary variable to represent the individual's gender. It follows that we can condition a function on the gender of an individual, *F(w,z|g).* The density would then be

$$\int f(w,z|g) = \int f(w|z,g=f)df(z|g=m)dF$$

where *m*=man and *w*=woman, and which we can redefine as

$$\int f(w,z|g) = \int f(w|z,g=f)\psi(z)dF$$

where Ψ is a "reweighting" function. This reweighting function can be expressed as

$$\psi(z) = \frac{P(f|z)P(m)}{P(m|z)P(f)}$$

and is easily estimated using a logistic regression.

Since wealth has many components and many factors contribute to wealth accumulation, we want to control for these factors as thoroughly as possible, creating an accurate counterfactual analysis of how much wealth men would have if they were a woman with the same characteristics. To this end, we estimate the counterfactual density of wealth distribution among women by using a reweighting function.

Cobb-Clark and Hildebrand (2006) use the same technique, but they extend it by breaking down the vector *z* into four components. Our analysis does the same, with the determining variables grouped into labor experience (*l*), education (*e*), intergenerational characteristics (*i*), and demographic information (*d*), as defined above. This gives the overall conditional density for wealth, as well as for each of our groups of determinants in the order that they are given. The sum of the *l,e,i,d* components equals the effects captured by the model. Subtracting the raw wealth gap from these components gives the unexplained portion.

The advantage to having this combination of distributional effects and wealth components is that it enables us to view the magnitude of the gap at a range of wealth levels and the components that contribute to them. The unexplained portion also gives an idea of how wealth accumulation acts outside of our model. This would include variables such as luck, which is unobservable but

can have a significant impact in the rate of returns on investments. It would also capture the effects of variables which are relevant but difficult to measure, such as individual consumption rates or interpersonal networks that could improve income and investment prospects. Finally, intra-household transfers would not be part of this model, such as a spouse's earnings paying for a primary residence that both partners share evenly.

Extension

We chose to extend our analysis by updating the data to the most recently available survey wave. Since wealth is only part of the SOEP every five years, the most recent survey occurred in 2012.

The timing is fortunate for our analysis. 2008 brought the Financial Crisis, both by eliminating a lot of existing wealth due to financial volatility and by a significant shift in labor market conditions. The former could favor women if the risk premia that men earn comes at the cost of higher losses in a bear market. The latter might create an environment in which the lack of job opportunities could push women out of the workforce, both due to hiring discrimination and due to reduced job searching in favor of traditional gender roles. On the other hand, it could increase women's workforce participation as they search for work because of lower household income caused by a spouse or partner losing his job. Having two samples with ten years between them also gives us to opportunity to compare, or most specifically, to study what have been the new developments in terms of gender equality in Germany.

Results

As previously mentioned in the method section, the decomposition analysis provides probability density functions given the characteristics of each gender and estimates how much wealth is attributed to each determinant: labor experience (l), education (e), intergenerational characteristics (i), and demographics (d). In the best-case scenario, the DFL decomposition would estimate a wealth gap and would exactly distribute it throughout the four determinants, with nothing remaining unexplained. Thus, the sum of all determinant estimates should sum up to match the wealth gap, and the unexplained estimate is the difference between the wealth gap and the sum of all four determinants.

In a more realistic setting such as in Sierminska et al. (2010) (see Table 4 in appendix) and our replications, however, the decomposition analysis yields positive unexplained estimates indicating that there's an unobservable factor that isn't considered in the determinants; in addition to negative unexplained estimates, indicating that determinants over-explain the gap, and some unconsidered factor works in favor of women given their characteristics. For example, a particularly high (*l*) result seen in Table 5.a and 5.b in the 75th and 90th percentile of our replications amounts to more than 60,000 of the unexplained wealth gaps.

	Replication 2002					
	Wealth Gap	**Income and labor market experience**	**Education level**	**Intergenerational factors**	**Demographics characteristics**	**Unexplained**
10th	0	0	0	0	0	0
SE	0	2113	291	13	291	2116
25th	500	-8750	250	0	0	9000
SE	357	18652	5337	180	1106	16838
%	100	-1750	50	0	0	1800
50th	11500	10963	2504	71	-38	-2000
SE	2310	38905	7883	950	3175	37955
%	100	95	22	1	0	-17
75th	25500	79853	10205	287	5355	-70200
SE	5366	45748	6274	854	3126	47324
%	100	313	40	1	21	-275
90th	46376	110500	8000	500	0	-72624
SE	9888	28220	2989	1740	4948	31862
%	100	238	17	1	0	-157
P50-P10	11500	10963	2504	71	-38	-2000
SE	2310	38413	7913	950	3185	37426
%	100	95	22	1	0	-17
P75-P25	25000	88603	9955	287	5355	-79200
SE	5272	44744	8395	854	3468	47523
%	100	354	40	1	21	-317
P90-P50	34876	99538	5496	429	38	-70624
SE	9303	42739	7995	2077	5411	42989
%	100	285	16	1	0	-203

Table 5.a. DFL decomposition: 2002 replication.

As seen on Table 6 (in Appendix), Sierminska, et al. (2010) have higher wealth gap estimates on all percentiles when compared to our 2002 and 2012 replication. While our replications outputs are closer alike, there's a decrease in wealth gap in the 50th and 75th percentile after a ten-year period.

	Replication 2012					
	Wealth Gap	**Income and labor market experience**	**Education level**	**Intergenerational factors**	**Demographics characteristics**	**Unexplained**
10th	0	0	0	0	0	0
SE	0	0	0	0	0	0
25th	550	257	332	13	-1	-50
SE	430	310	122	87	25	273
%	100	47	60	2	0	-9
50th	12750	21649	3410	-251	-57	-12000
SE	3402	4715	1336	1011	492	4648
%	100	170	27	-2	0	-94
75th	14300	66661	7867	111	-439	-59900
SE	6072	10428	2285	1762	1118	10777
%	100	466	55	1	-3	-419
90th	33000	93794	7311	1061	-956	-68211
SE	11162	23613	3227	3066	2243	25466
%	100	284	22	3	-3	-207
P50-P10	12750	21649	3410	-251	-57	-12000
SE	3402	4715	1336	1011	492	4648
%	100	170	27	-2	0	-94
P75-P25	13750	66404	7535	98	-438	-59850
SE	5835	10554	2281	1730	1101	10842
%	100	483	55	1	-3	-435
P90-P50	20250	72146	3901	1313	-899	-56211
SE	10171	21666	2899	2616	1865	23128
%	100	356	19	6	-4	-278

Table 5.b. DFL decomposition: 2012 replication.

Intergenerational determinants produce consistently negative values, but this is in line with the intuition and our descriptive statistics. Educating sons has been a long-time cultural default in Germany, but parents who are themselves educated are more likely to seek education for their daughters, resulting in positive intergenerational effects for women. Also, as we see in our descriptive wealth statistics, widows hold more wealth than widowers. Since we are acutely aware of the gender wealth gap, we know that a husband would be more likely to leave a significant inheritance than a wife.

An interesting inconsistency when comparing the paper with our replication results, is the 75th percentile. Decomposition results indicate that (*d*) determinant has a higher explanatory power where women derive more wealth as opposed to the counterfactual. It is unclear and inconsistent with previous studies how length and number of marriages, coming from abroad, having children

under five in the household or living in East Germany in 1989 could aid women's wealth accumulation in this percentile.

In all cases, income and labor market experience and education determinants overpower the wealth gap explanation. Reversing the order for robustness to (*i)*, (*d)*, (*e)*, (*l)*, still indicated stronger explanatory power to (*l*) and (e) determinants. Results are published in the appendix.

Considering the importance of (*l*) and (*e*) determinants in explaining overall wealth, lower job attainment and education levels work at a disadvantage for women. Study results indicating prevalent marriage patterns where women tend to marry older men (Gibson et al., 2006) and eventually distance themselves from the labor force due to childbearing (Warren et al., 2001), are in line with our decomposition results.

Notably, the "Unexplained" column is negative or zero in all reported levels in 2012 and most in 2002. The magnitude of this effect increases in percentage of the raw gap through the wealth distribution through the 75th percentile, then decrease slightly for the 90th percentile. One possible explanatory factor is that the large values from labor experiences drive this wealth gap on a personal level, but the labor income is then redistributed at a household level.

Repeating the decomposition in 2012 by married individuals, given that they predominate our sample with 5,458 observations, provides further insight into the composition of the overall wealth gap. The results, as shown in Table 5.c support the idea that part of the unexplained overall wealth gap occurs between couples. In the married subsample, the labor determinants *(l)* range from 119% to 306% of the raw wealth gap, and the model consistently provides significant negative values for the unexplained portion of the wealth gap.

Additionally, we observe higher wealth gap amounts when comparing the married subsample to both our replications with all marital status groups. However, the decomposition attributes relatively lower numbers than expected to the (*l*) determinant but consistently estimates a negative unexplained gap, which suggests a likely unconsidered factor to be intra-household transfers. One possible explanation is the cultural expectation for women to be housewives, while men take advantage of their higher earning potential due to the existing wage gap. This effect seems most prevalent at higher wealth levels.

Replication 2012 (Married subsample)						
	Wealth Gap	**Income and labor market experience**	**Education level**	**Intergenerational factors**	**Demographics characteristics**	**Unexplained**
10th	0	0	0	0	0	0
SE	0	0	0	0	0	0
25th	550	-50	250	-50	450	-50
SE	334	46	109	54	271	310
%	100	-9	45	-9	82	-9
50th	12750	-518	2873	-918	23313	-12000
SE	3418	483	1235	497	4397	4674
%	100	-4	23	-7	183	-94
75th	14300	-267	5150	-833	70150	-59900
SE	4959	1133	3562	1243	11236	12092
%	100	-2	36	-6	491	-419
90th	33000	-1375	7204	-3613	98995	-68211
SE	10449	1959	5978	2059	22026	24887
%	100	-4	22	-11	300	-207
P50-P10	12750	-518	2873	-918	23313	-12000
SE	3418	483	1235	497	4397	4674
%	100	-4	23	-7	183	-94
P75-P25	13750	-217	4900	-783	69700	-59850
SE	4832	1138	3570	1235	11298	12211
%	100	-2	36	-6	507	-435
P90-P50	20250	-857	4331	-2694	75682	-56211
SE	9429	1914	5490	2004	19702	22891
%	100	-4	21	-13	374	-278

Table 5.c. DFL decomposition: married subsample in 2012 replication.

Conclusion

Gender equality has received much attention in recent years, and although certain interventions have taken place, our analysis demonstrates that gender wealth gap remains an issue to be addressed. The decomposition analysis technique tells a more detailed story. As previously mentioned, wealth ratios indicate that the wealth gap in financial and business assets has decreased over the past decade, and the DFL decomposition also shows that the wealth gap varies depending on the level of wealth involved. It also points to labor market experience as the chief driver in the wealth gap, often over-explaining the raw gap and being balanced by other factors.

The main drivers of wealth inequality involve traditional gender roles and marriage patterns, which will be hard to overcome in order to achieve gender wealth parity. For example,

while intra-household transfers are important in explaining the wealth gap, they prevail because of the larger determinate of labor market experience, fueled by the gender pay gap. Furthermore, while a higher proportion of women pursued advanced degrees in 2012, there was little significant effect reflected in the education portion of DFL the decomposition.

Our research provides a basis for other questions regarding gender and wealth accumulation. A following paper could endeavor to define the intra-household wealth transmission channels. Particularly interesting would be assessing what assets are jointly owned, such as housing, and which are kept separately, such as financial assets. Additionally, incorporating these wealth data into a panel from 2002 to 2017 could provide valuable insights to the evolution of wealth through the Financial Crisis. This would produce insight into the interaction between gender and financial wealth.

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Appendix

Method

This section more clearly explains the mathematical mechanisms behind the DFL decomposition. As stated above, the kernel of the wealth distribution function would be *F(w,z,g)*, where *w* is the wealth of an individual, *z* is a vector of individual characteristics, and *g* is a binary variable to represent the individual's gender. It follows that we can condition a function on the gender of an individual, *F(w,z|g).* The density would then be

$$\int f(w,z|g) = \int f(w|z,g=f)df(z|g=m)dF$$

where *m*=man and *w*=woman, and which we can redefine as

$$\int f(w,z|g) = \int f(w|z,g=f)\psi(z)dF$$

where Ψ is a "reweighting" function. This reweighting function can be expressed as

$$\psi(z) = \frac{h(z|g=f)}{h(z|g=m)}$$

and is easily estimated using a logistic regression.

where h(.) is a density function. The data gives the probability *P(x|g=i)*, estimated with a logistical regression. Combining this data and the definition of (.) above with Bayes' Law,

$$\psi(z) = \frac{P(f|z)P(m)}{P(m|z)P(f)}$$

with which the wealth of a woman can be reweighed to find her counterfactual "man" wealth.

The above model can be extended using wealth accumulation factors, for labor experience (*l*), education (*e*), intergenerational characteristics (*i*), and demographic information (*d*). This gives a kernel density equation for the overall wealth equation that is a sum of the integrals of each component:

$$f(w) = f(w|g=j) = \int_l \int_e \int_i \int_d f(w,l,e,i,d|g=j)dldedidd$$

This equation can be expanded in such a way that each component can be set to the counterfactual by using the reweighting function. Holding other components constant, the counterfactual for labor

experience becomes the following, that is to say the wealth of a woman if she were a man with the same labor market experience, but holding other factors constant:

$$f(w|l^{|g=m}, e^{|g=f}, i^{|g=f}, d^{|g=f})$$

	Female																	
	Sierminska, Frick and Grabka (2010)						Replication 2002						Replication 2012					
	Total	Married	Co-habitating	Single divorced/ separated	Single-widowed	Single-never married	Total	Married	Co-habitating	Single divorced/ separated	Single-widowed	Single-never married	Total	Married	Co-habitating	Single divorced/ separated	Single-widowed	Single-never married
Demographics																		
Age (in years)	49.4	50.2	36.9	53.2	73.9	32.0	50.1	50.5	38.2	54.2	73.5	33.1	52.2	55.0	39.6	59.4	74.2	34.3
% Immigrant	11.2	14.1	5.5	10.7	8.7	7.5	12.1	15.2	8.0	11.8	7.9	7.3	13.1	17.4	5.3	14.3	8.3	7.5
Income																		
Equiv. Annual post-gov. Income	18,915	21,355	19,086	14,182	14,782	17,091	12,229	10,636	17,057	16,813	14,085	11,788	16,035	14,564	22,458	18,199	17,956	15,209
Individual annual labor income	10,019	9,827	17,092	12,714	2,249	11,711	8,712	8,641	14,487	12,541	2,693	9,560	12,093	12,110	20,301	12,783	3,779	13,173
Education																		
Low	26.1	22	17	24.3	41.1	33.2	25.6	22.0	16.0	21.2	39.7	32.1	18.9	17.1	11.0	19.5	31.0	19.7
Middle	47.9	51.2	47	45.3	45.7	40.9	48.6	52.9	45.6	45.2	43.8	41.2	49.1	53.0	45.4	49.0	50.1	39.6
(Higher) Vocational	11.4	11.2	17.2	12.5	6.7	12.2	11.0	10.8	16.7	14.2	6.6	10.7	11.8	11.8	20.1	11.8	5.1	12.3
Higher Education	14.6	15.7	18.8	17.9	6.5	13.7	11.9	12.2	18.4	15.8	3.9	12.5	18.1	17.2	22.3	18.1	10.4	23.2
Labor Market Status																		
FT Employed	20.6	17	44.6	27.4	3.5	29.4	20.6	16.2	46.1	33.1	4.6	31.2	24.1	18.9	49.5	24.9	6.0	37.7
PT Employed	13.5	19.3	12.7	12.4	3.6	4.6	14.4	19.7	10.5	13.9	4.6	6.9	16.0	22.2	14.1	11.6	4.9	8.1
Self-Employed	2.7	3.1	2.5	3.7	0.8	2.6	2.9	3.5	3.0	3.7	0.3	2.6	4.5	4.6	7.4	6.1	0.6	4.7
Not Employed	42.5	46	15.9	35.9	88	13.3	49.0	48.7	28.1	36.2	85.4	35.4	43.3	43.3	18.1	41.3	85.4	29.8
Unemployed	5.7	4.8	8.9	12.5	1.6	6.4	4.6	4.3	5.5	8.7	1.2	6.0	3.6	3.0	2.1	10.4	1.5	4.6
Civil Servants	2.7	3.1	3.8	2.9	0.6	2.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Vocational Training	7.5	0.7	7.9	2	0.3	36.5	2.6	0.1	3.0	1.0	0.0	13.6	1.7	0.2	3.6	0.0	0.0	6.3
Irregular/Marginal Work	4.8	6.1	3.7	3.4	1.7	4.8	4.6	6.2	2.4	2.4	2.3	3.2	6.6	7.7	5.0	6.4	1.5	7.6
Regional Characteristics							0	0	0	0	0	0						
% East Germany	18.7	17.7	22.7	19.6	18.6	19.2	20.4	18.6	28.1	23.7	21.3	20.8	20.7	20.6	26.5	27.5	24.7	13.6
Net Worth (Wealth)																		
Mean, in €	67,373	83,722	35,425	33,761	102,192	24,214	63,093	75,659	30,572	34,063	94,600	23,277	69,952	84,517	41,439	50,798	103,447	30,220
Median, in €	10,045	35,094	4,057	1,040	12,940	-	11,000	33,500	3,000	2,000	15,000	850	16,000	40,000	7,000	3,700	30,000	4,500
Relative Wealth Position	83	103	44	41	126	30	88	106	43	48	132	33	85	103	51	62	126	37
Quintile Shares																		
Bottom	-2.1	-2.4	-7.0	-2.6	-0.2	-1.8	-0.4	-0.3	-2.0	-1.4	0.0	-0.8	-0.6	-0.4	-1.6	-1.2	0.0	-1.2
2	0.3	1.4	0.0	0.0	0.5	0.0	0.4	1.4	0.1	0.0	0.0	0.0	0.7	1.7	0.7	0.0	0.0	0.2
3	3.8	8.8	2.4	1.2	3.8	0.5	4.2	9.2	2.2	1.5	0.0	0.8	5.4	9.9	3.7	1.6	0.1	3.0
4	19.8	23.1	10.6	10.6	22.6	6.3	20.8	24.0	10.9	13.9	0.2	6.1	22.5	24.7	16.2	15.5	0.3	10.7
Top	78.3	69.1	93.1	90.8	73.4	95.0	75.1	65.7	88.7	86.0	0.7	94.0	71.9	64.1	81.2	84.1	0.7	87.3
Inequlity																		
Gini	0.78	0.70	0.95	0.88	0.72	0.91	0.74	0.67	0.85	0.82	0.72	0.90	0.72	0.65	0.79	0.81	0.68	0.83
p90/p50	18.01	5.86	24.64	99.40	19.67	n.d.	16.83	5.97	33.33	53.75	20.00	61.52	12.50	5.55	19.29	46.49	9.00	20.00
p75/p50	8.77	3.19	6.01	22.97	10.17	n.d.	7.68	3.15	8.33	17.50	10.00	11.76	6.25	3.00	6.71	15.27	5.33	4.58

Table 1. Descriptive statistics of female sample: Sierminska et al. (2010), 2002 replication and 2012 replication.

	Male																	
	Sierminska, Frick and Grabka (2010)						Replication 2002						Replication 2012					
	Total	Married	Co-habitating	Single divorced/ separated	Single-widowed	Single-never maried	Total	Married	Co-habitating	Single divorced/ separated	Single-widowed	Single-never maried	Total	Married	Co-habitating	Single divorced/ separated	Single-widowed	Single-never maried
Demographics																		
Age (in years)	47.1	53.3	39.2	50.2	70.7	30.5	48.0	53.4	40.7	53.3	72.6	31.1	51.3	58.8	41.1	56.9	77.1	33.9
% Immigrant	11.8	14.3	5.1	12	6.5	8.6	12.2	14.0	7.4	14.7	7.3	9.1	11.0	13.6	9.5	8.2	9.4	7.1
Income																		
Equiv. Annual post-gov. Income	20,788	21,877	20,375	20,531	17,613	18,712	25,661	29,708	24,959	24,728	18,994	15,760	28,421	33,588	31,789	30,385	20,619	16,572
Individual annual labor income	22,952	26,139	24,459	25,862	5,272	15,975	21,158	24,183	22,704	21,007	4,457	14,580	22,732	26,039	29,906	25,484	3,454	14,852
Education																		
Low	17.6	13.1	9.4	15.3	19.1	32.1	17.1	13.8	8.2	12.7	16.3	30.4	13.0	9.3	11.5	7.4	12.2	23.1
Middle	47.9	47.7	53.2	49.3	59.2	44.9	49.4	49.5	56.5	59.8	60.7	43.1	49.2	49.2	47.0	58.5	58.6	46.2
(Higher) Vocational	13.1	13.7	17.6	11.2	10.5	10.5	13.8	14.7	14.5	15.6	12.0	11.0	13.9	15.6	15.7	13.7	7.8	10.3
Higher Education	21.4	25.5	19.8	24.2	11.2	12.4	17.6	20.3	17.9	12.0	9.8	12.2	21.7	24.3	25.0	19.8	20.5	15.5
Labor Market Status																		
FT Employed	42.6	44.9	52.7	44.5	5.9	37.4	47.8	50.8	58.8	45.5	6.2	42.2	44.7	44.0	68.9	48.3	4.4	41.9
PT Employed	2	1.5	2.4	0.7	1.3	3.5	1.8	1.2	3.1	0.9	3.9	2.8	2.2	1.8	4.7	2.9	0.6	2.3
Self-Employed	7.3	7.7	10.8	9.4	4.8	4.8	6.7	7.7	9.5	5.4	2.1	3.9	7.4	8.1	8.6	6.5	0.1	6.7
Not Employed	25.7	33	10	22.4	83.8	6.6	31.6	33.4	16.2	27.6	81.6	25.8	36.4	42.1	12.7	29.6	94.3	26.8
Unemployed	6.6	5.1	9.7	13.9	1.9	7.8	5.5	4.8	7.7	13.9	0.8	6.0	3.8	2.2	1.4	10.2	0.6	6.7
Civil Servants	5.2	6	5.8	7.2	0.9	3.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Vocational Training	8.3	0.6	5.3	0.8	0.1	31.6	3.0	0.0	1.1	2.0	0.0	12.4	2.3	0.1	1.1	0.0	0.0	8.4
Irregular/Marginal Work	2.4	1.3	3.4	1.1	1.3	5.2	1.9	0.8	2.2	1.9	1.2	5.0	2.9	1.6	2.7	2.5	0.0	6.4
Regional Characteristics																		
% East Germany	19	17.9	23.2	23.5	18.7	19	19.6	18.7	26.0	21.8	19.8	19.3	20.1	20.2	23.5	17.1	19.5	19.8
Net Worth (Wealth)																		
Mean, in €	97,378	130,648	61,636	63,570	120,142	33,908	81,003	103,759	49,786	55,939	104,170	30,025	83,321	107,132	58,703	82,404	122,193	35,778
Median, in €	19757	53994	6500	5170	26707	414	22500	53451	7000	10000	29700	1500	28750	63500	12000	16100	70000	2050
Relative Wealth Position	120	161	76	78	148	42	113	145	70	78	145	42	102	131	72	100	149	44
Quintile Shares																		
Bottom	-1.6	-1.4	-2.2	-5.8	0.0	-1.7	-0.5	-0.3	-1.3	-1.0	0.0	-1.2	-0.6	-0.4	-1.6	-0.9	0.0	-0.8
2	0.5	2.0	0.3	0.0	1.2	0.0	0.8	2.5	0.5	0.2	0.9	0.0	0.8	3.1	0.5	0.2	2.0	0.0
3	4.5	8.5	2.6	2.0	6.9	0.7	6.2	10.5	3.5	3.4	5.3	1.2	7.1	11.7	4.7	5.8	10.9	1.5
4	17.7	19.0	10.6	13.1	23.4	7.3	22.1	23.4	15.8	18.5	25.9	8.4	22.5	23.8	17.9	20.8	25.7	10.1
Top	78.9	71.9	88.8	90.8	68.4	93.6	71.4	64.0	81.5	78.9	67.8	91.6	70.1	61.8	78.5	74.1	61.3	89.1
Inequlity																		
Gini	0.75	0.66	0.84	0.90	0.68	0.89	0.71	0.64	0.79	0.77	0.68	0.87	0.70	0.62	0.78	0.74	0.62	0.84
p90/p50	11.69	5.14	25.02	33.96	11.50	167.65	10.29	4.96	21.50	18.00	10.64	58.67	8.10	4.17	15.92	14.79	4.71	55.76
p75/p50	5.40	2.68	6.64	9.77	5.67	35.40	4.89	2.62	7.14	8.85	5.56	10.67	3.98	2.28	6.04	6.04	2.57	13.41

Table 2. Descriptive statistics of male sample: Sierminska et al. (2010), 2002 replication and 2012 replication.

	Sierminska, Frick and Grabka (2010)					
	Wealth Gap	**Income and labor market experience**	**Education level**	**Intergenerational factors**	**Demographics characteristics**	**Unexplained**
10th	0	0	0	0	0	0
SE	0	6229	5673	578	601	12501
25th	3950	3946	904	154	-54	-1000
SE	934	1060	706	46	978	1129
%	100	100	23	4	-1	-25
50th	18250	34002	3721	560	-533	-19500
SE	2558	39329	5268	4536	5331	51502
%	100	186	20	3	-3	-107
75th	32500	1629	-11660	-4951	-17339	64821
SE	3663	64119	7279	1400	1977	65798
%	100	5	-36	-15	-53	199
90th	67959	85226	7862	1950	140	-27220
SE	7682	62465	26109	888	9598	70097
%	100	125	12	3	0	-40
P50-P10	18250	34002	3721	560	-533	-19500
SE	2558	37901	6575	4468	5304	49666
%	100	186	20	3	-3	-107
P75-P25	28550	-2317	-12564	-5105	-17285	65821
SE	3268	63646	7429	1418	2292	6524
%	100	-8	-44	-18	-61	231
P90-P50	49709	51225	4141	1390	673	-7720
SE	6264	54551	25231	4599	10490	69153
%	100	103	8	3	1	-16

Table 4. DFL decomposition: Sierminska et al. (2010) in 2002.

	Sierminska, Frick and Grabka (2010)		Replication 2002		Replication 2012	
	Wealth Gap	**Unexplained**	**Wealth Gap**	**Unexplained**	**Wealth Gap**	**Unexplained**
10th	0	0	0	0	0	0
SE	0	12501	0	2116	0	0
25th	3950	-1000	500	9000	550	-50
SE	934	1129	357	16838	430	273
%	100	-25	100	1800	100	-9
50th	18250	-19500	11500	-2000	12750	-12000
SE	2558	51502	2310	37955	3402	4648
%	100	-107	100	-17	100	-94
75th	32500	64821	25500	-70200	14300	-59900
SE	3663	65798	5366	47324	6072	10777
%	100	199	100	-275	100	-419
90th	67959	-27220	46376	-72624	33000	-68211
SE	7682	70097	9888	31862	11162	25466
%	100	-40	100	-157	100	-207
P50-P10	18250	-19500	11500	-2000	12750	-12000
SE	2558	49666	2310	37426	3402	4648
%	100	-107	100	-17	100	-94
P75-P25	28550	65821	25000	-79200	13750	-59850
SE	3268	6524	5272	47523	5835	10842
%	100	231	100	-317	100	-435
P90-P50	49709	-7720	34876	-70624	20250	-56211
SE	6264	69153	9303	42989	10171	23128
%	100	-16	100	-203	100	-278

Table 6. DFL decomposition summary: Sierminska et al. (2010), 2002 replication and 2012 replication.

	Female		Male	
Variable	**Coefficient**	**SE**	**Coefficient**	**SE**
Length of marriage	674.17184***	131	347.60868	188
Number of marriages	19313.001***	3965	4085.5677	5329
Coming from abroad	-39354.817***	4399	-40132.776***	5154
Has a partner	-11373.723*	4542	-9618.5337	5730
Lived in East Germany	-52173.998***	3559	-37365.351***	4222
Number of children below 5	-18009.286***	3746	-6732.4394	4756
Over 65 years old	9078.4806	6378	-6852.2499	9085
Lower vocational education	15777.908***	4379	-1296.2015	5497
Upper vocational education	18712.145**	6195	18100.317*	8122
University degree	43049.403***	8307	25999.464**	9053
High job autonomy	29615.134**	9036	9421.3338	8261
Permanent Income	-0.10090187	0	1.1176807**	0
Working Experience Full-time	521.45498*	241	1725.0294***	278
Working Experience Part-time	479.8857	304	282.12155	985
Unemployment Experience	-1519.7055*	747	-1382.448	1468
Not in workforce	11761.981*	5109	3014.0856	6993
No labor market experience	2102.2964	5890	18241.05**	5928
Father with higher education	11272.344	14250	17057.02	14313
Mother with higher education	11762.568	12817	-1261.6377	14683
Parent with higher education	-14200.704	15920	-9349.1941	17875
Recent inheritence 92-02	72733.734***	10513	42777.966***	9590
Old inheritance (before 1992)	-17917.514	14039	45240.013**	14555
Income squared	.00001449*	0	7.473e-06*	0
Income cubed	-2.404e-11*	0	-1.920e-11**	0
Constant	11839.299*	5487	-5617.8282	7327
N	**5817**		**5322**	

p<0.05; ** p<0.01; *** p<0.001

Table 7. OLS coefficients: 2002 replication.

	Female		Male	
Variable	**Coefficient**	**SE**	**Coefficient**	**SE**
Length of marriage	670.86192***	158	185.79897	195
Number of marriages	17301.173***	4279	-13443.308*	5823
Coming from abroad	-41398.982**	5065	-34189.323*	6564
Has a partner	-8162.9369	5390	-15348.875	8145
Lived in East Germany	-51016.71***	4597	-37454.476*	4252
Number of children below 5	-9241.173	4843	5805.2637	7054
Over 65 years old	133.78825	93	35.697489	138
Lower vocational education	16033**	5540	1905.3859	4979
Upper vocational education	23304.736**	7732	18323.682*	8854
University degree	38136.322***	8739	30395.406**	7879
High job autonomy	-3245.4539	9900	12404.076	10015
Permanent Income	-0.77711498	1	1.9410167**	0
Working Experience Full-time	919.37849***	246	1826.2127**	301
Working Experience Part-time	1445.7763***	345	-128.42813	760
Unemployment Experience	-1881.9879**	550	-181.03008	546
Not in workforce	16017.335**	5437	18334.594*	7689
No labor market experience	3460.5374	8706	13489.368*	5984
Father with higher education	11354.761	10678	-9497.3239	22301
Mother with higher education	-20338.608	10984	8219.1321	14391
Parent with higher education	5986.5584	13669	7634.7054	24189
Recent inheritence 92-02	33465.458**	11848	58102.9**	21376
Old inheritance (before 1992)	12053.072	18357	-12371.238	25567
Income squared	.00005554***	0	-6.66E-07	0
Income cubed	-3.367e-10***	0	-3.57E-12	0
Constant	6006.8001	6213	-18889.871*	6328
N	**4662**		**4164**	

* p<0.05; ** p<0.01; *** p<0.001

Table 8. OLS coefficients: 2012 replication.