Adjustment to a Large Shock - Do Households Smooth Low Frequency Consumption?

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Abstract

We test different consumption theories using the German Reunification "experiment". German reunification was a large, unexpected income shock for East Germans, and led to an exogenous variation in the gap that different birth cohorts of East Germans experienced between their actual and optimal wealth holdings. This shock allows us to test different low frequency consumption theories without relying on the comovement of consumption and income over the life cycle. In our empirical work, we derive three stylized features concerning the saving behavior of East vs. West Germans: (i) East Germans save more than West Germans after reunification, (ii) this east-west gap in saving rates is increasing in the age of the birth cohort, and (iii) for every cohort, this gap is declining over time. In our theoretical work, we analyze which consumption theories can reproduce these three stylized facts. We find strong evidence in favor of the precautionary savings model. We reject rule of thumb behavior, and find only weak evidence for habit formation.

1 Introduction

German reunification was a large positive economic shock for East Germans. Natural experiments of this scale have typically been missing for industrialized countries, except for periods of war. We use the natural experiment of German reunification to test different theories of low frequency consumption behavior within a life cycle setting.

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The life cycle hypothesis, originally formulated by Modigliani and Brumberg in 1954, is the dominant paradigm in economics for studying consumption and saving behavior.[1] Under perfect foresight, the life cycle hypothesis implies that consumption changes should be uncorrelated with expected income changes.

The comovement of consumption and income over the working life has been recognized early on as a challenge for the life cycle hypothesis (Thurow, 1969). This comovement seems to suggest that agents do not choose consumption rationally but rather act according to a rule of thumb, consuming a constant fraction of their current income in every period of their life. Yet, there exist several explanations for this phenomenon that are in line with rational behavior, most importantly the presence of liquidity constraints, precautionary savings, or changing demographics over the life cycle.[2] Several studies conclude that these three factors can cause the observed comovement of income and consumption over the working life (e.g. Attanasio and Weber, 1995, and Attanasio et al., 1999, for demographics, Gourinchas and Parker, 2002, for precautionary savings, and Gross and Souleles, 2002, for evidence of liquidity constraints).[3] Habit formation is another explanation for the coincidence of high income growth rates and high saving rates (e.g. Carroll and Weil, 1994). It is difficult to come to a conclusion about the relative importance of different theories in studies that are solely based on the observed comovement phenomenon, since they potentially suffer from omitted variable biases (Gourinchas and Parker, 2002). Browning and Crossley (2001, p.14) conclude that "the issue is [...] which of several reasonable life-cycle models is the correct one. [...] Richer data is needed to resolve the source of the consumption tracking of income seen in the data."

This paper exploits the natural "experiment" of German reunification. Using the natural experiment of German reunification allows us to differentiate more clearly than studies based on the comovement of consumption and income between rule of thumb behavior on the one hand and optimizing behavior on the other hand. Moreover, we derive and test predictions that arise uniquely under different rational consumption theories. The candidate theories are saving for retirement, precautionary saving, habit formation, consumption of durable goods, and demographics. For East Germans, German reunification signified a large shock to labor and retirement incomes, as well as to wealth levels, and, as we show below, different theoretical models give unique predictions about the resulting saving behavior of different birth cohorts in the transition path of the East German economy to a new steady state. The identification of our estimates is driven by exogenous variations of the net present value of the shock for people at different stages of their life cycles. For example, reunification had different economic implications for an East German who was born in 1970 and was at the

[1] There are varying definitions of the life cycle hypothesis. We use the term mainly to emphasize rational behavior and a finite lifetime.

[2] Another possible explanation lies in the complementarity of consumption and labor (Heckman, 1974).

[3] Most of these studies do not test for rule of thumb behavior explicitly. An exception is the study by Attanasio and Weber (1995). They formally reject rule of thumb behavior as an explanation for the comovement, once they take shifts in family composition and labor supply into account.

beginning of her life cycle in 1990, than for an East German who was born in 1930 and was close to retirement age at the time of reunification. We concentrate on the saving behavior of the working population,[4] and find three stylized facts: (i) a positive gap in the saving rates of East vs. West Germans, (ii) an increase of this East-West gap in the age of the birth cohort, and (iii) a decrease of this gap over time for every cohort. Given the low explanatory power of empirical studies of household saving behavior, it is particularly valuable that we can base our analysis on a comparison of East Germans with a control group, namely West Germans. If changes in unobserved variables influence the saving rate over time, we can reasonably expect these to affect both groups to the same extent. East Germany is the only former communist country experiencing income shocks associated with the adaptation of the market system in a very sudden way,[5] and being provided with a control group, namely the West Germans.

Natural experiments have frequently been employed to analyze high frequency behavior of consumption, using quarterly, monthly or even daily data. Most of these studies focus on relatively small income changes, and find that, in contrast to the permanent income hypothesis, consumption does react to predictable income changes.[6] Notable exceptions to this result are found in the studies of Browning and Collado (2001), Hsieh (2003), Paxson (1992), and Souleles (2000), which analyze large income changes that the consumer faces repeatedly over the life cycle. The welfare losses associated with setting consumption equal to income in the respective experiments fall between 0.01% and 1.3% of annual consumption for the studies that find evidence against the life cycle hypothesis, while they fall in the range of 2.1% to 7% for the studies that do not find evidence against it.[7] This suggests that costs of reoptimization - psychological, monetary, or opportunity costs - might explain the empirical results that are in apparent contradiction to the permanent income hypothesis. Stephens (2003) finds evidence against the permanent income hypothesis in an experiment exploiting a large income change, namely the receipt of social security checks. His study is

[4] For an analysis of the saving behavior of Germans during the retirement period, see Börsch-Supan et al. (2001). Further, Börsch-Supan et al. (2000) give a description of saving behavior of West Germans before and shortly after reunification.

[5] The unions pressed for a rapid adjustment of East German wages and pensions to the West German levels. This also seemed politically necessary, although economically doubtful, in order to prevent massive migration from East to West Germany (Steiner and Puhani, 1997). For people from other Eastern European countries, emigration possibilities were far more restrictive.

[6] See for example Johnson, Parker and Souleles (2004), Parker (1999), Shapiro and Slemrod (1995), Shea (1995), Souleles (1999), Souleles (2002). Most of these studies find no or only weak evidence for liquidity constraints.

[7] We assume a time separable constant relative risk aversion utility function that is additive over monthly consumption with a risk aversion factor of 2, and a discount factor and gross interest rate of unity (see Browning and Crossley, 2001). These are the results of our calculations: Johnson, Parker and Souleles (2004): 0.2%, Parker (1999): 0.6%, Shapiro and Slemrod (1995): 0.05%, Shea (1995): 0.01%, Souleles (1999): 1.3%, Souleles (2002): 0.01%, Browning and Collado (2001): 7%, Hsieh (2003): 3.4%, and Souleles (2000): 2.1%. We do not have enough information to calculate the utility loss for the study by Paxson (1992).

unique, however, in the sense that it analyses daily consumption. Natural experiments have not yet been employed with regard to low frequency consumption behavior since experiments of a scale large enough to influence annual consumption are typically missing.[8] It is so far also undecided whether the repetition of income changes is important in generating rational behavior, which would suggest that consumers have to learn how to behave optimally. Note that the experiment analyzed in this paper, namely the exogenous shock of reunification, is different from those used in the above cited papers, which exploit preannounced changes in income.

In the next section we summarize the effects of our experiment, i.e. the influence of German reunification on East Germans. After a brief description of the panel data set that we use, we derive some stylized facts with a simple graphical analysis, and confirm them in a regression analysis. Then, we establish theoretical predictions for the saving behavior of East Germans vs. West Germans from rule of thumb behavior and different versions of the life cycle model - incorporating retirement saving, precautionary saving, demographics, habit formation, and durable goods purchases. The last section concludes.

2 German Reunification

After the fall of the Berlin Wall on November 9, 1989, the events towards a political and economic reunification of East and West Germany proceeded at a fast speed. On the 1st of July 1990, an economic and currency union was established, and on October 3, 1990, the western and eastern parts of Germany were formally unified.

The East German currency was abolished on July 1, 1990. The exchange rate from Mark (East) into Deutsche Mark was 1:1 for small amounts of accumulated wealth, and 2:1 for amounts of wealth above a certain threshold per person, depending on age.[9] The less favorable rate for larger amounts resulted in a loss of around one third of private savings. Since net disposable income per capita and the price level in East Germany were lower than in West Germany throughout the post-war era (e.g. net disposable income - using a 1:1 exchange rate - amounted to only 45% of the West German level in 1989 (Sinn and Sinn, 1991)), wealth levels of East Germans were on average considerably lower than those of West Germans in 1990. Moreover, home ownership was less common in East Germany. Private debt was exchanged at the rate 2:1, while pension rights and wage contracts were transformed 1:1 (Sinn and Sinn, 1991).

Retirement payments have been calculated using the West German formula, but taking

[8] Levenson (1996) analyzes changes in social security provisions in Taiwan that were large enough to potentially influence annual consumption. Using pseudo panel data, he finds no significant change in consumption on announcement of these changes. He provides several caveats for interpreting this result as evidence against the permanent income hypothesis.

[9] East Germans less than 15 years old could exchange 2000 Mark (East) at the rate 1:1, while persons between 15 and 60 years could exchange 4000 Mark (East), and persons older than 60 years 6000 Mark (East) at this more favorable rate (Sinn and Sinn, 1991).

East German wages as a reference point (Sinn and Sinn, 1991).[10] The replacement ratio in Germany is comparatively high and lies between 70 and 75%. Nierhaus (1997) calculates that the real incomes of retired East households increased on average by 90% between 1989 and 1994, and concludes that in a comparison of real incomes retired East households are the clear "winners" of German reunification. In 1996, the average nominal income of retirees in eastern Germany was 82% of the western German level. The average nominal pension income per household in the East even exceeds the average pension income per household in the West since 1995 (Sinn, 2002). This is mainly due to the higher female labor market participation rate in the GDR than in the FRG. However, due to the lower age of labor force exit in East Germany after reunification (see e.g. Börsch-Supan and Schmidt, 2001), and due to the rapidly declining female employment rate (see e.g. Bonin and Euwals, 2002), the social security wealth of an average working East German household at reunification should not be larger than that of a West German household.

Sinn (2002) reports that nominal income per household in the East rose from around 35% of the West level in the spring of 1990 (before the economic and currency union) to above 80% in 1994. From 1996 on, it has stagnated at around 85% of the West level. These income figures include transfers and social security payments. Employees' compensation rose to 76% of the West level in 1996, and only to 78% by 2001 (Arbeitsgemeinschaft deutscher wirtschaftswissenschaftlicher Forschungsinstitute, 2002). Table 11 in the appendix reports the development of household incomes, pension household incomes, employee's compensation and inflation rates over the 1990s.

Since purchasing power comparisons are not available between eastern and western Germany after reunification, it is unclear whether the stagnant difference in nominal incomes of around 15 percentage points in the second half of the 1990s corresponds to a significant difference in real incomes. Sinn (2002) concludes that "given the somewhat lower price level in the East, which primarily results from the low housing costs, this implies an average real household income of at least 90% of the West". The general perception seems to be that further convergence of nominal incomes will not occur in the near future.

In addition to incomes, labor force participation rates and unemployment rates changed dramatically over the 1990s in eastern Germany. Unemployment rates increased from officially zero in the GDR to 18.8 percent in eastern Germany in 2000. The employed share of the working-age population in eastern Germany declined from 83% in 1990 to 65.2% in 1999, while the western German share remained constant at 73% (Burda and Hunt, 2001).

2.1 Modeling German reunification

In our baseline analyses, we assume that individuals from the former East Germany face the same mean real income with the same risk as individuals from the former West Germany after reunification. As described above, real incomes might in fact not differ much between

[10] As a result, on average the gap between Eastern and Western retirement payments corresponds to the gap between Eastern and Western labor incomes.

eastern and western Germany. Moreover, many people have migrated from eastern to western Germany or have started commuting after reunification.[11] For each theoretical model, we also discuss shortly the implications of three alternative income scenarios: first, a jump in real incomes to a level $\rho < 1$ of West incomes at reunification, second, a gradual adjustment over the first half of the 1990s, with real incomes corresponding to 90% of the West level from the second half of the 1990s on,[12] and third, the ratio of East to West incomes being 90% for the youngest cohorts, and linearly falling to 70% for the oldest cohorts, based on the graphical results in appendix B. Potential East-West income risk differences do not matter for models assuming perfect foresight or certainty equivalence, but will be considered in the precautionary savings model (see section 5.3).

For all models except habit formation, wealth levels at the time of reunification are a sufficient statistic for the differences between East and West Germans. As explained above, wealth levels of East German households were typically lower than wealth levels of West German households at reunification due to the lower nominal incomes in the GDR, and due to the unfavorable exchange rate formula applied to large wealth levels. We hence model the impact of reunification as causing an exogenous variation in initial wealth levels, endowing East Germans with lower than the optimal wealth levels they would have acquired would they have lived in West Germany from birth on.

In the absence of a better wealth measure, we use data on interest and dividend income from financial wealth from the German Socio-Economic Panel survey round of 1992 in order to calibrate the theoretical models (see section 3 below for more information on the data).[13] Because of small cell sizes, we build 5 year moving cohort means of this asset income, separately for the East and the West sample, and construct an East-West ratio for each cohort group. Since there is still a lot of noise in the data, we regress the resulting ratios on a linear trend (figure 1 and table 1). The estimated East to West wealth ratio in 1992 is 0.21 for the oldest cohort group (born between 1928 and 1932), and 0.63 for the youngest cohort group (born between 1968 and 1972). Hence, even for the youngest cohort the East-West

[11] Burda and Hunt (2001) report that from 1989 to 1999, 15% of the eastern German population migrated to western Germany. Moreover, during the decade of the 1990s, the number of East-West commuters was even higher than the number of migrants. Due to human capital differences, it might still be possible that on average East Germans who work in West Germany face different income processes than West Germans.

[12] For this scenario, we assume that the ratio of East incomes to West incomes evolves as shown in table 11 for the first 6 years after reunifcation, that the ratio is 0.87 in the 7th year, and 0.9 from then on.

[13] The survey question for asset income asks: "How high was the income received from interest, dividends and profits from these savings and securities in the last calendar year?" Some households give an exact amount, while others just indicate one of five given ranges (less than 500 DM, 500 to 2000 DM, 2000 to 5000 DM, 5000 to 10000 DM, more than 10000 DM). For those indicating a range, we use the mean income of households who actually give the exact amount within this range as a proxy. The question in the survey round 1992 refers to income from financial wealth in 1991. Information about income from financial wealth is sufficient for us if we can assume that East and West Germans held the same portfolio of financial wealth, resulting in the same interest rates earned on financial wealth. Since stock holdings were not yet common in Germany in the early 1990s, this assumption seems reasonable. Fuchs-Schündeln and Schündeln (2004) give evidence that our chosen measure captures financial wealth reasonably well.

wealth ratio in 1992 is smaller than the average East-West income ratio over the 1990s. One would expect the wealth difference to be larger for older cohorts, since they lived under separate regimes for a longer time.[14]

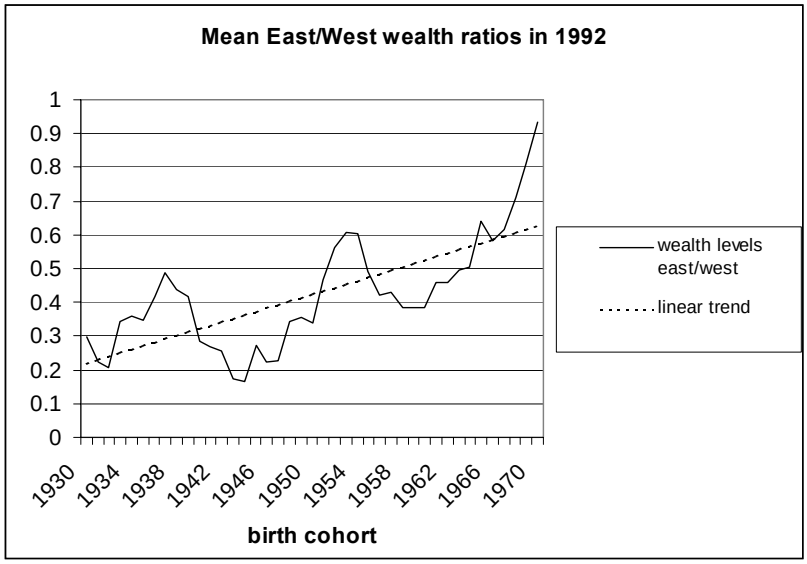

Figure 1: Actual and estimated east-west wealth ratios of different cohorts in 1992

dependent variable: wealth ratio	Coeff.	Std. Err.
trend	0.0102	0.0016
constant	0.2103	0.0383
R^2	0.512	

Table 1:
Estimation of wealth ratios

Figure 2 shows the average financial wealth holdings of East and West Germans in 1992.[15] While in both parts of Germany wealth holdings are increasing in the age of the cohort, the difference is clearly increasing in the age of the cohort.

[14] This calculation neglects real wealth holdings. If we include a measure of real wealth holding and regress the new total wealth ratio on a linear trend, the constant is 0.1436 and the trend is 0.0098 (both highly significant). As expected, the wealth differences become larger for all birth cohorts if real wealth is included.

[15] An interest rate of 5% on financial wealth is assumed in 1992.

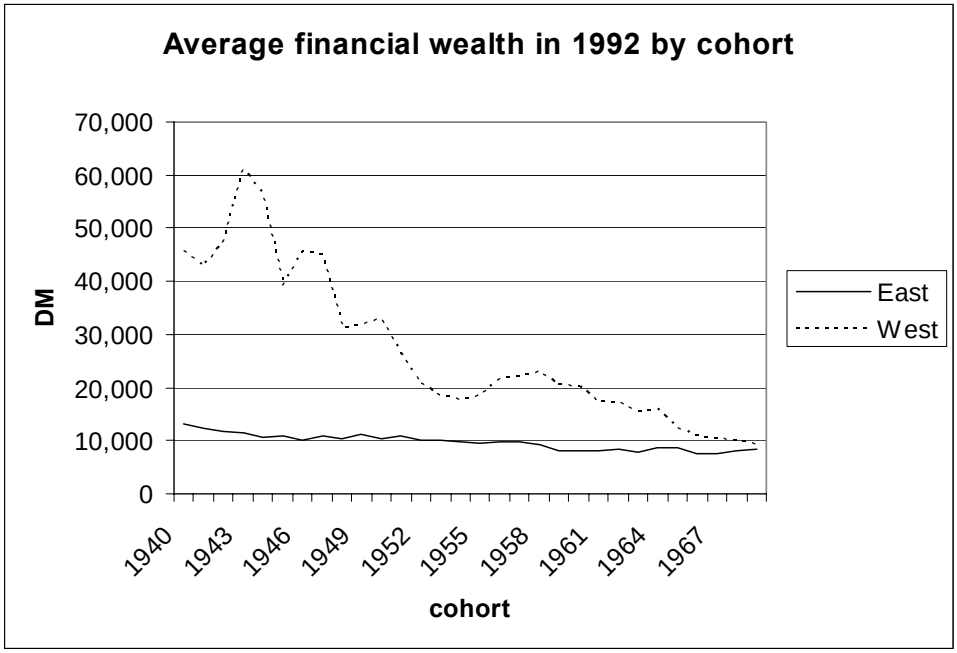

Figure 2: Average financial wealth holdings of East and West Germans in 1992 by cohort

3 The data

The data comes from the German Socio-Economic Panel (GSOEP). This annual survey was started in West Germany in 1984. From 1990 on, it covers also the territory of the former German Democratic Republic. We use the survey rounds from 1992-2002 for the initial graphical analysis, and the survey rounds 1992-2000 for the regression analysis.[16] The question concerning financial saving was only introduced in 1992. We use the original sample established in 1984, and the subsample covering the territory of the former GDR started in 1990.[17]

The saving data in the survey is recorded at the level of the household. Information about personal characteristics that serve as controls, e.g. marital status, are taken from the head of household. Because of our focus on labor force participants, we exclude households whose head of household is retired, but include households whose head is unemployed. We drop households whose head serves an apprenticeship. Further, we keep only households

[16] We additionally use the survey rounds 1990 and 1991 in the habit formation analysis. Due to German data protection laws, researchers outside of Germany can only work with a 95% random sample of the full Socio-Economic Panel data set. A detailed description of the survey can be found in SOEP Group (2001).

[17] We drop subsamples focusing on migrants, because foreigners might have different savings motives. Moreover, we do not use refreshment samples added in 1998 and 2000, because for these households we do not have observations from earlier years.

whose head is 65 years or younger at the time of the survey. The final sample size consists of 23,959 observations for the years 1992-2000, namely 14,874 in the West sample and 9,085 in the East sample.

The saving variable consists of positive financial saving and amortization payments for owner-occupied housing and other dwellings. This variable is left-censored for those who report zero financial saving. Details of the construction of this variable, and a comparison to data provided by the German Central Bank, are given in appendix A. We build the saving rate as the ratio of saving to net disposable household income. Both saving and income are directly reported in the survey.[18] The household is specifically asked to state monthly net income including different regular income sources. However, financial income is not mentioned as a subcomponent to be included into this measure. The question concerning saving is asked immediately after the income question. It seems hence somewhat more likely that respondents refer to disposable labor income and saving out of disposable labor income instead of saving out of the sum of labor and capital income when answering the questions. We therefore assume that the constructed saving rate captures saving out of labor income (including transfers) over labor income (including transfers), both times excluding financial income. In our theoretical analysis, we will report predictions for the saving rate defined the same way, namely saving out of labor income divided by labor income. Sensitivity analyses reveal that the qualitative results of the theoretical models would not change given a more comprehensive income measure.

All real variables are adjusted to represent purchasing power in 2000. In accordance with the residence in the observation year, inflation rates are taken from the CPI in eastern or western Germany until the year 1999, and from a common CPI from 2000 on.

4 Empirical Results

4.1 Graphical analysis

Figure 3 depicts the saving rate as provided by the Statistical Office over the period 1950 to 2001 (until 1990 only for West Germany; starting in 1991 the data includes the territory of the former GDR). Until the mid 1970s, the saving rate in Germany was steadily increasing in conjunction with the economic recovery after World War II. This is consistent with the life cycle hypothesis, since Germany experienced dramatic growth during the post-war period. From the mid 1970s to the beginning of the 1990s, there was a small decline in the rate

[18] The question about savings reads: "Do you usually have an amount of money left over at the end of the month that you can save for larger purchases, emergency expenses or to acquire wealth? If yes, how much?". The question regarding household income reads: "If you take a look at the total income from all members of the household: how high is the monthly household income today? Please state the net monthly income, which means after deductions for taxes and social security. Please include regular income such as pensions, housing allowance, child allowance, grants for higher education, support payments etc. If you do not know the exact amount, please estimate the amount per month."

followed by an increase. From 1990 on, the rate steadily declined.

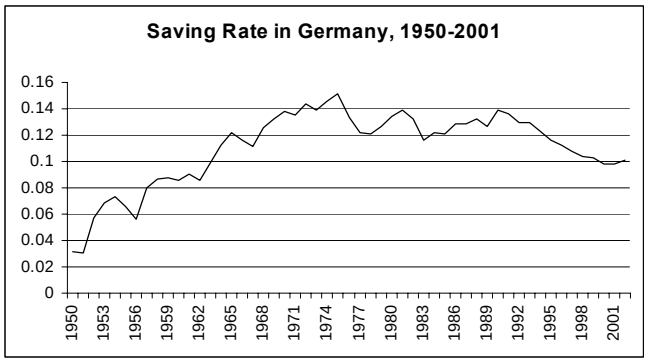

Figure 3: Saving Rate in Germany, 1950-2001. Note: From 1950-1990 the graph shows the saving rate for West Germany, after 1991 it includes East Germany.

In the GSOEP sample from 1992 to 2002, the saving rate of West Germans is largely stable at around 12 percent (figure 4). The saving rate of East Germans is declining over time, from almost 15 percent in 1992 to around 11 percent in 2002. The saving rates converge in 1999, and from 2000 on the average saving rate of East Germans is slightly smaller than the average saving rate of West Germans. Figure 5 depicts the average saving ratio constructed from financial saving only. The pattern is very similar, with a stable saving ratio for West Germans, and a larger and declining saving ratio for East Germans. Again, both saving rates become very close in 2000, and finally converge in 2002. Since both graphs give evidence that convergence occurred in 2000, we concentrate the analysis on the time period 1992 to 2000 from now on.

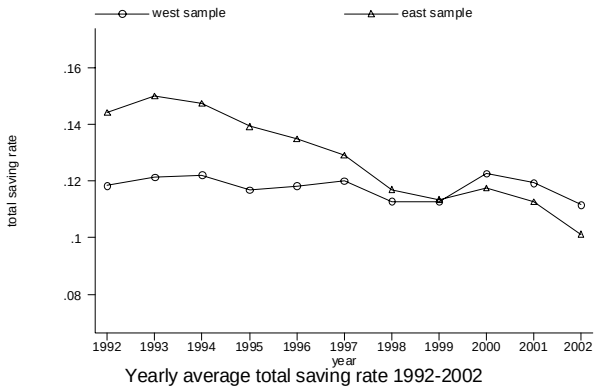

Figure 4: Average saving rate in West and East sample over time

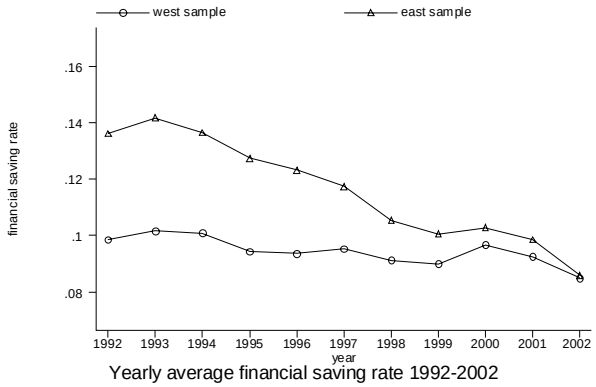

Figure 5: Average financial saving rate in West and East sample over time

Figure 6 shows how different cohorts' saving rates change with age in the East and West samples, grouping cohorts of five adjacent birth years together. The saving rates are generally higher in the East sample than in the West sample. Moreover, they tend to be declining over time for every cohort in the East, while they are rather flat over time in the West. Looking at the East-West differences of the cohort age profiles (figure 7), one can observe three features. First, the differences in the saving rates between East and West Germans of a given age and cohort are mostly positive. Second, the East-West difference is increasing in the age of the cohort. Last, the difference has a decreasing trend over time for every cohort.[19] The cohort results are very consistent with results from the *Einkommens- and Verbrauchsstichprobe* (EVS), which is conducted every five years, covers around 60,000 households, and is considered to provide the most reliable measure of household wealth (see appendix 15 for details).

[19] These three features also arise and are confirmed in regression results if the saving rate comprises only financial saving.

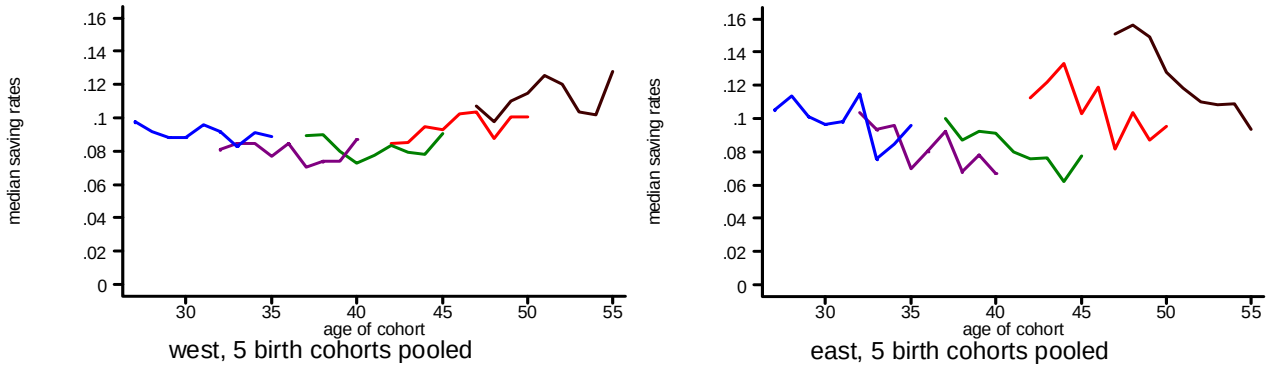

Figure 6: Cohort-age profiles of saving rate in West sample (left panel) and East sample (right panel). Each solid line represents five adjacent birth cohorts

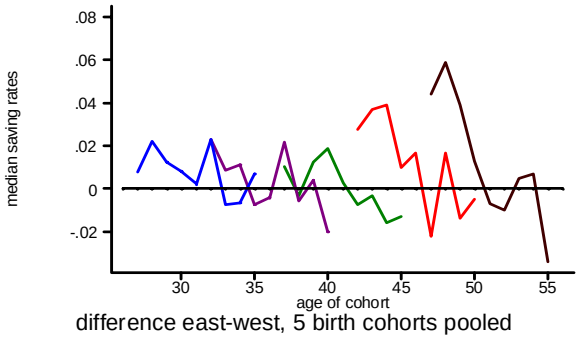

Figure 7: Cohort age profile of East-West difference of saving rate. Each solid line represents five adjacent birth cohorts

4.2 Regression analysis

We investigate the statistical significance of the three stylized saving rate features found in the last section, and allow for various saving motives and relevant control variables in a regression framework. Since the saving rate is left-censored, we estimate random-effects tobit models. We start from the following specification:

$$\frac{S_{i,t}}{Y_{i,t}} = e^{\alpha} \cdot Y_{i,t}^{\beta} \cdot e^{\gamma Z_{i,t}} \cdot e^{\delta birthyear_i} \cdot e^{f(age_{i,t},\theta)} \cdot e^{\varepsilon_{i,t}}$$

which is, after taking logs and moving $\log(Y_{i,t})$ to the right hand side, equivalent to

$$\log(S_{i,t}) = \alpha + (\beta + 1)\log(Y_{i,t}) + \gamma Z_{i,t} + \delta birthyear_i + f(age_{i,t}, \theta) + \varepsilon_{i,t} \qquad (1)$$

where S is saving and Y is disposable income. Disposable income is included as a control to proxy for temporary income shocks, and to account for the fact that the rich have higher saving rates (Carroll, 2000). Z is a vector of household characteristics including marital status of the household head, the number of individuals above age 16 in the household, and the number of children living in the household. The term $f(age_{i,t}, \theta)$ is a cubic function in age, to be able to account for the complex shape of saving over the life cycle. The omitted marital status is single or widowed. Due to collinearity with year of birth and age, time dummies cannot be included into the regression. To capture macro shocks, we instead include the real interest rate on savings accounts. To take the logarithm of saving, we assume saving is left-censored at 1 instead of zero, which makes the logarithm left-censored at 0.

We create an East dummy that takes on the value 1 if the household lived in East Germany before the reunification, and create interactions of the dummy with all independent variables. Let $\beta_{East}, \delta_{East}$, and θ_{East} be the coefficients on the respective interaction terms. The following three hypotheses test the significance of the three stylized facts that we derived in the graphical analysis:

1. For a given income, saving of East Germans is higher than saving of West Germans: $\beta_{East} > 0$.

2. The difference in the saving rates of East and West Germans is declining in the birth year: $\delta_{East} < 0$.

3. The difference in the saving rates of East and West Germans is declining over the course of the 1990s: $\frac{\partial f(East * age_{i,t}, \theta_{East})}{\partial age} < 0$.

An explanation seems in order for the test of the third prediction. Since we cannot include time dummies due to collinearity, we use age to test this prediction. This test is based on the assumption that life cycle effects in saving, captured by age, do not differ

between East and West Germans. Given this assumption, the term $f(age_{i,t}, \theta)$ captures the life cycle effect for every cohort of East and West Germans, and hence $f(East * age_{i,t}, \theta_{East})$ captures the additional effect of time for individuals from the East.

In our first specification, we do not include any control variables. In the second specification, we control for marital status, family composition, and macroeconomic shocks. In the third specification, the control variables are interacted with the East sample dummy as well. Results are shown in table 2.
As expected, income has a very high explanatory power for saving. Moreover, saving of a household is significantly decreasing in the number of adults and the number of children in the household. Divorced households save significantly less than single or widowed households. Cohort and age variables have no explanatory power for the saving behavior of West Germans.

The estimation results confirm the three stylized facts. First, the coefficient on the interaction term of income and East sample is positive and significant, indicating that the saving rates of East Germans are higher than those of West Germans. Second, the coefficient on the interaction of cohort and East sample exhibits a significant negative sign. This shows that the difference in the saving rates of East and West is smaller the younger the cohort. Last, the derivative of the cubic in age interacted with the East sample dummy with respect to age is negative except for the very youngest (table 3). This validates that the difference between the saving rates of East and West Germans is declining over time except for the very young.

From the other interaction terms, only the coefficients regarding family status are significant. East German households whose head is married or divorced save less than their West German counterparts, relative to single and widowed households. The fact that most of the other interaction terms with control variables are insignificant corroborates the assumption that the economic environment after reunification is not fundamentally different for East and West Germans.

Dependent variable	(i) log(saving)		(ii) log(saving)		(iii) log(saving)	
	Coeff.	Std. Err.	Coeff.	Std. Err.	Coeff.	Std. Err.
INCOME VARIABLE/INTERACTION:						
log(income)	3.287	0.072***	3.444	0.079***	3.383	0.081***
log(income)*eastsample	0.603	0.121***	0.579	0.123***	0.712	0.131***
COHORT/AGE VARIABLES:						
cohort (year of birth-1900)	-0.013	0.009	0.007	0.033	0.004	0.040
age	-0.121	0.162	0.090	0.169	0.003	0.173
age sq.	0.0001	0.0039	-0.003	0.004	-0.002	0.004
age cube ($*10^{-3}$)	0.020	0.030	0.038	0.030	0.025	0.031
COHORT/AGE INTERACTIONS:						
cohort*eastsample	-0.140	0.015***	-0.140	0.015***	-0.137	0.068**
age*eastsample	0.240	0.281	0.311	0.278	0.516	0.296*
age squared*eastsample	-0.009	0.007	-0.011	0.007*	-0.015	0.007**
age cube*eastsample ($*10^{-3}$)	0.071	0.051	0.093	0.051*	0.123	0.051**
OTHER CONTROLS:						
married			-0.150	0.087*	0.073	0.105
divorced			-1.035	0.116***	-0.851	0.139***
adults (age>16)			-0.295	0.030***	-0.284	0.040***
children			-0.272	0.031***	-0.241	0.037***
real interest rate			0.164	0.171	0.137	0.210
constant	-18.841	2.185***	-24.646	3.947***	-22.727	4.592***
OTHER INTERACTIONS:						
married*eastsample					-0.705	0.189***
divorced*eastsample					-0.596	0.251**
adults*eastsample					-0.038	0.060
children*eastsample					-0.098	0.068
real interest rate*eastsample					0.073	0.361
eastsample	3.037	3.814	3.063	3.786	-0.738	7.768
obs	23,959		23,959		23,959	
log likelihood	-44,994		-44,872		-44,862	

Notes: Std. errors with an * indicates that the estimate is significant at 10% level, ** at 5% level, *** at 1% level

Table 2:
Random effects panel tobit estimation

test of H_0 :	(i) coefficient	(i) p-value	(ii) coefficient	(ii) p-value	(iii) coefficient	(iii) p-value
$\frac{\partial f(East*age_{i,t},\theta_{East})}{\partial age}(age=20)=0$	-0.023	0.764	-0.024	0.755	0.045	0.662
$\frac{\partial f(East*age_{i,t},\theta_{East})}{\partial age}(age=30)=0$	-0.090	0.000	-0.108	0.000	-0.079	0.263
$\frac{\partial f(East*age_{i,t},\theta_{East})}{\partial age}(age=40)=0$	-0.115	0.000	-0.136	0.000	-0.130	0.058
$\frac{\partial f(East*age_{i,t},\theta_{East})}{\partial age}(age=50)=0$	-0.100	0.000	-0.109	0.000	-0.107	0.121
$\frac{\partial f(East*age_{i,t},\theta_{East})}{\partial age}(age=60)=0$	-0.036	0.357	-0.026	0.499	-0.009	0.904

Table 3:
Test of third prediction

5 Consumption Theories

This section turns to the main aim of this paper, namely testing different consumption theories based on the natural experiment of reunification. We analyze which behavior different consumption theories would have predicted back in 1990 for the saving rate differences, and then conclude which theories actually can explain the three stylized facts that we observe in the data. If we find evidence in favor of a specific theory, we conduct additional empirical tests. We start with rule of thumb behavior, and then turn to four different rational consumption theories, namely retirement saving, precautionary saving, habit formation and demographics. Last, we consider durable goods purchases. For each of the consumption theories, the simplest possible life cycle model is used. Since our aim is to analyze whether any single theory is sufficient to explain the stylized facts, we do not build a more comprehensive life cycle model that incorporates elements from different theories.

5.1 Rule of thumb behavior

Motivated by the comovement of income and consumption over the working life, rule of thumb consumers are most often assumed to consume a certain constant fraction of their income in every period of their life. This form of rule of thumb behavior would imply that East Germans do not react to their lower wealth levels, but just consume the same constant fraction of their incomes as West Germans. We can clearly reject this form of rule of thumb behavior based on the regression results. Of course, East Germans could consume according to a different rule of thumb than West Germans. Yet, as long as rule of thumb behavior means that consumption decisions are solely based on current income, neglecting wealth, risk, and income expectations, the cohort pattern and the declining difference between East and West saving rates over time should not arise.

5.2 Retirement saving

In this subsection, we ask whether a model using saving for retirement as the sole saving motive would have predicted the three stylized facts. Agents maximize lifetime utility subject to an intertemporal budget constraint. They work up to period R and live up to period $T > R$. Labor income Y and retirement income are both deterministic, with retirement income amounting to a constant fraction $\alpha < 1$ of labor income. There is no growth in the economy.[20] The subjective discount factor β is equal to the inverse of the constant gross interest rate, $\beta = \frac{1}{1+r}$.

We model the impact of German reunification as follows. West Germans live in the described framework, starting life with zero assets. They accumulate wealth while working, and drive down their assets while retired. Based on the estimated wealth ratios, we assume that the wealth level of an East German household in 1990 amounts to a fraction $\kappa(t) < 1$ of a West German household of the same age, with t being the age of the household at reunification, and $\kappa'(t) < 0$.

This model is able to replicate a positive saving rate gap that is increasing in the age of the cohort, but since the saving rate for every household is constant over time, the saving rate gap in this model does not decline over the course of the 1990s. The lower wealth holdings at reunification of an East German household that faces the same labor and retirement income as a West German household of the same age induces the East household to save more. Moreover, the East-West difference is larger for older cohorts, since the East household has less time left to partially make up for the lower wealth through higher saving while working, and because the relative wealth holdings of East households are smaller for older cohorts.

Formally, the difference between the saving rates of two East and West households reduces to

$$\left(\frac{S}{Y}\right)_{t,East} - \left(\frac{S}{Y}\right)_{t,West} = \frac{(1-\kappa(t))\, r A_{t-1}}{\left(1-\beta^{T-t+1}\right) Y} \tag{2}$$

where t is the age of the household at reunification, and A_{t-1} is the wealth holding of the West German household at the end of life cycle period $t-1$. This term is unambiguously positive as long as $A_{t-1} > 0$, i.e. as long as the average West German household is not borrowing. This point is crucial for our analysis: any economic model that predicts borrowing and hence negative wealth holdings by young households fails to replicate the empirical facts not only because on average we observe positive wealth holdings by young households in the data, but also because under such a model young East Germans are better off than West Germans, and hence should save less.[21] Equation 2 also shows that the saving rate

[20] If growth is positive, agents should borrow while young and save in the later part of their working life. Yet, data from many countries show that the young are not on average borrowing. Here, we simplify by assuming zero income growth.

[21] While they received lower utility up to reunification, under such model young East Germans have lower debt levels and hence higher net worth than West Germans at reunification (including the present

gap is increasing in the age of the cohort t, as long as wealth holdings are not decreasing in age during the working life, but that the gap is constant over time.[22]

We conclude that the retirement saving model cannot replicate the decrease in the saving rate gap over time for any given cohort. Moreover, we have to rely on the unrealistic assumption that income is not increasing over the working life to generate the other two stylized facts. Last, note that 84% of West German households receive public pensions as the only source of retirement income, and the average contribution of private pension income to total retirement income amounts to only 3 percent (Börsch-Supan and Schmidt, 2001). Hence, private retirement saving plays a very small role in Germany. Life expectancy has been sharply increasing for East Germans after reunification, but it is still slightly lower than life expectancy of West Germans, which makes the retirement saving motive potentially weaker for East Germans.

5.2.1 Alternative income processes

In the first alternative income scenario, East incomes jump immediately at reunification to a fraction of West incomes, $Y_{East} = \rho Y_{West}$ with $\rho < 1$, and remain constant at this level. The saving rate gap then becomes

$$\left(\frac{S}{Y}\right)_{t,East} - \left(\frac{S}{Y}\right)_{t,West} \frac{rA_{t-1}}{1-\beta^{T-t+1}} \left(\frac{1}{Y_{West}} - \frac{\kappa(t)}{Y_{East}}\right)$$

which is unambiguously positive as long as $\kappa(t) < \frac{Y_{East}}{Y_{West}} = \rho$, i.e. the East-West wealth ratio is smaller than the East-West income ratio for every cohort. As laid out in section 2, this was the case. None of the model predictions change using this income process. This is also the case if we assume that the East-West income ratio is smaller for older cohorts, since empirically it still holds that $\kappa(t) < \rho(t)$ for every cohort.

If we assume a gradual adjustment process of East incomes to West incomes, some of our predictions change. Especially, the gradual adjustment leads to a steeper income path in East Germany than in West Germany, introducing a borrowing motive for East Germans immediately after reunification. Hence, the saving rate gap between East and West could be negative, and the East-West saving rate gap would be increasing over time for these cohorts.

discounted value of future income, which does not differ for East and West Germans). If we had assumed a rising income path under the retirement saving model, young West Germans might be borrowing, and the saving rate gap between East and West would be negative for young cohorts. This problem arises again in the habit formation model (see section 5.4).

[22] The gap is also constant over time if the consumption path is rising, since the difference between East and West consumption within one cohort is constant. The retirement model can only generate a declining gap over time for any given cohort if incomes are rising, i.e. the denominator of the saving rate gap is increasing over time. Yet, this would lead to a borrowing motive for young West Germans, making the saving rate gap negative for young cohorts.

5.3 Precautionary saving

In this section, we include income uncertainty into the life cycle model (see e.g. Carroll, 1992), and abstract from a retirement period. Each agent maximizes the discounted value of future utility from consumption up to period T:

$$\max_{\{C_t\}_{t=0}^{T}} \sum_{t=0}^{T} \beta^t E_0 \left\{ u\left(C_t\right) \right\} \tag{3}$$

subject to the intertemporal budget constraint:

$$X_{t+1} = \left(1 + r\right)\left(X_t - C_t\right) + Y_{t+1} \tag{4}$$

and a borrowing constraint

$$X_{t+1} \geq 0 \tag{5}$$

where C_t is consumption, and X_t is cash on hand at the beginning of the period.

Labor income follows the stochastic path

$$Y_t = P_t \epsilon_t$$

with

$$P_{t+1} = G P_t \mu_t$$

and

$$\log \epsilon_t \sim N\left(-\frac{\sigma_\epsilon^2}{2}, \sigma_\epsilon^2\right), \quad \log \mu_t \sim N\left(-\frac{\sigma_\mu^2}{2}, \sigma_\mu^2\right)$$

where P_t is the permanent component of income, G is the gross growth rate of the permanent component of income, ϵ_t is a transitory income shock, and μ_t is a permanent income shock.

The one period felicity function is of the constant relative risk aversion form:

$$u\left(C_t\right) = \frac{C_t^{1-\gamma}}{1-\gamma} \tag{6}$$

where γ is the coefficient of relative risk aversion.

To solve the model numerically, we represent one year as a model period. We calibrate $\sigma_\epsilon^2 = \sigma_\mu^2 = 0.01$, $r = 0.02$, $\gamma = 3$, $G = 1.02$, and $\beta = (1 + 0.04)^{-1} = 0.9615$. Life consists of 45 periods. After having solved the model, we simulate 1,000 life cycle paths, assuming that all West German agents start life with zero wealth. We use the estimated East-West wealth ratios for different cohorts to determine the wealth of East German households at reunification.

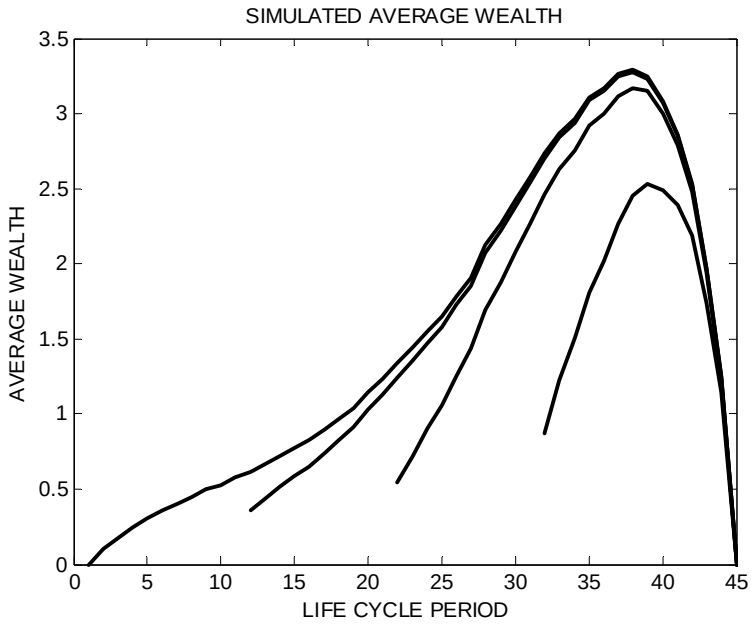

Figure 8: Results from the precautionary savings model: simulated average wealth over the life cycle

5.3.1 Simulation results

We depict four cohorts constructed as averages from 1,000 life cycle paths each: one cohort faces the whole life cycle under the economic circumstances described above, representing West Germans. The other three cohorts are only entering this economic environment at a certain point in their life cycle, namely at period 10, 20, or 30. These cohorts represent East Germans born in 1960, 1950, or 1940. They are endowed with only 56%, 45% or 35%, respectively, of the wealth of a West German of the same age in 1990.

The wealth holdings of the West Germans are increasing with age until period 38 (Figure 8). All three of the East German cohorts start with low wealth holdings, but approach the wealth level of the West Germans over time. The older a cohort is at reunification, the larger is the initial difference between its wealth and the wealth of its West German counterpart.

The saving rate of the West German cohort is highest at the beginning of the life cycle in order to rapidly build up a buffer stock. It is declining over the whole life cycle. The East-West wealth differences translate into differences in the saving rates. Figure 9 depicts the cohort-age profile of the saving rate differences between East and West cohorts over the time period 1990 to 2000, analogous to figure 7.[23] First, note that for every cohort, East

[23]Since our empirical analysis focuses on the behavior of the working age population, we omit in this

German saving rates are higher than West German saving rates over the whole decade. Second, the differences between East and West German saving rates are larger for older cohorts than for younger cohorts. Last, for every cohort the difference between East and West Germans' saving rates declines over time, while East Germans manage to build up a reasonable buffer stock. The precautionary saving model is able to replicate all three stylized facts found in the data.

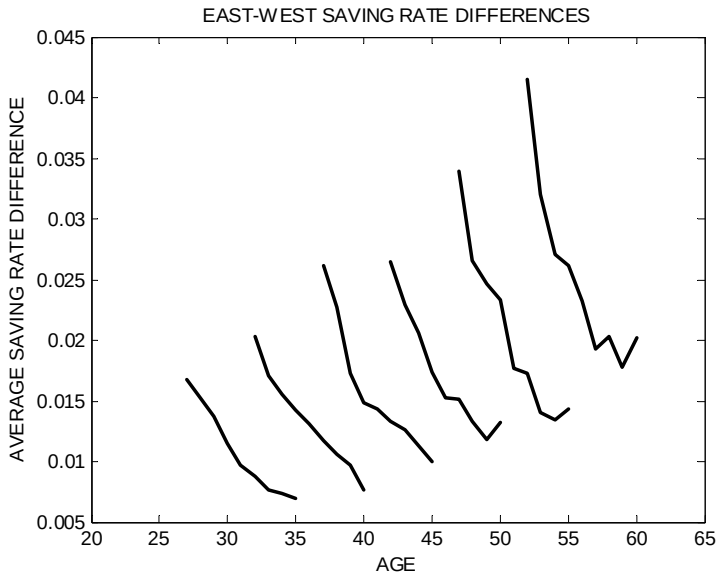

Figure 9: Results from precautionary savings model: Cohort-age profile of East-West difference in saving rates

picture cohorts that are in the last periods of the life cycle, running down their assets.

5.3.2 Alternative income processes

As in the retirement saving model, if we assume that East incomes jumped immediately to a level $\rho < 1$ of West incomes, the results do not change as long as the ratio of East-West wealth holdings at reunification is smaller than the ratio of East-West incomes after reunification, i.e. as long as $\kappa(t) < \rho(t)$ for every t. Simulations with the precautionary saving model also show that, even if East incomes exhibit greater growth rates than West incomes over the first years of the 1990s, the three features still arise. The decline of the saving rate gap over time occurs more slowly, and the initial gap is larger.

5.3.3 Risk differences

In this subsection, we investigate whether there are substantial differences in the income risk of East and West Germans, and whether we can find additional evidence for precautionary behavior in our data. We also want to make sure that the three stylized facts in the data do not arise solely due to higher labor risk in East Germany, even if wealth levels would be the same in East and West Germany.

Unemployment rates in East Germany have been rising sharply after reunification, and since 1999 are double the size of unemployment rates in West Germany (note, however, that these unemployment rates concern the current residence, not the residence before reunification). On the other hand, the wage distribution in the GDR was more compressed than in West Germany before reunification, and while wage dispersion in the East has been rising after reunification, it still has not reached the Western German level (OECD 2001). Biewen (2000) uses the measure of disposable household income employed in this paper and finds that, despite a rise since reunification, inequlity remains substantially lower in the East than in the West by 1996.

To test whether labor income risk differences drive the results, we include two income risk measures in the regression, namely the time-series variance of individual income over 1992-2000, and the unemployment rates in eastern and western Germany (see tables 10 and 13 in the appendix for summary statistics). The variance of net disposable household income is on average larger for West Germans than for East Germans in our sample.[24,25]

[24] The variance and the coefficient of variation of the unpredictable component of income are also larger on average for West Germans than for East Germans. Moreover, the regression results are very similar to those presented in table 4 if we include the variance of the unpredictable component of income instead of the variance of income in the regression. The predictable component of individual income is constructed by regressing the logarithm of income on a cubic function of age, occupation, education, marital status, family composition, and interaction terms with age and age squared, separately for East and West Germans. The unpredictable component is the difference between actual income and the exponential of the predicted logarithm of income.

[25] Note that the unemployment rate differences between East and West have rather increased over the 1990s, and the general perception is that the high unemployment rates in the East will persist for the near future or even be exacerbated after the inclusion of Eastern European countries into the European Union. Hence, the third stylized fact, namely the declining East-West saving rate gap over time, cannot easily be

Dependent variable	(i) log(saving)		(iii) log(saving)	
	Coeff.	Std. Err.	Coeff.	Std. Err.
INCOME VARIABLE:				
log(income)	3.376	0.080***	3.413	0.081***
log(income)*eastsample	0.739	0.132***	0.683	0.133***
COHORT/AGE VARIABLES:				
cohort (year of birth-1900)	-0.035	0.042	0.003	0.040
age	-0.016	0.173	-0.002	0.173
age sq.	-0.002	0.004	-0.002	0.004
age cube (*10^{-3})	0.029	0.031	0.026	0.031
COHORT/AGE INTERACTIONS:				
cohort*eastsample	-0.128	0.070**	-0.141	0.068**
age*eastsample	0.498	0.297	0.509	0.297*
age squared*eastsample	-0.015	0.007**	-0.015	0.007**
age cube*eastsample (*10^{-3})	0.119	0.053**	0.121	0.053**
OTHER CONTROLS:				
married	0.067	0.105	0.083	0.104
divorced	-0.852	0.139***	-0.805	0.140***
adults (age>16)	-0.278	0.040***	-0.287	0.040***
children	-0.238	0.037***	-0.240	0.037***
real interest rate	-0.187	0.229	0.131	0.211
constant	-18.235	4.753***	-22.688	4.595***
OTHER INTERACTIONS:				
married*eastsample	-0.721	0.190***	-0.770	0.189***
divorced*eastsample	-0.595	0.251***	-0.688	0.249***
adults*eastsample	-0.050	0.061	-0.038	0.061
children*eastsample	-0.101	0.068	-0.098	0.068
real interest rate*eastsample	0.314	0.374	0.064	0.361
eastsample	-2.928	7.938	-0.186	7.771
unemployment rate	-0.077	0.022***		
unemployment rate*eastsample	0.117	0.029***		
variance of income (*10^{-7})			-0.325	0.048***
variance of income*eastsample (*10^{-7})			-0.095	0.267
obs	23,959		23,794	
log likelihood	-44,854		-44,532	

Notes: Std. errors with an * indicates that the estimate is significant at 10% level, ** at 5% level, *** at 1% level

Table 4:
Random effects panel tobit estimation with income risk measures

test of H_0:	(i) coefficient	(i) p-value	(ii) coefficient	(ii) p-value
$\frac{\partial f(East*age_{i,t},\theta_{East})}{\partial age}(age=20)=0$	0.046	0.659	0.044	0.672
$\frac{\partial f(East*age_{i,t},\theta_{East})}{\partial age}(age=30)=0$	-0.073	0.321	-0.080	0.260
$\frac{\partial f(East*age_{i,t},\theta_{East})}{\partial age}(age=40)=0$	-0.120	0.090	-0.131	0.057
$\frac{\partial f(East*age_{i,t},\theta_{East})}{\partial age}(age=50)=0$	-0.097	0.171	-0.109	0.111
$\frac{\partial f(East*age_{i,t},\theta_{East})}{\partial age}(age=60)=0$	-0.002	0.977	-0.015	0.850

Table 5:
Test of third prediction with inome risk measures

The results for the interaction terms of interest do not change significantly (tables 4 and 5). The coefficient on the unemployment rate is negative and significant, yet the interaction term with the East sample dummy is positive and significant. This shows that for East Germans, higher unemployment rates are associated with higher saving. The results for the variance of income are similar, although the interaction term is now insignificant instead of positive. While the significant negative coefficients on income risk for the West sample are hard to explain, note that wealth holdings of western households could be at their optimal level, in which case income risk should not influence saving significantly.

In addition to these empirical findings, we include risk differences in the theoretical model. For this purpose, we estimate the variance of the permanent and temporary income shock as suggested by Carroll and Samwick (1997). The procedure is described in appendix D. The estimated variance of the temporary income shock is slightly larger in the East German sample, while the estimated variance of the permanent income shock is smaller (see table 6). Using the estimated variances in the calibration of the model leads to somewhat larger East-West saving rate differences, with the largest initial difference for the older cohorts amounting to around 6 percentage points. The other features of figure 9, namely the cohort ordering and the rapid decline in the saving rate differences, do not change.[26]

	σ^2_ϵ	σ^2_μ
West sample	0.03766	0.01194
	(0.00299)	(0.00112)
East sample	0.03777	0.01175
	(0.00259)	(0.00097)

Note: Standard errors are in parenthesis

Table 6: Estimated variances of the temporary and permanent income shock

explained by a precautionary saving motive caused solely by the higher unemployment risk.

[26] Results are available from the author upon request.

5.4 Habit formation

Consider the certainty equivalence habit formation model

$$\max E_t \sum_{i=t}^{T} \beta^{i-t} u\left(C_i - \lambda C_{i-1}\right)$$

subject to the budget constraint

$$A_i = (1+r)\left(A_{i-1} + Y_i - C_i\right)$$

with A_{t-1} and C_{t-1} given. The parameter λ represents the strength of the habit motive. Assuming $\beta = \frac{1}{1+r}$, we can solve the model analytically and get the following solution[27]:

$$C_i = \alpha_t \left[(1+r)\, A_{t-1} + \sum_{i=t}^{T} \left(\frac{1}{1+r}\right)^{i-t} Y_i\right] - \alpha_t \lambda \frac{1 - \left(\frac{1}{1+r}\right)^{T+1-t}}{1 - \left(\frac{1}{1+r}\right)} C_{t-1} + \lambda C_{i-1} \qquad (7)$$

with $\alpha_t = \left[\sum_{j=0}^{T-t} \lambda^j \left(\frac{1}{1+r}\right)^j \frac{1-\left(\frac{1}{1+r}\right)^{T+1-t-j}}{1-\left(\frac{1}{1+r}\right)}\right]^{-1}$.

Since the habit formation model involves a backward looking component, the wealth levels of East Germans at reunification are no longer a sufficient statistic for the shock of reunification. Instead, we additionally have to make assumptions about the consumption levels of East Germans before reunification. With habit formation, consumption depends on past consumption, namely consumption one period lagged, C_{i-1}, and the initial "endowed" consumption, C_{t-1}. Hence, consumption adjusts slowly to the new optimal level after the increase in incomes associated with German reunification. In the meantime, saving rates are high and decreasing.

Since an easily interpretable equation of the difference in the saving rate between East and West German birth cohorts cannot be derived from equation 7, we show results from two simulations. In the first simulation, we assume a relatively weak habit motive of $\lambda = 0.1$, while in the second we assume a strong habit motive of $\lambda = 0.9$. Income is constant over the life cycle,[28] and East German cohorts are assigned with the estimated wealth levels at reunification. Endowed consumption levels for West Germans at the beginning of the life cycle are set such that the saving rate in the first period roughly corresponds to the saving rate of young West Germans of around 10% that we observe in the data. To achieve this, for the weak habit motive endowed West consumption equals $C_{t-1} = 0$,

[27] We follow the methodology developed by Alessie and Lusardi (1997) for the infinite horizon case, denoting $C_i^* = C_i - \lambda C_{i-1}$, and solving for the optimal C_i^* in a first step.

[28] As in the retirement model, a growing income path would lead West agents to borrow at some point during early life, unless the habit motive is implausibly large. Hence, this would make young East Germans actually better off than young West Germans.

while for the strong habit motive it equals $C_{t-1} = 0.9$. For East Germans, we assume that "endowed" consumption C_{t-1} corresponds to the consumption level in the last period before reunification. We set East German pre-reunification consumption equal to 75% of the consumption of West Germans of the same age, since this corresponds to the gap that we observe in the posession of durable goods in 1990 (see section 5.4.2). Figure 10 shows the resulting differences between the saving rates of East and West cohorts for the four birth cohorts born in 1960, 1950, 1940, and 1930, from 1991 to 2000.

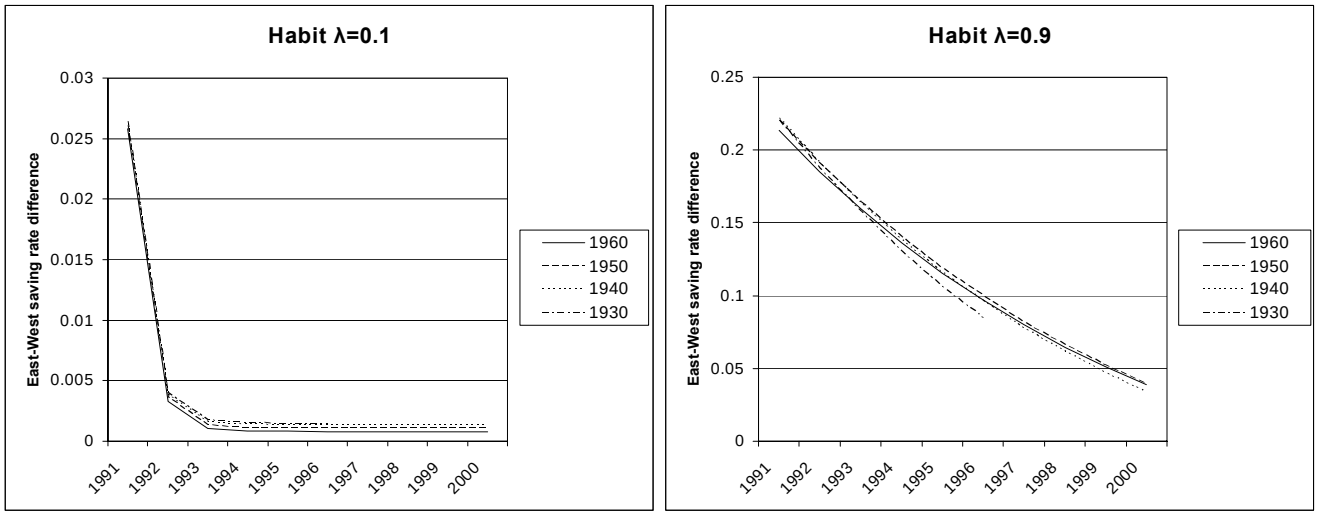

Figure 10: East-West difference in saving rates with weak and strong habit motive

The difference between the saving rates of East and West Germans is positive for all cohorts in the first years after reunification, and declining over the course of the 1990s. For a weak habit motive, the decline is very rapid, while for a strong motive it occurs more slowly. Initial differences are increasing in the strength of the habit motive. Under both a weak and a strong habit motive, there is no pattern in the saving rate gap for different cohorts. Under the current calibrations, the gap is virtually similar for all cohorts in the same year. In both simulations, consumption for West Germans is relatively flat except for the first periods of the life cycle. Since the consumption levels in the last period before reunification play a more important role than the wealth levels at reunification in determining the saving rates, the East saving rates immediately after reunification are also quite similar for all cohorts. This leads to similar saving rate gaps for different cohorts.

We conduct different sensitivity analyses with respect to the chosen parameter values. Only very rare configurations can generate a cohort ordering as seen in the data. Two crucial parameters are the strength of the habit motive, and the inital endowed consumption of West Germans. Only with a strong habit motive and endowed West consumption of zero is the model able to match all three stylized facts. However, in this case the cohort

ordering arises because West German consumption increases very slowly over the life cycle, resulting in implausibly high initial saving rates of up to 0.8. Moreover, a large habit motive seems relatively implausible. For example, Dynan (2000) and Guariglia and Rossi (2002) find indeed no significant evidence for any habit motive in a model similar to ours. We conclude that the ability of the habit formation model to match the stylized facts of a cohort ordering in the saving rate differences relies crucially on the strength of the habit motive, in combination with low endowed consumption for West households.[29]

The habit model might fair better in matching the cohort ordering, if older East German cohorts exhibit stronger habit than younger cohorts, because they lived under the socialist system for a longer time period. However, in the empirical analysis in section 5.4.2, we do not find evidence for stronger habits among older East cohorts.

5.4.1 Alternative income processes

The results from the baseline calibration do not change if East incomes rise immediately and permanently to a level 0.8 of West incomes. In the case of a strong habit, the inital saving rate differentials become more realistic, but a reverse cohort pattern arises. If we model gradual income adjustment over the first years after reunification, the initial saving rate differences are negative, since East Germans borrow in the first years after reunification. Last, assuming that the ratio of East to West incomes is larger for older cohorts also leads to a reversed cohort pattern.

5.4.2 Additional habit evidence

The idea of habit formation is contradicted by the behavior of the saving rate right around reunification. Sinn and Sinn (1991) report the saving rate in eastern Germany in the last quarter of 1989, and in 1990 (see figure 11). In the first two quarters of 1990, when wages and pensions were already rising sharply, but the currency union was not yet in place, the saving rate rose from 12.7% in the fourth quarter of 1989 to 18.4% and 22.4% in the first and second quarter of 1990. In June of 1990, the saving rate peaked at 39.5%, and plummeted immediately after the currency union to -9.3% in July and -9.7% in August. In the fourth quarter of 1990, it was already back at 13.4%. This sharp movement of the saving rate in 1990 could be explained by massive purchases of goods immediately after the implementation of the currency union, in contrast to habit formation.

We do the following additional exercise in order to get some intuition whether habit formation might play an important role in our data. In 1990, GSOEP asked East households

[29] We also conduct sensitivity analyses regarding the endowed consumption of East Germans. We assume that East consumption in the last period before reunification equals 45% of West consumption of the same birth cohort, based on nominal income differences at reunification, or rather the same cohort-specific percentage that we estimated for the wealth levels. The first case does not result in any cohort pattern, while in the second case a weak cohort pattern arises for the first years after reunification, and the cohort paths cross later on.

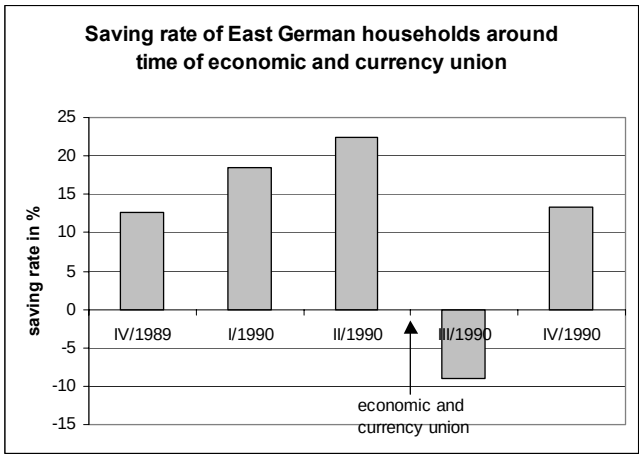

Figure 11: Saving rate of East German households, from last quarter of 1989 to last quarter of 1990.

about their relationships with households in West Germany. GSOEP provides information whether a household had friends or relatives in West Germany, whether these West Germans provided the household with presents, and the average yearly amount of presents in Deutsche Mark. Given the same income process, households with better connection to West households could potentially have achieved higher consumption levels through these presents, and should hence save less than their counterparts after reunification if habits are important. 84% of the sampled households had friends or relatives in West Germany, and 23% regularly received gifts. The average yearly amount of gifts conditional on receiving a gift was sizeable, namely 306 DM (around 150 USD).

Additionally, GSOEP provides data about certain durable consumption goods and housing conditions of East Germans in June 1990, i.e. one month before the introduction of the economic and monetary union, and four month before reunification. Most durable consumption goods, i.e. cars and telephones, were rationed in the GDR, and were often available only after long waiting periods or to persons favored by the government. Hence, even controlling for income, durable goods possession varied significantly in the population. Generally, because of the waiting periods, the older a household, the more likely was the possession of durable goods. While it would be preferable to have information on nondurable goods consumption to test for habit formation, under the strong assumption of the absence of adjustment costs the following predictions can be made. Holding income changes constant, households that had relatively high consumption levels experience smaller adjustments to their new optimal consumption levels, and should hence save less than their counterparts with lower initial consumption levels. To test this prediction, we include a dummy for car ownership in 1990 and two indices into the regression. One index is constructed by counting

and summing up possession of electronic goods in 1990. The second index counts possession of equipment associated with housing.[30] Habit formation would predict a negative coefficient on the interaction terms of both indices and the car ownership dummy with the East sample.

percentage of households equipped with good in 1990	West Germany	East Germany
car	89.0	71.7
electronic goods		
washing machine	91.5	43.7
color tv	95.9	77.4
freezer	86.4	66.9
housing equipment		
telephone	97.4	23.9
bath inside residence	98.8	91.4
hot water	99.2	95.2
toilet inside residence	98.7	87.6
modern heating system	91.7	65.1

Table 7:
Equipment of households with durable goods in 1990

Table 7 gives an overview of the equipment with durable goods in East and West Germany in 1990.[31] As one can see, the vast majority of households in West Germany was well equipped with durable goods in 1990, while the percentage of East German households equipped with the respective good was always lower, on average by 25 percentage points.

In the first column of table 8, we include the yearly amount of received gifts in the standard regression. This variable probably captures to a great extent nondurable goods. In the second column, we include as well both indices for electronic goods and household equipment, the car ownership dummy, and their interaction terms with the eastsample (all referring to ownership in 1990).[32] The sample size is reduced to 19,591, since not all households provided information on all goods, and some households were built only after 1990.

[30] Both indices just sum the dummy variables for possession, not assigning weights to the different goods. The electronic goods in the index all have prices of a similar scale.

[31] For West Germany, the values are either from 1991 or 1992, since the 1990 survey did not ask the relevant questions. It seems probable that the values did not change much over time.

[32] The usual controls and interaction terms are included, but not reported to save space. They did not change significantly.

Dependent variable	(i) log(saving)		(ii) log(saving)		(ii) log(saving)	
	Coeff.	Std. Err.	Coeff.	Std. Err.	Coeff.	Std. Err.
INCOME VARIABLE:						
log(income)	3.248	0.089***	3.132	0.091***	3.248	0.089***
log(income)*eastsample	0.827	0.143***	0.866	0.145***	0.823	0.142***
COHORT/AGE VARIABLES:						
cohort (year of birth-1900)	0.002	0.042	0.008	0.043	0.005	0.042
age	-0.259	0.196	-0.343	0.201	-0.155	0.204
age sq.	0.004	0.004	0.006	0.005	0.002	0.005
age cube (*10^{-3})	-0.020	0.033	-0.032	0.034	-0.005	0.034
COHORT/AGE INTERACTIONS:						
cohort*eastsample	-0.143	0.069**	-0.137	0.070**	-0.142	0.069**
age*eastsample	0.741	0.329**	0.844	0.328***	0.744	0.329**
age squared*eastsample	-0.021	0.008***	-0.023	0.007***	-0.021	0.008***
age cube*eastsample(*10^{-3})	0.167	0.057***	0.180	0.057***	0.168	0.057***
USUAL CONTROLS	yes		yes		yes	
USUAL CONTROLS INTERACTIONS	yes		yes		yes	
RELATIONS WITH FRG						
amount of gifts received (*10^{-3})	0.086	0.067	0.067	0.076	0.091	0.194
amount of gifts * middle age (*10^{-3})					0.053	0.201
amount of gifts * old age (*10^{-3})					-0.049	0.215
age group dummies					yes	
EQUIPMENT IN 1990						
car			1.149	0.173***		
electronic goods			-0.125	0.103		
housing equipment			0.751	0.171***		
EQUIPMENT INTERACTIONS						
car*eastsample			-0.299	0.238		
electronic goods*eastsample			0.366	0.134***		
housing equipment*eastsample			-0.702	0.183***		
obs	19,986		19,591			19,986
log likelihood	-37,080		-36,290			-37,080

Notes: Std. errors with an * indicates that the estimate is significant at 10% level, ** at 5% level, *** at 1% level

Table 8:
Habit formation evidence

test of H_0 :	(i) coefficient	(i) p-value	(ii) coefficient	(ii) p-value	(iii) coefficient	(iii) p-value
$\frac{\partial f(East*age_{i,t},\theta_{East})}{\partial age}(age=20)=0$	0.095	0.407	0.130	0.256	0.096	0.401
$\frac{\partial f(East*age_{i,t},\theta_{East})}{\partial age}(age=30)=0$	-0.077	0.299	-0.065	0.387	-0.077	0.304
$\frac{\partial f(East*age_{i,t},\theta_{East})}{\partial age}(age=40)=0$	-0.149	0.033	-0.151	0.031	-0.149	0.034
$\frac{\partial f(East*age_{i,t},\theta_{East})}{\partial age}(age=50)=0$	-0.121	0.082	-0.130	0.063	-0.120	0.085
$\frac{\partial f(East*age_{i,t},\theta_{East})}{\partial age}(age=60)=0$	0.008	0.923	0.000	0.999	0.010	0.898

Table 9:
Test of third prediction

The three predictions are still confirmed in this estimation (see tables 8 and 9). Turning to the variables of interest, we see that the coefficient on amounts of gifts received from friends and relatives in the FRG is not significant. This estimate is not in line with the theory of habit formation. This is probably the most exogenous measure of consumption levels, since whether a household had friends or relatives in the FRG should have been close to random in the East sample. Moreover, this measure best reflects non-durable consumption levels. In order to test whether habits are stronger for older cohorts, we also interact this variable with age group dummies, where "old age" refers to household heads aged 50 to 65, and "middle age" refers to household heads aged 35 to 49. As column (iii) shows, while the interaction term with old age is negative, the interaction term with middle age is positive, and all interaction terms are insignificant. Thus, we do not find any evidence for stronger habits among older cohorts.[33] Turning to the interaction terms in column (ii), the coefficient on electronic goods is positive and significant, while the interaction terms on housing equipment and car ownership are negative. The latter two results are in line with habit formation, while the first one runs against it. The negative coefficient on the interaction term with housing equipment is significant, while the negative coefficient on the car interaction term is not significant (p-value 0.21). However, the caveat applies that housing is associated with the largest adjustment costs and hence least suited to test for habits.

From the theoretical model, we concluded that only a strong habit model can generate all three stylized facts. The evidence towards habit formation from our empirical tests remains inconclusive, and at best very weak.

5.5 Demographics

The changing family composition over the working life, especially the presence of children in the household, changes the optimal household consumption pattern over time. As Attanasio

[33] This result also holds if we interact the amount of gifts received directly with age.

and Weber (1995) show, the logarithm of family size exhibits a pronounced hump-shape over the life cycle. They also find that, after controlling for demographics, consumption change does not react to income changes, in line with the certainty equivalence model. In the empirical estimates, we control for the number of adults and the number of children in the household (see table 2). Although the inclusion of the controls weakens the significance of the cohort pattern as well as the declining trend in the saving rate difference over time, they still arise significantly.

5.6 Durable goods purchases

Temporarily higher saving rates by East Germans might be due to durable goods purchases. The consumption flow from durable goods could only be raised by increasing the stock of durable goods. If households are credit constraint and the wealth levels are not high enough, they might have to save temporarily for durable goods expenditure.

While this line of argument might explain the two stylized facts of higher and declining relative saving rates of East Germans, it is less clear why the cohort pattern should arise based on this argument. Higher relative saving rates of older cohorts could be caused either by a higher new optimal stock of durable goods for older cohorts, by a lower endowed stock of durable goods for older cohorts, or by more stringent credit constraints for older cohorts. The first argument is not valid in a life cycle setting. Due to the higher wealth levels for younger households, and given the same permanent income, the optimal consumption level is higher for younger cohorts than for older cohorts. The second argument is improbable given typical increasing life cycle consumption paths, and it is especially improbable in the context of the GDR because of the long waiting periods often associated with purchases of durable goods. More stringent credit constraints for older cohorts are also not likely, since older East cohorts do not on average possess less wealth than younger East cohorts, and more stringent credit constraints should arise due to less collateral.

5.7 Other differences between East and West

Other differences between East and West Germans might have the effect that life cycle profiles are different in these two samples, hence invalidating the test of our third prediction in section 4.2. These could be differences in risk aversion or in the discount factor. It is difficult to argue whether risk aversion and discount factors were influenced by the different environments East and West Germans lived in for 40 years. Higher patience or higher risk aversion in the East sample could explain why the saving rates are generally higher in the East than in the West. However, both parameters should not necessarily give rise to a cohort saving pattern, neither to a decline in the East-West saving gap over time.

6 Conclusion

The natural experiment of German reunification allows us to discriminate between different consumption theories that can potentially explain the puzzle of consumption and income comovement over the life cycle by analyzing the saving behavior of East Germans relative to West Germans after the large economic shock of German reunification. We observe three stylized facts of the saving rate gap between East and West Germans. First, East Germans save more than West Germans over the decade of the 1990s. Second, this positive difference is larger the older the cohort. Third, for each cohort, the difference is declining over time. The strength of our test lies in the simultaneous presence of the three stylized facts. First, we notice that the precautionary saving model is robustly able to generate the three stylized facts. It is the only saving motive that is sufficient in isolation to qualitatively replicate the stylized features of the saving rate. Second, we can clearly reject rule of thumb behavior in our sample. Third, we do not find evidence that changes in the family composition over the life cycle cause the stylized facts. Last, we find only very weak evidence in favor of a habit formation model.

Some earlier studies using natural experiments and higher frequency data found evidence against rational consumption and saving behavior. We believe that this study comes to different conclusions due to the immense size of the shock, easily comprising several annual incomes for most East Germans. Reoptimization after reunification became necessary even if transaction costs, whether psychological or monetary, might have been large.

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Appendix

A Construction of saving rate

A.1 Financial saving

Positive financial saving is identified by a direct question regarding this item. We cross-checked the saving rate of positive financial saving over disposable income with the average saving rate given by the Bundesbank, and both are very similar (see figure 12). Hence, we are confident that this measure consists of deposits into bank accounts of various kinds (including building societies), and purchase of stocks and bonds, similar to the definition of the Bundesbank. Correspondingly, negative financial saving would be defined as withdrawal from bank accounts, and sales of bonds and stocks. Yet, we do not have this information, and accordingly our saving measure is left-censored for those who report zero financial saving. Last, financial saving should also comprise amortization of, minus take-up of, consumer loans. Questions about consumer loans were only added in 1997 to the survey, and they do not indicate the date and amount of a take-up, but only the sum of amortization and interest payments. Hence, we have to omit this category.[34]

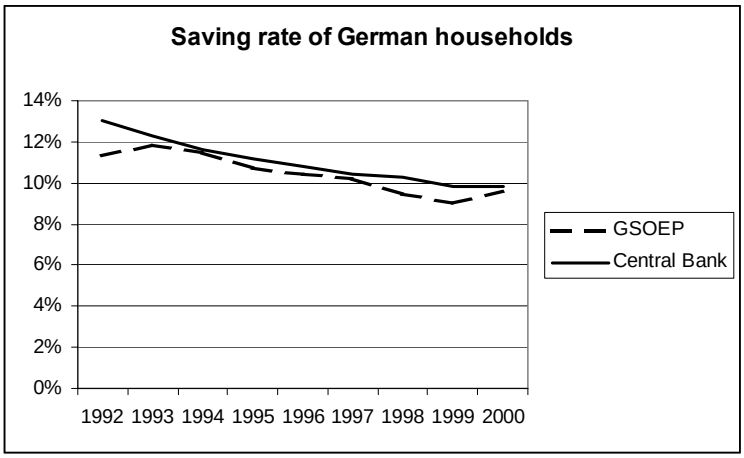

Figure 12: Average saving rate of German households, as provided by the Central Bank and constructed from our GSOEP sample.

[34] A certain fraction of these consumer loans is probably used to finance the purchase of durable household goods, and is paid back in the course of less than a year. For these loans, take-up and amortization fall into the same year, and hence overall saving associated with these loans is correctly set to zero. Moreover, consumer loans play a relatively small role in Germany. The average stock of houshold consumer debt amounted to 2533 DM in 1998 (Münnich, 2001).

A.2 Real saving

Real positive saving consists of purchase of real estate and amortization of mortgages, while negative real saving comprises sale of real estate and take-up of a mortgage. We do not have information about sales prices of housing. This is not problematic under the assumption that the amount acquired by the sale of real estate flows into financial saving or new real saving rather than consumption, thereby leaving the sum of saving at zero. Moreover, since the purchase of a house must be financed by financial dissaving and/or the take-up of a mortgage, the sum of these three saving measures also results in zero saving. Hence, in net the amortization of mortgage is the real saving measure we are interested in. We also assume that expenditure in upkeep and improvement of housing equals the depreciation of the house, and hence both categories of real saving sum to zero.[35]

To calculate the monthly amortization of a mortgage from the sum of interest and amortization payments, we make the following four assumptions. First, the borrower pays back the mortgage in constant annuity amounts. Second, the overall duration of the mortgage is 30 years, which is the average duration of mortgages in Germany (Eurohyp, 2002). Third, the interest rate on the mortgage is equal the average interest rate on 10 year fixed mortgages during the period 1971 to 2001, namely 8.25% (Rheinische Hypo Frankfurt, 2002). Fourth, interest accrues yearly. From these four assumptions, we can calculate the percentage of observed annuity payments that is due to amortization, depending on the time elapsed since taking on the mortgage. At the beginning of the mortgage, amortization accounts for a very small part of the annuity payment, while at the end almost all the annuity payment constitutes amortization. We assume that the start year of the mortgage is the year in which the owner moved into the house. If a household indicates that it purchased the house it was previously renting, we take the year of the purchase as the year the mortgage was taken up. For those individuals who report in a survey year that they became owner of the house they had already lived in before, we assume that the mortgage starts in the respective survey year. Given the year of the mortgage and the schedule of interest to amortization ratios, we can calculate the monthly amortization in Deutsche Mark from the reported amount of the annuity. Only this amortization amount is counted as real saving.

For those cases in which the calculated start date of the mortgage is more than 30 years ago, we proceed as follows. If the maximum year of mortgage in the survey years is bigger than 40, we assume that the calculation of the start date of the mortgage was wrong. For these payments, we proceed as described below for amortization payments for properties that are not owner occupied. If the maximum year is smaller than 40, we assume that we have the right start date, and that all payments in years of mortgage bigger than 30 consist entirely of amortization, since in fact the interest amount is probably very small.

The survey also reports interest and amortization payments for properties that are not owner occupied. Unfortunately, it gives no hint as to when these properties were acquired,

[35] There is one more form of real saving that we regard as minor in the German context and have to omit due to lack of data, namely the purchase, minus sale, of gold and jewelry.

and hence we cannot determine the start year of the mortgage. We therefore just assume that the ratio of interest to amortization in the annuity payment is equal to the median ratio of owner-occupied housing.

B Graphical analysis of East-West incomes

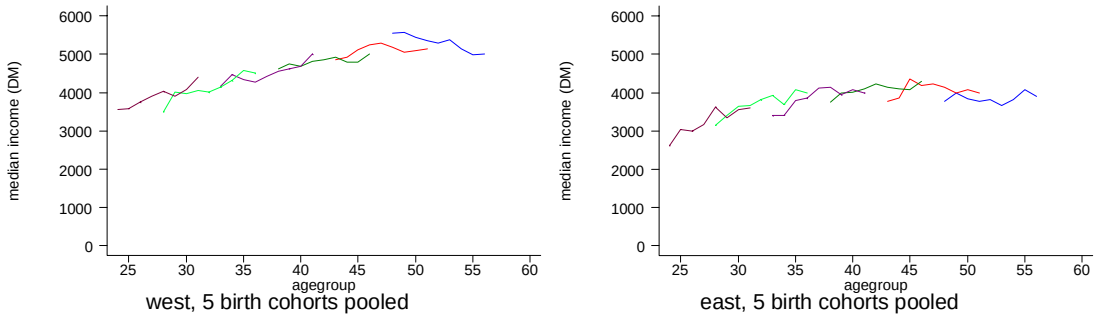

Figure 13: Cohort-age profiles of income in West sample (left panel) and East sample (right panel). Each solid line represents five adjacent birth cohorts

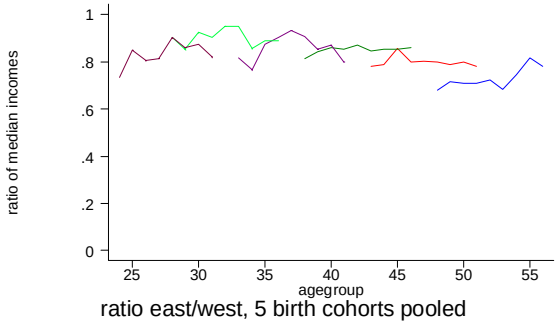

Figure 14: Cohort age profile of East-West ratio of income. Each solid line represents five adjacent birth cohorts

Figures 13 and 14 analyse cohort-age profiles of nominal net disposable household income for East and West Germans from 1992 to 2000.[36] West German nominal incomes were higher than East German nominal incomes over the observation period. Focusing on the ratios, one can see that they are rather flat or only slightly increasing over time for any given cohort. The ratio tends to be smaller for older cohorts, i.e. the income differences are larger for older cohorts. This motivates the third alternative income scenario, in which the ratio of East-West incomes is .9 for the youngest cohorts, and falls linearly to .7 for the oldest cohorts.

[36] The incomes are inflated to year 2000 values using different inflation rates for East and West up to 1999.

C Results from the Income- and Expenditure Survey

The *Einkommens- and Verbrauchsstichprobe* (EVS) is a cross-sectional household survey conducted every five years, covers around 60,000 households, and is considered to provide the most reliable measure of household wealth. Unfortunately, due to data access restrictions for researchers outside Germany we cannot work directly with the EVS, but rely on summary statistics reported in Münnich (2001). Figure 15 shows the change in financial wealth holdings of eastern and western German households for three different cohort groups, namely young, middle, and old, focusing on a similar cohort composition as we use in figures 6 and 7 (hence, the "old" are comprised by households up to age 55).[37] From 1993 to 1998, young households in East and West Germany accumulate on average the same amount of wealth, while the middle aged East households accumulate more wealth than West households, and the difference is largest for the old. This should translate into saving rate differences in the years in between that are positive and increasing in the age of the cohort, as found in GSOEP.

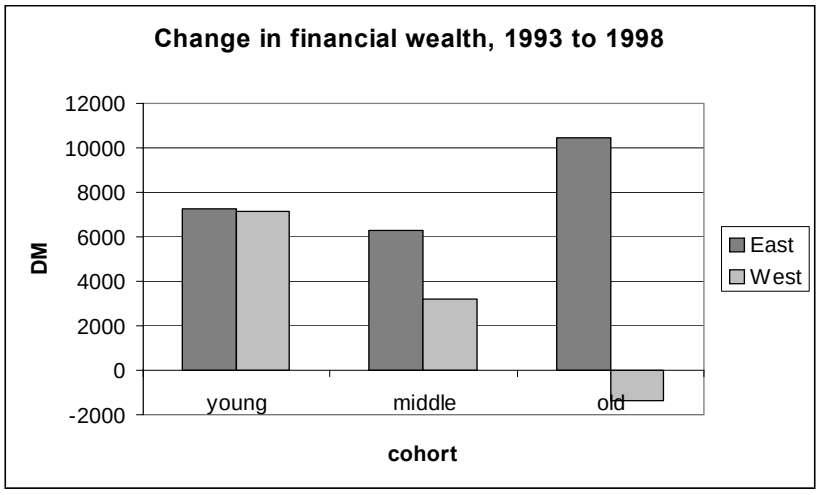

Figure 15: Change in average wealth holdings between 1993 and 1998 by cohort group from EVS

[37] Since the summary statistics are reported by age, not cohort, the cohort composition changes slightly over time: the young comprise household heads born between 1958 and 1968 in 1993, and between 1963 and 1973 in 1998. Similarly, the middle aged are cohorts born between 1948 and 1958 in 1993, and between 1953 and 1963 in 1998, while the old are born between 1938 and 1948 in 1993, and between 1943 and 1953 in 1998. In the EVS, East and West refers to current residence, not residence before the reunification.

D Risk estimation

Following the procedure described in Carroll and Samwick (1997), remove the predictable income growth component g to get the following model in logarithms: $y_t = p_t + \varepsilon_t$ and $p_t = p_{t-1} + \mu_t$.

It is easy to show that $Var\left(y_{t+d} - y_t\right) = d\sigma_\mu^2 + 2\sigma_\varepsilon^2$, since $y_{t+d} - y_t = \mu_{t+1} + \mu_{t+2} + ... + \mu_{t+d} + \varepsilon_{t+d} - \varepsilon_t$. Construct the unbiased estimate v_{id} of $Var\left(y_{i,t+d} - y_{i,t}\right)$ for household i as $v_{id} = \left(y_{i,t+d} - y_{i,t}\right)^2$. This holds since, after removing the predictable component of income growth g, $E\left(y_{i,t+d}\right) = y_{i,t}$.

To identify σ_μ^2 and σ_ε^2 separately, construct v_{id} for all households i and all distances $d > 2$. σ_μ^2 and σ_ε^2 are the resulting coefficients in the regression $v_{i,d} = d\sigma_\mu^2 + 2\sigma_\varepsilon^2 + u_{i,d}$. By focusing on $d > 2$, the estimates will be consistent in the presence of serial correlation of the order MA(2) in ε_t.

E Summary statistics

Variable	West sample			East sample		
	Obs.	Mean / Per cent	Std. Dev.	Obs.	Mean / Per cent	Std. Dev.
saving rate	14,874	0.118	0.116	9,085	0.132	0.137
income	14,874	4,908	2,451	9,085	3,957	1,755
age	14,874	42.2	9.8	9,085	42.4	9.2
children	14,874	0.91	1.01	9,085	0.87	0.92
adults (age>16)	14,874	2.19	1.01	9,085	2.40	1.04
sex (male=1)	14,874	72.8 %		9,085	54.1 %	
married	14,874	65.5 %		9,085	72.9 %	
divorced	14,874	14.3 %		9,085	13.6 %	
std. dev. individual income	14,762	963	866	9,032	811	577

Note: monetary values are in DM, inflated to 2000 values (1 DM approx. 0.5 Dollar)

Table 10: summary statistics

	nominal employees' compensation East/West	nominal household incomes East/West	nominal pension household incomes East/West	inflation rates (CPI) East/West
1991	0.493	0.57	0.74	n.a.
1992	0.619	0.68	0.83	2.61
1993	0.692	0.76	0.92	2.41
1994	0.726	0.81	0.98	1.34
1995	0.752	0.83	1.03	1.12
1996	0.758	0.85	1.08	1.27
1997	0.761	0.85	1.09	1.20
1998	0.763	0.85	1.10	1.14
1999	0.773	0.85	1.12	0.62
2000	0.775	n.a.	n.a.	n.a.
2001	0.776	n.a.	n.a.	n.a.

Source: Arbeitsgemeinschaft deutscher wirtschaftswissenschaftlicher Forschungsinstitute e. V. (2002), Federal Statistical Office, Sinn (2002), ifo Wirtschaftskonjunktur, 7/1999
Note: Values for nominal pension household incomes are taken from figure 1 in Sinn (2002) and are approximate. The federal statistical office stopped reporting CPI separately for East and West in 2000.

Table 11: East-West ratios of incomes and inflation rates, 1991-2001

	hourly gross wage in manufacturing (DM) 1998	disposable income p.c. (in 1000 DM) 1999
Berlin	26.62	27.8
WEST		
Baden-Württemberg	27.94	33.3
Bayern	25.92	31.3
Bremen	29.69	34.0
Hamburg	29.79	32.1
Hessen	27.67	30.1
Niedersachsen	29.29	29.7
Nordrhein-Westfalen	26.94	32.0
Rheinland-Pfalz	26.90	29.4
Saarland	27.57	29.3
Schleswig-Holstein	26.32	30.1
EAST		
Brandenburg	20.23	25.9
Mecklenburg-Vorpommern	19.89	24.7
Sachsen	19.30	25.9
Sachsen-Anhalt	19.65	25.1
Thüringen	18.65	25.7

Source: Arbeitskreis VGR (2002) and Institut der Deutschen Wirtschaft (1999, 2000)

Table 12: Wages and disposable income, by federal state

	Unemployment rates (in %)	
	Western Germany	Eastern Germany
1992	5.9	15.4
1993	7.3	15.1
1994	8.2	15.2
1995	8.3	14.0
1996	9.1	15.7
1997	9.8	18.1
1998	9.4	18.2
1999	8.8	17.6
2000	7.8	17.4
2001	7.4	17.5
2002	7.9	18.0

Source: Federal Statistical Office

Table 13: Unemployment rates in eastern and western Germany, 1992-2002