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## The Role of Education and Household Composition for Transitory and Permanent Income Inequality. Evidence from PSID Data

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# RUHR

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Johannes Ludwig

## **The Role of Education and Household Composition for Transitory and Permanent Income Inequality**

**Evidence from PSID Data**

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Johannes Ludwig<sup>1</sup>

# The Role of Education and Household Composition for Transitory and Permanent Income Inequality

Evidence from PSID Data

## Abstract

*Transitory and permanent shocks to income have been shown to be important determinants of household consumption. This paper shows that there are significant differences in the development of transitory and permanent inequality of household income between demographic groups since the 1980s. Using data from the Panel Study of Income Dynamics the educational attainment and the composition of a household are found to play a key role. While permanent inequality increases steadily for educated households, it is flat over large parts of the sample period for the less educated households. Transitory inequality increases for all households headed by couples whereas it is constant for single households. Taken together, permanent shocks explain on average a larger part of the income variance of educated households whereas transitory shocks are relatively more important for the less educated. These results that can be explained by changes to skill demand and an increased female labor force participation are potentially able to explain empirical findings on the transmission of changes in income inequality to consumption inequality.*

*JEL Classification: D31, E24*

*Keywords: Income inequality; transitory and permanent inequality; income dynamics*

*March 2014*

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# 1 Introduction

There is a broad consensus that income inequality in the US has risen drastically since the beginning of the 1980s (see e.g. Autor et al. 2008, Heathcote, Perri & Violante 2010, for a different view see Sabelhaus & Song 2010). However, only few authors make use of the insight of Moffitt & Gottschalk (1995) that the measured income inequality consists of two components evolving differently over time: inequality due to permanent differences of household income at a certain point in time and inequality due to transitory income fluctuations of a certain household over time. This paper shows that in the last three decades the evolution of transitory and permanent inequality of net household income differs significantly between groups of different educational attainment and household composition.

It is important to disentangle the different elements of overall income inequality to better understand the reasons behind its enormous increase. The increase in permanent differences is mostly explained by skill-biased technical progress and increased international trade, whereas the increase in transitory fluctuations is believed to be due to a rise in job and firm instability (Ziliak et al. 2011). Differences between groups found can then help to understand how the importance of the reasons differs according to educational status or household composition.

Furthermore, it has been shown empirically by Blundell et al. (2008) that the differentiation between permanent and transitory inequality is also important for welfare analysis. Based on the permanent income hypothesis an increase in overall income inequality should lead to an equivalent increase in the inequality of consumption. Blundell et al. (2008) demonstrate that this is not the case in the US in the 1980s because only permanent changes to income are found to translate into household consumption whereas transitory fluctuations do not affect the consumption level. The question if the importance of permanent and transitory inequality differs between population subgroups is important since Krueger et al. (2010) have found that changes in income inequality translate differently into consumption inequality for households in the upper and lower part of the income distribution. Similar evidence has recently been found by Meyer & Sullivan (2013).

The data used stems from the Michigan Panel Study of Income Dynamics (PSID). The variances of transitory and permanent net household income for the various groups are identified by using the moments in levels as proposed by Moffitt & Gottschalk (1995) and in differences as proposed by Meghir & Pistaferri (2004). Both procedures are necessary, since Daly et al. (2013) have recently shown that transitory variances estimated in levels and permanent variances estimated in differences are biased when unbalanced panel data is used.

All demographic groups are shown to suffer from considerable increases in overall residual income inequality. However, the subgroup analysis can show that there are significant differences between groups. Higher educated households experience a drastic steady rise in permanent income inequality while less educated households are not only characterized by smaller increases but even do not show any increase in permanent inequality between 1985 and 2002. The development of transitory inequality on the contrary is affected significantly by household composition. All couple households experience an increase in transitory fluctuations during the last three decades whereas I do not find any evidence for a positive trend in transitory inequality for households headed by singles.

By relating the size of transitory and permanent inequality to each other for the groups it can be shown that the composition of overall income variance differs considerably between education groups. For the less educated households transitory shocks to income account for a larger share of the overall residual variance in comparison to educated households where permanent shocks clearly dominate. As transitory shocks are usually found to be more easy to insure, this evidence can explain why income inequality translates to a

higher degree into consumption inequality at the upper end of the income distribution as found by Krueger et al. (2010) and Meyer & Sullivan (2013).

As has been proposed by Lemieux (2006), I also check for the importance of composition effects for the development of aggregate inequality. However, despite the fact that single households and educated households become more numerous over time, the estimated composition effects are found to be rather small. At the beginning of the sample period the differences in inequality levels between educated and less educated groups are still small such that composition effects merely become important towards the end of the sample period.

My results concerning permanent inequality are well in line with recent evidence on the effects of technical progress and computerization on income distribution. Among others Autor et al. (2008) show that a process of “polarization of work” has a non-monotone effect on skill demand that increases income inequality in the upper part of the income distribution, but not necessarily in the lower part of the income distribution. The result that permanent inequality increases more strongly for the highly educated fits into this picture as those households are also likely to be in the upper part of the income distribution. Differences in transitory inequality between single and couple households found can be explained by an increase in female labor force participation. If more and more couple households are characterized by two earners, there is an additional source of transitory fluctuations which is absent in single households.

The paper is organized as follows. Chapter 2 summarizes the most important findings on transitory and permanent inequality. Based on these the hypotheses for the empirical investigation are presented in Chapter 3. In Chapter 4 I present the construction of the dataset and the sample selection whereas Chapter 5 describes the methodological aspects: the income process, the identification of transitory and permanent inequality and the definition of population subgroups. The empirical results – descriptive statistics and the figures for transitory and permanent inequality – are described in Chapter 6. I also test whether the results depend on the parametric income model chosen. Chapter 7 investigates how important composition effects are for the aggregate. Finally, Chapter 8 discusses the results with regard to the hypotheses and Chapter 9 concludes.

## 2 Characteristics of Transitory and Permanent Inequality

Although there is some discussion about the precise timing, most authors agree that transitory inequality of male earnings has been increasing since the beginning of the 1970s until the mid-1980s. Thereafter, it ceases to increase, is mostly found to be flat or slightly declining (Ziliak et al. 2011, Moffitt & Gottschalk 2012). The original finding of Moffitt & Gottschalk (1995) was that permanent and transitory inequality of male earnings contribute roughly equally to the rising earnings inequality between 1970 and 1990. Gottschalk & Moffitt (2009) extend the sample until 2004 and find that after 1990 permanent earnings inequality increases further until the end of the sample whereas transitory inequality is flat. Thus, the share of transitory variation in overall earnings inequality drops. The transitory variation of total household income, on the contrary, is found to increase rather constantly throughout the last three decades (Gottschalk & Moffitt 2009, Dynan et al. 2012). However, using administrative data DeBacker et al. (2013) have recently found that since the end of the 1980s permanent inequality of total household income increases much more strongly and accounts for the vast majority of the increase in overall inequality.

The main reasons for the increase in permanent income inequality are well-known and broadly discussed – skill-biased technical progress and increased international trade are the most prominent factors mentioned (see e.g. Autor et al. 2008). There is far less consensus on the precise reasons for the increase in transitory



income inequality. Most authors conjecture that labor market and business cycle effects drive the observed patterns since transitory fluctuations of earnings are found to be positively correlated with the unemployment rate (Moffitt & Gottschalk 2002, Hacker & Jacobs 2008). Ziliak et al. (2011) show that a declining job stability in the US labor market that increases transitions between employment and unemployment is an important factor contributing to male earnings volatility. Other reasons mentioned are a declining firm stability due to increased international competition, a higher importance of bonuses and overtime labor compensation and a higher share of self-employed workers with more unstable earnings profiles in the labor force (Gottschalk & Moffitt 2009).

How does the educational attainment influence transitory and permanent inequality of income? Hacker & Jacobs (2008) and Dynan et al. (2012) find that transitory variance of total family income is higher the lower the level of education. As low educated household members are unemployed more often, their income fluctuates on average more over time. However, they both do not find any difference in the growth rate of transitory inequality between education groups. Meghir & Pistaferri (2004) as well as Blundell et al. (2008) investigate the development of permanent income inequality. Both articles find that the level of the permanent variance – contrary to the transitory variance – is highest for the high educated groups. Meghir & Pistaferri further show that the series are decreasing for the high educated and increasing for the low educated while the trends in Blundell et al. are less clear. Note that both studies do not investigate the development after 1990.

My analysis differs from the aforementioned as the literature on transitory and permanent inequality has mostly used individuals as units of observation and (male) labor earnings as variable of interest. Some studies interested in total family income have examined only married couples. Since economic decisions like consumption and savings are made at the household level based on net household income, I have decided to use the household as the unit of observation and net household income as my variable of interest. Further, I examine all kinds of households. This has mainly two advantages: First, it will yield a more representative picture of the importance of transitory and permanent inequality for the US economy. Second, I will be able to determine how the two elements of income inequality differ between single and couple households. The latter aspect has not been studied before to the best of my knowledge.

Moreover, most authors only estimate variances in levels *or* in differences. This is not sufficient since the data sources used are usually unbalanced panels. Daly et al. (2013) have shown that unbalanced panels suffer from non-classical measurement error that biases transitory variances estimated in levels and permanent variances estimated in differences upward. Thus, both procedures are necessary to obtain unbiased results.

### 3 Hypotheses

A fraction of permanent income differences can always be explained by permanent differences in observable characteristics and a fraction of transitory fluctuation is due to temporary changes in the observables. As these explainable effects are of minor interest to me, I will filter them out by using regression residuals as dependent variables. Income inequality in the following therefore always has the character of residual inequality.<sup>1</sup>

Which results should be expected from the following empirical investigation? In general, if total household income is used as a variable of interest, all of its components (labor earnings of head, spouse and other household members, asset income, transfer income, taxes) can contribute to the overall transitory fluctuation.

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<sup>1</sup>Some studies like Moffitt & Gottschalk (1995) study the effect of using income levels as a variable of interest in comparison to using residuals. Their result is that using income levels does not change the main results found, but just increases the level of permanent income variation.

Thus, households with more sources of income will differ from households that only rely on the labor earnings of the household head. Households headed by couples are on average more likely to have several sources of income (income of spouses, income of adult children, government transfers directed towards families with children) compared to households headed by singles. Hence, the correlation between the different transitory shocks will determine if the transitory fluctuations of overall household income is higher for couple households compared to single households. Many economists have found that families use different income sources as an insurance to shocks (see e.g. Heathcote et al. 2009), i.e. that the correlations between the different transitory shocks are negative. Thus, it should be expected that the transitory variances are smaller for couple households compared to single households.

For permanent differences two different effects have to be weighted. On the one hand the different sources of household income are usually correlated positively. The spouse of a higher-income earner is more likely to also have a high income which increases permanent differences of household income for couples compared to singles. This could also be the case for permanent inequality in *residual* income. Differences in residual income are typically explained by demand for unobserved skills: If the head is very motivated, this could increase the motivation of the spouse. However, for the residuals of the different income sources this effect is probably rather small. On the other hand there are wealth effects reducing permanent differences for couples. If the head of the household has a very high residual income, additional earnings of the spouse become unnecessary. If the head has a negative residual income, additional earnings of the spouse are needed to reach an average income. Thus, a priori it is unclear if households headed by couples have higher permanent inequality compared to those headed by singles, but it is likely that the wealth effects outweigh the positive correlation of residual incomes. Then, permanent inequality will also be higher for singles compared to couples.

*H1: Both the level of transitory and permanent inequality are higher for households headed by singles compared to households headed by couples.*

The development of the influence of education over time has already been studied for transitory inequality by Hacker & Jacobs (2008) and Dynan et al. (2012) who find an increase of comparable size for all education groups. The effect of education on permanent residual inequality is dependent on the demand for unobservable skills. It seems reasonable to assume that the demand for unobserved factors like motivation or ability is higher in white-collar jobs where the result of the work cannot be monitored directly. Thus, permanent differences of residual income should be higher at least for high-educated singles and one-earner couples compared to the less educated. The same is true for two-earner couples as long as the importance of wealth effects does not differ largely between education groups. This consideration is in line with the finding that the level of permanent income inequality is higher in high educated groups (Meghir & Pistaferri 2004, Blundell et al. 2008).

To determine the development over time information is needed on the change in demand for unobserved skills. If it increases, the price of unobservables rises and permanent inequality should rise as well. There is empirical evidence that the demand for unobserved skills has risen since the beginning of the 1980s (Juhn et al. 1993, Gosling et al. 2000). If this increase is enduring and more pronounced in the white-collar sector, it raises wages for well-educated workers endowed with a high level of unobservable skills and permanent inequality should rise faster in this group.

*H2: Over time permanent income inequality increases faster for the high educated groups.*

Finally, it is well-known that the overall composition of the labor force changed significantly during the

last thirty years: The share of households with high educational degrees increased strongly and the share of households headed by singles expanded as well. Since I expect differences between educational groups and between single and couple households, compositional changes of the workforce should exhibit aggregate effects. Concerning permanent inequality the increase in educated households and in households headed by singles will have an additional increasing effect as more households enter groups with higher permanent differences.

*H3: Compositional changes exhibit a positive effect on aggregate permanent inequality.*

The effect on transitory inequality is unclear. A higher share of single households increases aggregate transitory inequality, a higher share of educated households has the opposite effect. Estimating the contribution of compositional changes to aggregate transitory inequality allows to check which effect dominates.

## 4 The Data

The Panel Study of Income Dynamics (PSID) is a widely used dataset that is popular especially due to its focus on a wide variety of different household income types. In addition, since the start of the dataset in 1968 it also contains information on health, family composition and other socio-economic indicators. The first sample of 5,000 families consisted of one part of 3,000 nationally representative households and another part of 2,000 households with lower incomes, the so-called Survey of Economic Opportunities (SEO). All individuals that lived in one of the 1968-sample families or that later became part of one have been followed even if they left the original sample household. To enhance representativeness two new samples were introduced during the 1990s, the Latino and the Immigrant sample. Until 1997 yearly interviews have been conducted with the sample households while since 1999 information is collected on a biennial basis (for more information see PSID Main Interview User Manual 2012).

The starting point of the investigation is the panel wave of 1978 since I am interested in the last three decades and I use two years for starting conditions. All observations up to 2009 are included in the sample. The variable of interest is household net income since it comprises best the resources available to the household that can be used for consumption and savings. Thus, I construct this variable as total household money income minus federal income taxes for head and spouse and minus federal income taxes for other family unit members. By definition, the head of a couple household is always male and the spouse is always female.

Most studies in this field use gross household income as variable of interest as federal income taxes for head and spouse as well as for other family unit members are only available in the PSID up to 1991. I simulate federal tax payments for the following years using NBER TaxSim (see appendix A1 for further details on tax simulation, the construction of the dataset and sample selection). I also deflate all income variables and use equivalence-weighting to control for the effects of household size. The households studied are those where the heads are in working age, i.e. between the age of 25 and 65. The final sample consists of 14,048 households and 115,293 observations.

## 5 Methodological Framework

### 5.1 The Income Process

In the following I use the income definition of Blundell et al. (2008): Real log income  $Y_{i,t}$  can be decomposed into a part that is explained by observable characteristics  $X_{i,t}$  and an unexplained part. The unexplained

part can then be separated into a permanent component  $P_{i,t}$  and a transitory component  $\nu_{i,t}$ . The goal of this specification is to disentangle mean-reverting shocks to income – the transitory part – from shocks that are non-mean-reverting – the permanent part:

$$\log Y_{i,t} = X_{i,t}\varphi_t + P_{i,t} + \nu_{i,t}.$$

It is intuitive that the permanent component of the overall shock is modeled as a random walk where the innovations are serially uncorrelated. In this specification the innovations  $\zeta_{i,t}$  are carried over from period to period and have a long-lasting effect on residual income:

$$P_{i,t} = P_{i,t-1} + \zeta_{i,t}.$$

The transitory part of residual variance follows an MA-process of order  $q$  because this specification allows the influence of the innovations  $\epsilon_{i,t}$  to die out after some a priori unknown amount of time:

$$\nu_{i,t} = \epsilon_{i,t} + \sum_{j=1}^q \theta_j \epsilon_{i,t-j}.$$

As mentioned before, most of the paper will be concerned with residual income  $y_{i,t}$ :

$$y_{i,t} = \log Y_{i,t} - X_{i,t}\varphi_t = P_{i,t} + \nu_{i,t}.$$

The definition of the growth in residual income

$$\Delta y_{i,t} = \zeta_{i,t} + \Delta \nu_{i,t}$$

is helpful to ascertain the order  $q$  of the moving average-process empirically. As it is assumed that  $\zeta_{i,t}$  and  $\epsilon_{i,t}$  are not only serially, but also mutually uncorrelated series of innovations, the number of autocovariances of residual income growth that are statistically different from zero determines the order  $q$  of the MA-process in transitory income. If the transitory part of residual income is e.g. an MA(1)-process, then  $Cov(\Delta y_{i,t}, \Delta y_{i,t+2}) = -\theta_1 Var(\epsilon_{i,t})$  needs to be statistically different from zero whereas  $Cov(\Delta y_{i,t}, \Delta y_{i,t+3}) = 0$ . Note that the results for  $q$  found in the literature are usually low. Orders higher than two have rarely been found.

Table 1 summarizes the variance and the three first autocovariances of unexplained income growth. It is only possible to calculate income growth up to 1996 as afterwards the underlying PSID data changes to a biennial frequency and first differences cannot be calculated. Data should be sufficient, though, to determine the income process.

All variances of income growth are positive and significantly different from zero. They are first increasing until 1985 and are slightly declining during the later 1980s. This pattern has already been discovered by Blundell et al. (2008) and is in perfect accordance with their results. Their sample ends with a jump upward in 1992 which can also be found in my data. First-order autocovariances are all negative and statistically different from zero. Second- and third-order autocovariances are close to zero, mostly insignificant and often switching algebraic signs, all higher-order autocovariances look very similar. Any MA( $q$ )-process in the transitory income part would imply autocovariances of order  $q+1$  to be significantly different from zero. Thus, the estimates indicate that the underlying income process can be described best by a simple idiosyncratic

Table 1: Variance and Autocovariance of Income Growth

Year	$Var(\Delta y_{i,t})$	$Cov(\Delta y_{i,t}, \Delta y_{i,t+1})$	$Cov(\Delta y_{i,t}, \Delta y_{i,t+2})$	$Cov(\Delta y_{i,t}, \Delta y_{i,t+3})$
1978	-	-	-	-
1979	0.1195***	-0.0402***	-0.0014	-0.0049
1980	0.1046***	-0.0414***	0.0013	0.0032
1981	0.1144***	-0.0446***	-0.0061*	-0.0007
1982	0.1197***	-0.0516***	0.0014	-0.0002
1983	0.1275***	-0.0474***	0.0046	0.0023
1984	0.1234***	-0.0518***	-0.0066*	-0.0016
1985	0.1442***	-0.0454***	-0.0038	-0.0045
1986	0.1317***	-0.0519***	-0.0014	0.0011
1987	0.1268***	-0.0497***	-0.0010	0.0006
1988	0.1356***	-0.0600***	-0.0045	-0.0044
1989	0.1281***	-0.0400***	0.0023	-0.0025
1990	0.1310***	-0.0559***	0.0012	-0.0073*
1991	0.1389***	-0.0556***	-0.0008	0.0042
1992	0.1671***	-0.0780***	-0.0092*	-0.0034
1993	0.1859***	-0.0759***	0.0009	-0.0024
1994	0.1779***	-0.0624***	-0.0136**	-
1995	0.1725***	-0.0635***	-	-
1996	0.1758***	-	-	-

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\*  $p < 0.05$ , \*\*  $p < 0.01$ , \*\*\*  $p < 0.001$

transitory shock that does not show any moving average-behavior. The resulting income process

$$\log Y_{i,t} = X_{i,t} \varphi_t + P_{i,t} + \epsilon_{i,t}$$

is a special case since  $\epsilon_{i,t} = \nu_{i,t}$ . Hence, there is no difference between the overall transitory shock to income and the transitory innovation.

## 5.2 Transitory and Permanent Inequality

Moffitt & Gottschalk (1995, 2002) have pointed out that the variance of the permanent shock to income  $P_{i,t}$  can be estimated using the levels of residual income. For  $q = 0$ , the following relationships can be set up:

$$\begin{aligned} Cov(y_{i,t}, y_{i,t+1}) &= Var(P_{i,t}), \\ Var(y_{i,t}) - Var(P_{i,t}) &= Var(\epsilon_{i,t}). \end{aligned}$$

This simple procedure delivers an overview over the trends in transitory and permanent income inequality and is therefore popular in macroeconomic applications (e.g. Heathcote, Storesletten & Violante 2010). Starting with Abowd & Card (1989) labor economics have a long tradition of estimating variance-covariance relationships in first differences. In this spirit Meghir & Pistaferri (2004) have developed a procedure to identify the variances of transitory and permanent innovations using the first differences of residual income.

In the case of a simple idiosyncratic transitory shock the variances are identified by:

$$\begin{aligned} Cov(\Delta y_{i,t}, \Delta y_{i,t+1}) &= -Var(\epsilon_{i,t}), \\ Cov(\Delta y_{i,t}, \Delta y_{i,t-1} + \Delta y_{i,t} + \Delta y_{i,t+1}) &= Var(\zeta_{i,t}). \end{aligned}$$

In principle these covariance relationships suffice to identify the variances of the permanent and transitory innovations. However, one complication encountered when using the PSID as a data source is the fact that the dataset changes to a biennial frequency after 1997. Thus, it is not possible to make use of the first difference  $\Delta y_{i,t}$  after 1997 as only the observations in  $t-2$ ,  $t$  and  $t+2$  are available. Therefore I define:

$$\Delta_2 y_{i,t} = y_{i,t} - y_{i,t-2} = \zeta_{i,t} + \zeta_{i,t-1} + \Delta_2 \nu_{i,t}.$$

This definition is helpful to estimate transitory and permanent variances in the years where only biennial values on income are available. Depending on the order  $q$  of the MA-process, similar relationships as before can be set up. For the simple idiosyncratic shock ( $q=0$ ):

$$\begin{aligned} Cov(\Delta_2 y_{i,t}, \Delta_2 y_{i,t+2}) &= -Var(\epsilon_{i,t}), \\ Cov(\Delta_2 y_{i,t}, \Delta_2 y_{i,t-2} + \Delta_2 y_{i,t} + \Delta_2 y_{i,t+2}) &= Var(\zeta_{i,t}) + Var(\zeta_{i,t-1}). \end{aligned}$$

With this procedure there is no way to identify the single variance of permanent innovation in year  $t$ , only a sum of the variances of the current and the year before can be estimated. However, this sum should be sufficient to get an idea about the general trend of the variance of permanent innovations. Heathcote, Perri & Violante (2010) use a similar procedure for PSID data.

In theory, the transitory variances identified from income levels and from second differences should be identical. However, it is a well-known fact in the literature that for the kind of income model used here the estimation of transitory and permanent income variances produces different results when it is executed in levels and in differences. Estimation in levels usually yields higher values for the variance of transitory innovations while the estimation in differences yields higher values for the variance of permanent innovations. This result has been found by researchers using PSID data (Heathcote, Perri & Violante 2010) as well as by researchers using other data sets (Fuchs-Schuendeln et al. 2010, Brzozowski et al. 2010, Domeij & Flodén 2010).

In a recent working paper Daly et al. (2013) show that the source of this divergence is twofold. First, the two methods use different sets of information. While estimation in levels uses only information from the periods  $t$  and  $t+1$ , estimation in differences also uses information from period  $t-1$ . Second and even more important, also the use of unbalanced panel data is responsible for the deviations. When units of observation enter the dataset later or leave it earlier, they usually have a lower annual income. Daly et al. therefore assume that earnings in the first and last period of working age are significantly smaller and more volatile. Further, they treat income observations around missing values as non-random. They show theoretically that these additional assumptions on the income process can explain the differences found in empirical studies between transitory and permanent variances estimated in levels and in differences. Their conclusion is that in case only unbalanced panel data is available transitory variances are estimated reliably in differences since there is no bias stemming from their extended income model. Furthermore, their empirical examination demonstrates that although the variances of permanent innovations are theoretically biased when estimated in levels, this bias is quantitatively negligible. Thus, they recommend that in practice the estimates in differences should be considered for transitory variances and the estimates in levels for permanent variances.

### 5.3 Population Subgroups

Finally, it needs to be specified how to differentiate between highly and less educated individuals. I have decided to use only the two classes “at least some kind of college education” and “only high school education or less”. Thus, twelve years of education marks the cut-off value. Other categorizations can be thought of: Meghir & Pistaferri (2004) use three groups, Hacker & Jacobs (2008) use four. These authors use individuals as their unit of observation and therefore do not need to differentiate further. As households are the unit of observation here, it is necessary to separate households headed by couples from households headed by singles who behave differently. Thus, to have a sufficient amount of observations in each year-group cell and to keep things tractable it is differentiated between five different groups:

- Households headed by a couple where both partners have more than 12 years of education (in the following: C2-group)
- Couple households with only one partner having more than 12 years of education (C1-group)
- Couple households with no “highly educated” partner (C0-group)
- Single households where the head is “highly educated” (S1-group)
- Single households where the head is “less educated” (S0-group)

I also experimented with splitting up the C1-group into (i) households in which only the head has more than 12 years of education, and (ii) households in which only the wife does. I find that these two groups show similar characteristics and are both rather small. Thus, I have decided not to distinguish between them. As individuals with a high school degree often differ from those with less than high school education, I checked as well how dividing up the S0-group into these two subgroups changes the main results of the paper. However, either the two groups do not differ significantly or the respective groups become too small to provide reliable results. Hence, it is not differentiated between them.

Table 2 shows the unweighted number of observations in the single groups, in total and in selected years.

Table 2: Number of households in the demographic groups

	1978	1990	2008	All years
Full sample	3,591	4,275	5,240	104,029
C2-Group	427	902	1,377	21,259
C1-Group	496	787	906	17,874
C0-Group	1,432	1,159	930	28,504
S1-Group	285	534	1,003	13,930
S0-Group	951	893	1,024	22,462

## 6 Results

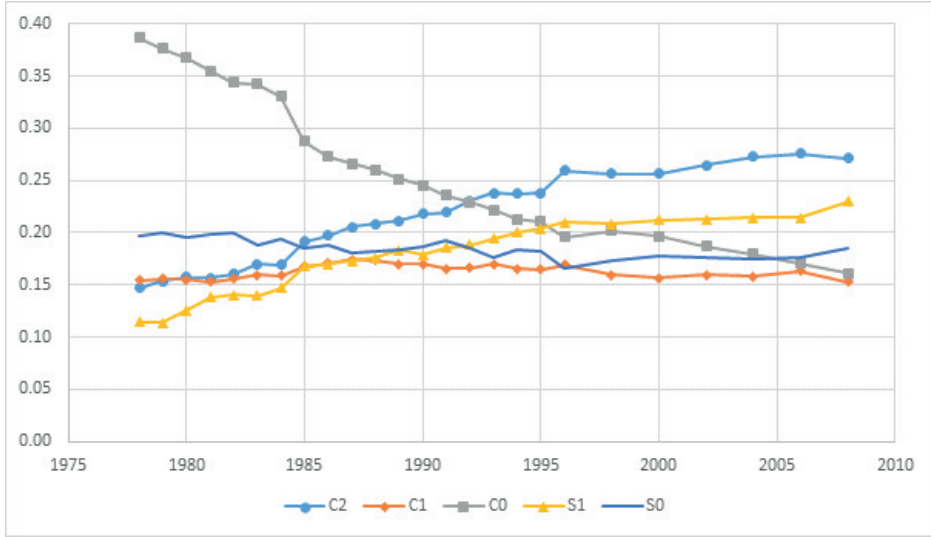
### 6.1 Descriptive Results

Figure 1 depicts how the size of the demographic groups changes over time<sup>2</sup>. In 1978 the C0-group is by far the largest group in the economy, encompassing nearly 40% of the sample population. In the following

<sup>2</sup>Differences to the values in Table 2 stem from the use of survey weights.

this group shrinks dramatically while the more educated S1- and C2-groups – the smallest groups in 1978 – steadily grow until they are the largest groups at the end of the sample. The two remaining groups, C1 and S0, are more or less flat over time and do not show any particular trend.

Figure 1: Population Shares of Education Groups



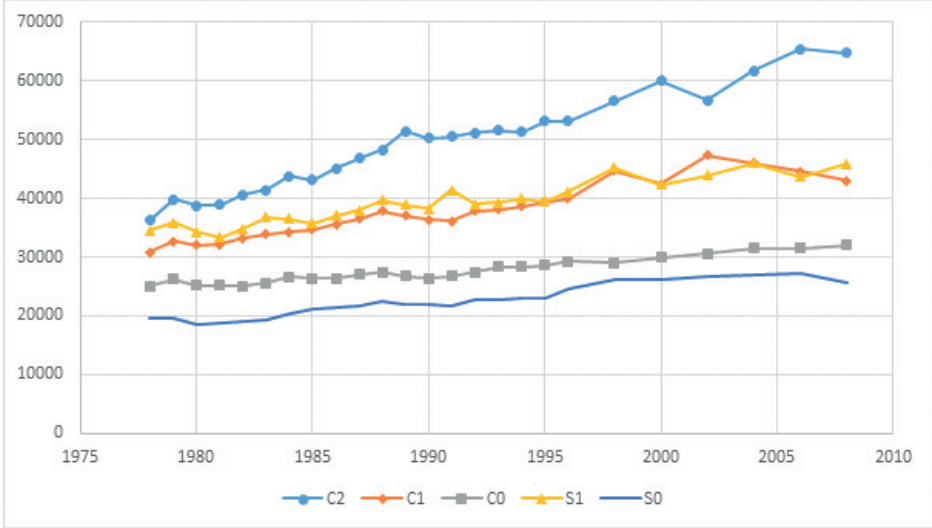
Thus, two independent trends can be detected: On the one hand, this figure exemplifies the drastic increase in the level of schooling in the population – the C2-group increases by 84% between 1978 and 2009 while the C0-group shrinks by 58% at the same time. On the other hand, also the share of households headed by singles in the population increases compared to households headed by couples. Both trends could be responsible for changes at the aggregate level.

Figure 2 shows the heavily discussed polarization of net household incomes during the last thirty years. While in 1978 the mean incomes of the five groups are still relatively close to each other, the development of group means is very different thereafter: C2-households are characterized by constant high rates of income growth and an overall growth in mean real equivalence-weighted net household income of 78.4% between 1978 and 2009. C0- and S0-households on the contrary also grow constantly, but at much slower rates. They can only realize 27.5% and 30.5% mean income growth, respectively. The result is that the differences in mean income between groups steadily increase.

As explained above, the remainder of the article will be concerned with residual inequality. However, it is necessary to also control for income differences explained by observable characteristics and check which effect they exert on overall income inequality. I regress log income on a set of variables that include sex of the household head, employment status of head and spouse (if present in each case), years of education of head and spouse, region of residence, ethnic group of head and spouse, residence in a big city, number of kids, number of household members, income from other family unit members, year of birth and financial support of people outside the household. Most of the coefficients are allowed to vary in estimated size from year to year. All regressions are conducted by OLS, the respective sample sizes can be found in the final column of Table 2. All following analyses concerning the aggregate level are based on a regression for the whole sample



Figure 2: Mean Real Net Household Income by Education Group



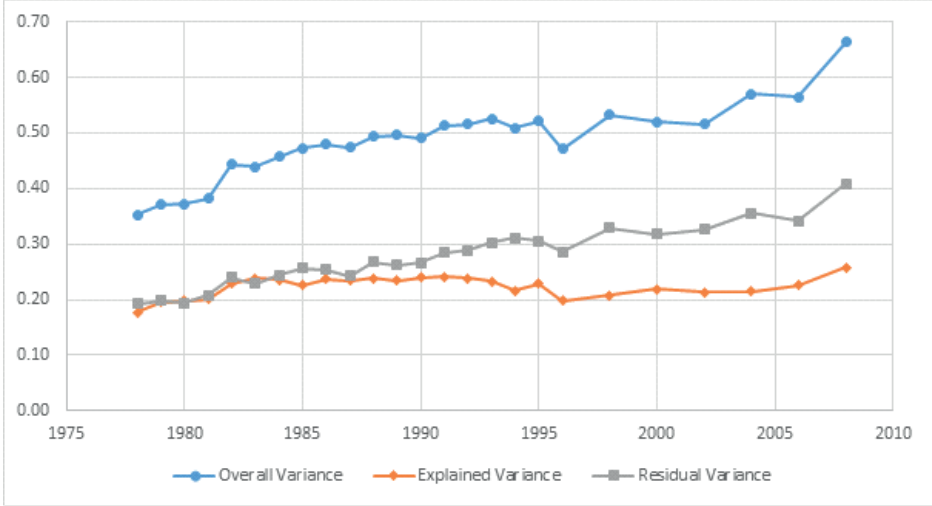
whereas regressions for the single groups are conducted to generate group-specific residuals. The  $R^2$  for the aggregate sample is 0.526, the values for the groupwise regressions are lower, but they all lie between 0.3 and 0.5.

Figure 3 shows how aggregate explained and residual inequality evolve over time. Throughout the paper inequality is measured as the variance of log income<sup>3</sup>. At the beginning of the sample between- and within-group inequality are equally important for overall inequality. Since 1983, though, the two series are diverging. While explained variance remains flat, residual inequality is constantly increasing. Thus, the increase in overall inequality since the mid-1980s is purely driven by residual inequality. It is therefore necessary to have a close look at the two components of residual inequality, permanent and transitory variance, to be able to understand which factors are responsible for the overall increase in income inequality in the last three decades.

This figure can also be replicated for all five educational groups (not shown here). If the sample is split up, the importance of explained variance is reduced since differences explained by education are now filtered out. The level of overall inequality also differs between groups: Singles show a higher income inequality compared to couples, groups with only low education (S0 and C0) have a more unequal distribution of overall income than their respective counterparts with higher education (S1, C1 and C2). Moreover, for less educated households a higher share of the income differences are explained by observable characteristics. However, the five series all show the same pattern as overall inequality: Explained variance is flat (in some cases even slightly declining) while the increase in overall income inequality is driven by an increase in residual inequality.

<sup>3</sup>It should be kept in mind that the variance of log income reacts more sensible to changes at the lower end of the income distribution whereas the Gini coefficient often used in other studies reacts more sensible to changes at the upper end of the income distribution.

Figure 3: Overall, Explained and Residual Inequality of Net Income



## 6.2 Transitory and Permanent Inequality

Figure 4 shows the development of overall residual income inequality as well as the shares explained by shocks to transitory and permanent income at the aggregate level and for all population subgroups. All of these values have been estimated using the information in income levels as in Moffitt & Gottschalk (1995)<sup>4</sup> under the assumption of a pure idiosyncratic shock in transitory income. Thus, we have to be cautious about interpreting the results for transitory inequality as Daly et al. (2013) have shown them to be biased upward. Table 3, therefore, summarizes the most important values only for permanent inequality.

Table 3: Variance of Permanent Income Shocks (estimated in levels)

	1978	2006	Average	Increase 1978-2006
Aggregate	0.113	0.227	0.171	100.6%
C2	0.081	0.234	0.149	190.1%
C1	0.089	0.153	0.123	71.5%
C0	0.093	0.176	0.131	89.5%
S1	0.141	0.240	0.195	69.9%
S0	0.126	0.239	0.187	89.3%

All groups have in common that the overall variance of residual income and permanent inequality have a clear increasing trend over time although the degrees are very different. At the aggregate level as well as for most groups the increase in overall inequality is only slightly steeper than the increase in permanent inequality. Thus, permanent inequality seems to be the major contributor to the increase in residual income inequality between 1978 and 2006. While permanent inequality doubles (0.113 in 1978 and 0.227 in 2006), inequality due to transitory fluctuation increases by less than 50% (0.080 in 1978 and 0.114 in 2006). Similar

<sup>4</sup>I use the second-order autocovariance here to determine the variance of the permanent shock although first-order autocovariances could also be used. This is done with respect to the biennial data after 1997. Results do not differ significantly.

evidence has recently been found by DeBacker et al. (2013).

The most important result from the analysis of income levels is the difference in permanent inequality between high educated (C2, S1) and the less educated groups (C0, S0)<sup>5</sup>: High educated households display a strong steady increase over the whole sample period that is significantly steeper than the increase in transitory inequality. For the C0- and S0-group, on the contrary, the increase in permanent inequality is smaller and there is a long period between 1985 and 2002 where there is no trend in permanent inequality at all<sup>6</sup>. Thus, in the years 1985-2002 the overall income variance increases considerably for the C2- and S1-group while it does not increase for the C0- and S0-group. As can be seen in the figures, the different development stems from the increasing permanent variation for the highly educated groups.

Figure 5 depicts the variance of transitory innovations  $\epsilon_{i,t}$  and a sum of the variances of permanent innovations  $\zeta_{i,t}$  and  $\zeta_{i,t-1}$  estimated using information in second differences.<sup>7</sup> Some of the series show particularly high values for transitory variation in the years 1992-1994. This phenomenon is well-known and probably brought about by an unusually high level of measurement error in these years.<sup>8</sup> Thus, in these three years it should not be trusted in the results too much. According to Daly et al. (2013) we also have to be careful in the following when interpreting the variance of permanent innovations estimated from differences since it is biased upward.

At the aggregate level the variance of transitory innovations is always higher than the variance-sum of permanent innovations. This stems from the fact that transitory innovations only affect income in period  $t$  while the permanent shock  $P_{i,t}$  is a sum of all past permanent innovations  $\zeta_{i,s}$  with  $s \leq t$ . It can also be seen that the variance of transitory innovations is increasing over time while the variance-sum of permanent innovations is flat over time.

The comparison between the educated groups, C2 and S1, and the less educated groups, C0 and S0, shows that the average level of transitory innovations is higher for the less educated groups compared to their respective educated counterparts. The average variance of permanent innovations, on the contrary, is higher for the educated groups. These findings underline the results from income levels that the overall permanent inequality is increasing more steeply over time for C2 and S1 compared to C0 and S0.

Figure 5 also shows differences between households headed by couples and households headed by singles. First, the variances estimated for singles are significantly higher than for couples which has already been the case above analyzing income levels. Second, the variances are also much more volatile. Third, while all households headed by couples show an increase in transitory innovation which is comparable in size at least in relative terms, the variance of transitory fluctuations does not show any trend for single households. Thus, household composition seems to be an important determinant for the development of transitory variances. This is not in line with the results from income levels and illustrates that the biases described by Daly et al. (2013) do not only affect levels, but also trends.

Table 4 summarizes the development of transitory inequality, but also puts the two components together. The final column reports the average ratio of transitory inequality estimated in differences to permanent

<sup>5</sup>The results for the C1-group are not discussed in detail in the following. The group is the smallest in the economy and the results are mostly an average between the C2- and the C0-group.

<sup>6</sup>The value of the percentage increase in permanent inequality for the S0-group displayed in Table 3 is highly dependent on the choice of the starting and final period and therefore misleading. Fitting linear trends through the S1- and S0-time-series yields a higher slope coefficient for the S1-group.

<sup>7</sup>In Appendix A2 it is shown that the results for transitory variation using this procedure do not differ significantly from the results obtained from using first differences until 1996. This reassures that the right specification for transitory income has been chosen.

<sup>8</sup>The PSID changed the methods of data collection and income imputation at that time and it has been found by Gouskova & Schoeni (2007) and Kim et al. (2000) that this led to a one-time increase in measurement error. Due to the income specification used this increase in measurement error directly feeds into the transitory variances measured. Therefore, the values for transitory variance in these years should be seen with some suspicion.

Figure 4: Variance of Permanent and Transitory Shocks to Net Income

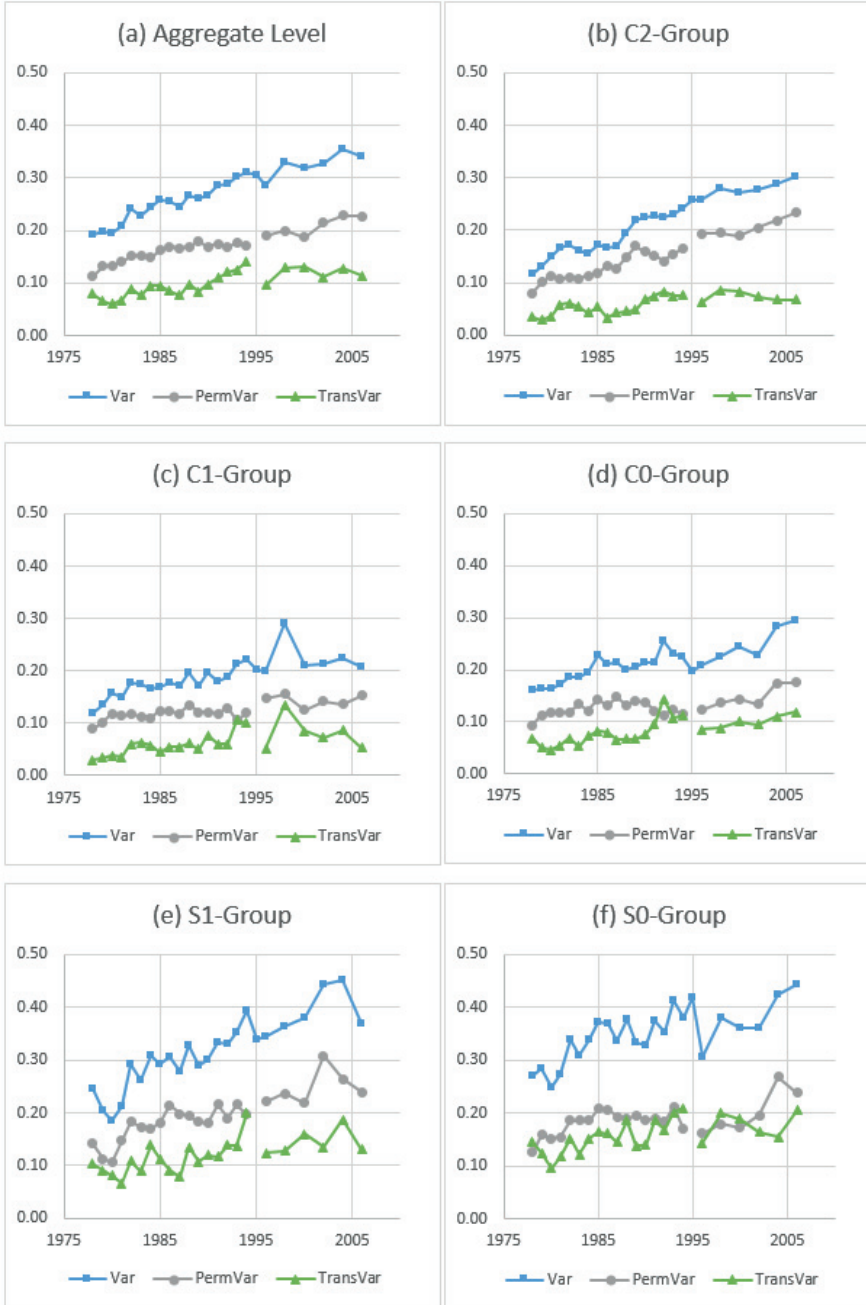


Figure 5: Variance of Permanent and Transitory Innov. (Second Differences)

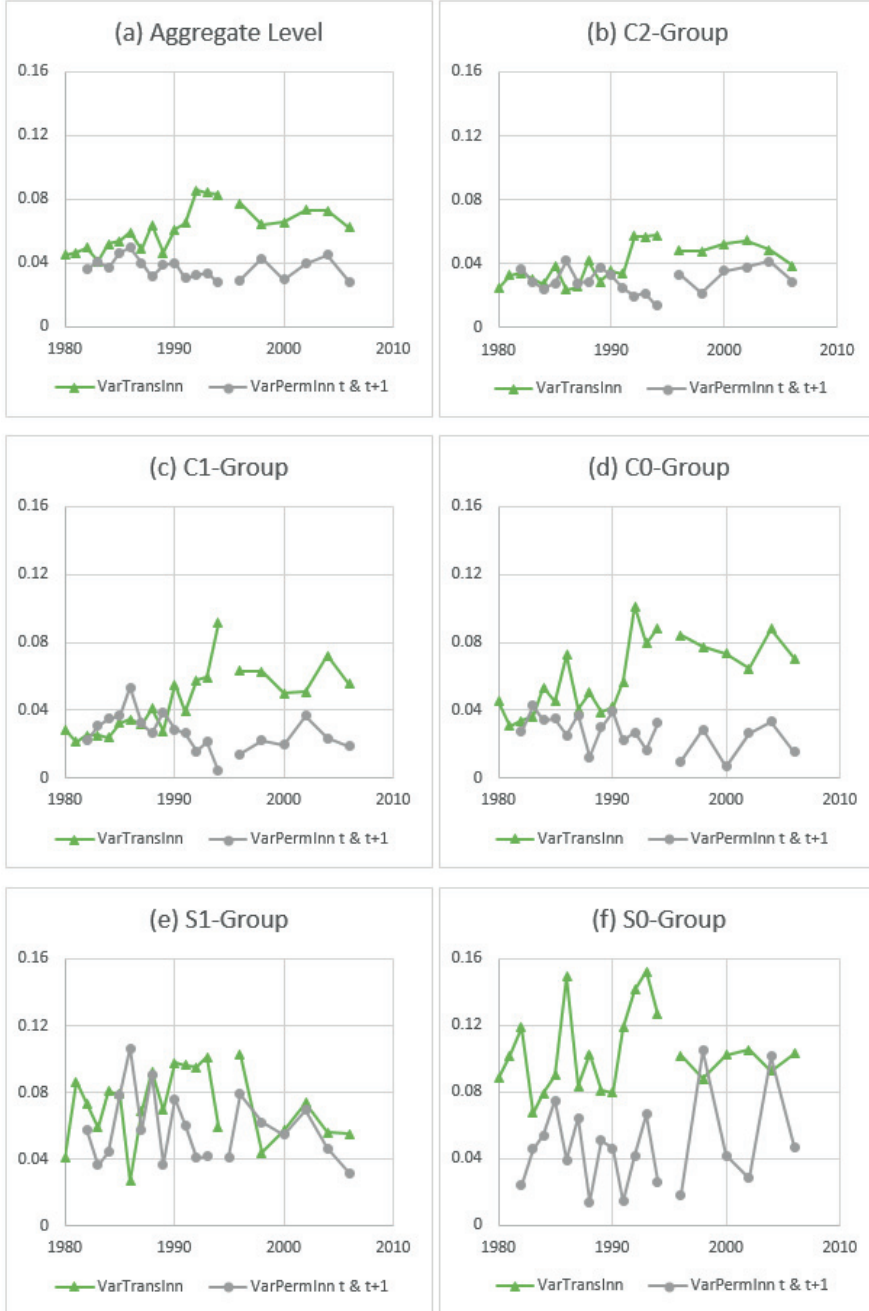
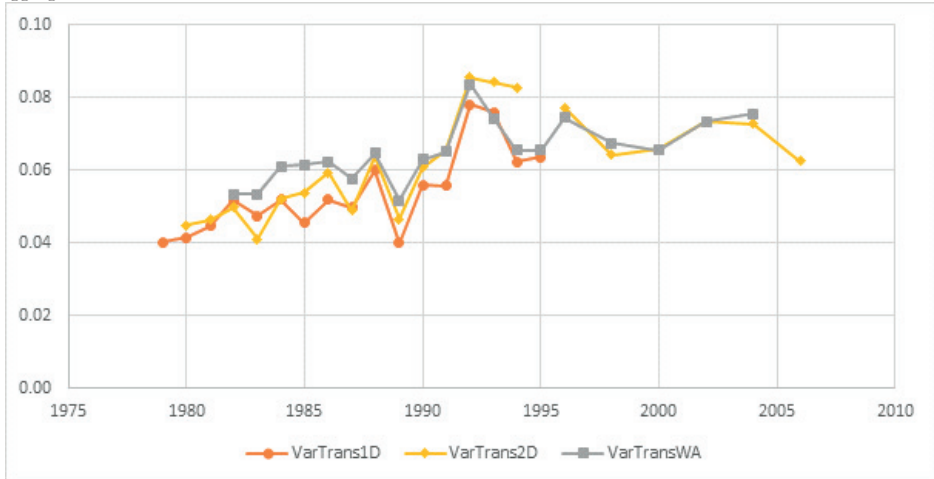


Table 4: Variance of Transitory Income Shocks

	Transitory Shock Variance (estimated in differences)			Ratio Trans./ Perm.-Shock Variance
	1980	2006	Average	Average
Aggregate	0.045	0.063	0.062	0.354
C2	0.025	0.039	0.040	0.263
C1	0.029	0.056	0.045	0.356
C0	0.045	0.071	0.061	0.461
S1	0.041	0.055	0.072	0.372
S0	0.088	0.103	0.104	0.548

inequality estimated in levels for all population subgroups. This value can be seen as a simple indicator of how important the two shocks to total income are for the groups. We have seen above that educational status has a higher influence on the development of permanent inequality while household composition determines the development of transitory inequality. The ratio of the two inequality values shows that the differences in education matter most for the overall composition of the shocks: the ratios of the less educated C0- and S0-group are on average considerably higher than the ratios of the C2- and S1-group. For the less educated singles it is more than double compared to the educated couples. Hence, the income process and income inequality for educated households are far more influenced by permanent shocks while transitory fluctuation plays a more important role for the less educated households.

Figure 6: Comparison of Transitory Variances from 1. and 2. Difference and from "Window Averaging", Aggregate Level



### 6.3 Robustness

A critique that is often voiced against the use of parametric earnings models is that the results are highly dependent on the specific model chosen (see e.g. Shin & Solon 2011). To check by how much my results depend on the income model I use a robustness test that has also been developed by Gottschalk & Moffitt (1994). The so-called “window averaging”-method uses average income over time as a proxy for permanent income. This average is calculated from all values inside a “window” around income in period  $t$ . The difference between average income and actual income in period  $t$  is transitory income. This very simple nonparametric model then allows the construction of permanent and transitory variances for every year  $t$ . Although the results obtained will be much smoother and cannot identify the exact timing of jumps and turning points compared to the ones from the parametric model, it is nevertheless helpful to compare them to the variances obtained above.

The change of the PSID data from an annual to a biennial frequency again complicates matters. From 1982 until 1992 I use a window that spans from  $t - 4$  to  $t + 4$  for permanent income in period  $t$ . Thus, the value is an average over 9 observations. At the end of the sample, from 1996 to 2005, I also use a window from  $t - 4$  to  $t + 4$ , but the average can then only be computed over 5 observations. For the years 1993-1995 the definition is changing from year to year due to differences in the sample periods that are available to compute the average. However, all averages are computed using a symmetric window and using at least 5 values for net household income. Leaving out the values for 1993-1995 does not affect the main results.

Figure 6 shows that the variances of transitory net household income obtained from the nonparametric moving average specification line up very closely with the ones obtained from second differences. This is also the case for transitory variances estimated from first differences that can be calculated up to 1995. This figure can as well be compiled for every single education group (not shown here) where the three variances also line up closely.

Figure 7: Comparison of Permanent Shock Variances from Income Levels and from "Window Averaging", Aggregate Level

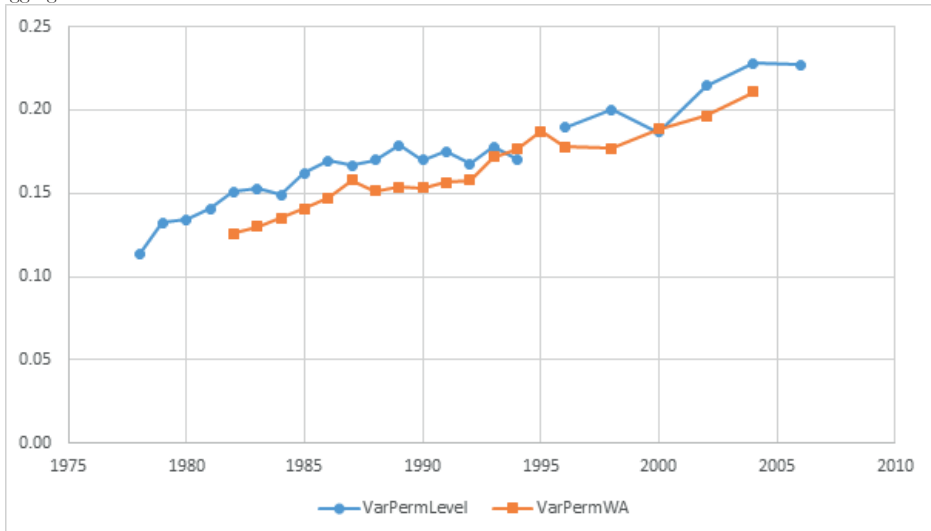


Figure 7 shows that variances of the permanent shocks obtained from income levels and from “window averaging” are reasonably close as well. Although the variance from the moving average specification behaves more smoothly over the sample and is in general slightly below the variance obtained from decomposition, the trend is very similar. These findings again also apply for the five education groups.

Thus, the robustness check shows that the results obtained from the parametric model chosen line up extremely well with results obtained from a fully nonparametric moving average specification. This shows that the income model assumed above fits the data well and is able to identify trends in transitory and permanent variation of net household income. Further, the robustness check is an additional support for the results of Daly et al. (2013). The moving average result for transitory inequality is close to the results from differences and the moving average result for permanent inequality is close to the results from levels.

## 7 Composition Effects

We have seen that the C2- and the S1-group – recently the two largest groups in the US economy – experienced strong increases in the permanent component of residual inequality. As depicted in Figure 1, there has been a dramatic change in the overall composition of the workforce over the last 30 years. Lemieux (2006) argues that composition effects have a high explanatory power for the rise in overall wage inequality. It is therefore interesting how much of the rise in aggregate overall, permanent and transitory income inequality in my data can be explained by changes in the composition of the workforce.

To identify the importance of composition effects at the aggregate level Lemieux (2006) constructs counterfactual residual variances. In a first step new aggregate measures of the overall, permanent and transitory income inequality have to be estimated. They are equal to a sum of the variances for the single groups  $j$  weighted by their share in the economy  $\theta_{jt}$  in period  $t$ :<sup>9</sup>

$$\widetilde{Var}(x_t) = \sum_j \theta_{jt} Var(x_{jt}).$$

Counterfactual residual variances describe how aggregate inequalities would have evolved if there had been no changes in group sizes. These values are attained by holding the group shares  $\theta_{jt}$  constant at their level in 1978:

$$\widetilde{Var}(x_t)^{CF} = \sum_j \theta_{j1978} Var(x_{jt}).$$

Figure 8 shows the comparison of  $\widetilde{Var}(x_t)$  and  $\widetilde{Var}(x_t)^{CF}$  at the aggregate level. Permanent variances are taken from the estimation in levels, transitory variances from the estimation in second differences. The figure clarifies that the influence of composition effects on aggregate inequality figures is surprisingly low. Both components are not affected by composition effects at all until 1990. Thereafter, inequality due to transitory fluctuation with constant 1978 group shares is slightly higher than the actual series since there are less households in the C0-group, but the effect is quantitatively negligible. For permanent inequality the

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<sup>9</sup>These variances should in general equal their respective counterparts estimated above. In this case though, differences arise due to the fact that the two values use residuals that stem from different regressions. The aggregate inequality values estimated above are derived from a regression that was done for the full sample. The new weighted-sum values make use of residuals derived from group-wise regressions. The inequality values for overall income inequality are slightly higher for the standard series. The reason for this is the fact that estimating the effect of observable characteristics group-wise allows the coefficients to vary between the groups and explain differences within the groups better. This has an attenuating effect on residual inequality or, more precise, especially on permanent differences in residual income. Therefore, the overall variance and the permanent variances are smaller in the weighted-sum series while the variance of transitory income fluctuation is not affected. However, the trend and all up- and downswings are mirrored in the weighted-sum series.



effect is bigger, but also only 11.2% of the overall increase between 1978 and 2006 is explained by the fact that households change from one demographic group to another. The effect on overall income inequality is even smaller. Using another year as a base year also reduces the influence of composition effects compared to using 1978.

Figure 8: Comparison of Actual Variances and Counterfactuals, constant 1978 group shares



The reason for the lack of an influence especially at the beginning of the sample is that up to the mid-1980s the C0-group still has a higher absolute level of permanent inequality than the C2-group. Hence, when the composition of households changes and the share of C0-households is reduced in favor of C2, this decreases aggregate permanent inequality. Changes from C0 in favor of S1 on the contrary increase permanent inequality. Both effects cancel each other out more or less until the 1990s. After 1990 the level of permanent inequality is higher within the C2-group compared to the C0-group and therefore composition effects become more important. Hence, if the demographic trends continue, composition effects might become more relevant in the future.

Changes in the composition of the US workforce, thus, only explain a small amount of the overall increase in income inequality. The major amount of the increase is due to changes within the groups.

## 8 Discussion

Differences between households headed by couples and those headed by singles have not been studied before. I find that both the level of permanent and of transitory inequality is higher for single households. Thus,

hypothesis H1 can be confirmed to the whole extent. Single households are hit relatively harder by transitory shocks as they have fewer different sources of income that serve as an insurance to shocks. The fact that also permanent variances are higher for singles shows that as assumed above, wealth effects reducing income differences outweigh the positive correlation of different sources of residual income.

Examining differences in the trends for singles and couples yields the observation that inequality due to transitory fluctuation shows an increase that is of comparable size for all couple households. For single households variances estimated from first differences, second differences and window averaging show a flat trend over time. Thus, the results indicate that transitory inequality does not increase for individual income, but that the rise seen in aggregate data is confined to couple households. However, it seems unlikely that increased job and firm instability that are seen as reasons for the rise in transitory inequality (Gottschalk & Moffitt 2009, Ziliak et al. 2011) are confined to couple households. DeBacker et al. (2013) have shown that the transitory variance of male earnings has not increased since the late 1980s, but that the increase in the transitory variance of total household income has been due to female labor earnings and investment income. As single households also realize income from investment, it cannot be the reason for the increase in transitory inequality for couples, but an increasing female labor force participation could serve as an explanation.

Table 5 shows that the share of female labor earnings in total household earnings increases steadily over time for all couple groups in the data. If the rise in the earnings of spouses is seen as an exogenous process due to a change in female preferences, the additional household income does not serve as an insurance to shocks. In this case its residual fluctuations are not correlated negatively with the fluctuations of the head's income and the overall net household income will in general exhibit higher transitory fluctuation.

The development of permanent inequality could also be affected by female labor force participation. As can be seen in Figure 4, permanent income differences increase much more strongly for educated couples than for educated singles although both increases are considerable. While educated couples have a much lower value for permanent inequality in 1978 (0.081 compared to 0.141), they are very close to the educated singles in 2006 (0.234 compared to 0.240). *Ceteris paribus*, an increasing labor market participation of women reduces the wealth effects, increases the covariance between the male and the female permanent shock and therefore increases permanent inequality for the couples. Thus, increased female labor force participation delivers a good explanation for the differences between singles and couples found.

Table 5: Share of Female Labor Earnings in Total Household Earnings

	1978	1990	2008	Growth 1978-2008
C2-Group	0.187	0.245	0.285	52.3%
C1-Group	0.155	0.227	0.279	80.5%
C0-Group	0.142	0.199	0.249	75.2%
All Couple Households	0.154	0.222	0.274	77.3%

Hypothesis H2 is supported by the data as well. Permanent income inequality increases particularly for the more educated households. This is consistent with the idea that wages are raised especially in the high-skilled sector when the demand for unobserved skill increases over time as in Juhn et al. (1993) and Gosling et al. (2000). In general, the results indicate that skill-biased technical progress - usually seen as the source of rising permanent differences in income - has been especially relevant for the more educated in the last thirty years. This finding is also well in line with the theory of "polarization of work" describing the effect of computerization on skill demand advocated among others by Autor et al. (2008).

Autor et al. (2008) show that there are significant differences in the development of wage inequality if

one separates the 90/10-percentile ratio into 90/50- and 50/10-ratios. While inequality in the upper part of the distribution constantly increases in the 1990s and 2000s, inequality in the lower part stays constant or declines. Autor et al. believe that skill-biased technical progress and computerization have a nonlinear effect on skill demand and that new technologies replaced especially non-manual tasks performed by “middle-educated” workers. This phenomenon should have increased demand for high-skilled, but decreased demand for individuals with an average education while it has left the demand for lower skilled manual workers unchanged.

The binary classification of education used does not allow for “middle-educated” workers, but it can be assumed that a fraction of the households labeled as “high-skilled” in the sample are middle-skilled. Then, the drastic increase in permanent income differences within the C2- and S1-group can be explained by increasing differences between high and middle-educated households since Autor et al. (2008) mention that the differences between skill groups can also be found in residual income. On the other hand the result that there is no increase in permanent inequality between 1985 and 2002 for the less educated C0- and the S0-group is also perfectly in line with this idea. The demand for less educated workers performing manual tasks stays constant over time such that (residual) income differences do not increase.

Finally, H3 is also supported by the data. Compositional changes exhibit an increasing effect on aggregate permanent inequality and a small dampening effect on transitory inequality. As already mentioned above, the size of the effect on permanent inequality is surprisingly small. This is also in line with the results of Autor et al. (2008) who show that composition contributes only little to aggregate inequality and that the large effects found by Lemieux (2006) have been exaggerated. However, the trend of higher educational degrees and more single households in the US economy is believed to continue further. Thus, composition effects could become a significant contributor to increasing income inequality in the next decades.

## 9 Conclusion

This paper has shown that permanent inequality has been the major driver of the increase in aggregate income inequality in the last thirty years. However, there are significant differences between demographic groups regarding the composition of residual household net income. I have demonstrated how transitory and permanent inequality evolve for groups of different educational status and for single and couple households. High educated households display a large and steady increase in permanent inequality compared to less educated households who are characterized by a more moderate increase. Couple households additionally are exposed to an increase of transitory inequality whereas single households are characterized by a constant level of transitory fluctuations.

By combining the two elements of residual income it could be shown that the ratio of transitory to permanent shock variance is far lower for households with a high educational attainment compared to the less educated households. Since high educated households usually can be found in the upper half of the income distribution, my results indicate that shocks that are harder to insure against account for the large majority of income shocks for households above the median. On the contrary, transitory shocks that have been found to be easier to insure against make up a larger part of the overall income shock within the less educated groups. Thus, this paper delivers an explanation why consumption inequality reacts more strongly to changes in income inequality in the upper part of the income distribution compared to the lower part of the distribution as found by Krueger et al. (2010) and Meyer & Sullivan (2013).

This conclusion depends on the assumption that the results found by Blundell et al. (2008) are equally valid for all demographic groups. However, it could be the case that high income households have access

to better insurance against transitory and permanent income shocks. Future research, hence, should be concerned with the questions how the possibilities to insure consumption against income shocks differ for population subgroups. The results then could be combined to explain the complete transmission of changes in income inequality to consumption inequality.

This paper shows that it is necessary to jointly examine households headed by singles and those headed by couples. The differences found show the importance of increased female labor force participation for transitory and permanent inequality, a result that could not have been found by examining only singles or only couples. Differences between single and couple households clearly deserve further investigation, especially to find out if increased female labor force participation is the sole reason for the rise in transitory income inequality of couple households.

Finally, the empirical results also highlight the importance of the insights of Daly et al. (2013). If variances had only been estimated in levels, the results would have wrongly shown an increase in transitory inequality for both groups of single households. Estimation in differences and the non-parametric “window averaging”-method though show that inequality is flat. The shortcomings of unbalanced panel data do not only bias the level, but also the trends of inequality. Thus, future work in this field necessarily needs to make use of both methods of estimation to prevent false conclusions about the size and dynamics of income inequality.

## Appendix A1: Dataset Construction and Sample Selection

The dataset has been constructed with the help of the PSID Data Center<sup>10</sup>. All top-coded income values are set to missing, all variables that are reported on a weekly or monthly basis are adjusted to an annual value and some unrealistically high values of these adjusted variables are removed.

NBER Internet TaxSim (v9)<sup>11</sup> (for more information see Feenberg & Coutts 1993) is used to simulate federal tax payments after 1992. Unfortunately, information on the economic situation of other family unit members is too sparse to conduct this exercise for them. Thus, taxes can only be simulated for head and spouse and consequently the household net income variable equals total household money minus federal taxes for head and spouse after 1992. As the share of income that other family unit members contribute to total household income is usually small, this change should not affect the results too much.

All PSID income variables are reporting previous year values. In years where the PSID is only available biennially an important problem arises: Household composition, education variables and household weights refer to survey year  $t$  and are not available for  $t-1$  while income variables refer to year  $t-1$  and are not available for  $t$ . To be able to simulate tax payments or to estimate weighted statistics a crucial assumption has to be made: non-income variables (city and state of residence, marital status, education of head and spouse, household composition and sample weights) of the survey year  $t$  are also valid for the previous year  $t-1$ . PSID interviews are usually conducted around March. Thus, this assumption does not seem too unrealistic. If this assumption is violated, weighted statistics can only be compiled up to 1997.

All income variables are deflated by the Personal Consumption Expenditure (PCE) Price Index taken from Bureau of Economic Analysis and, thus, are expressed in prices of 2005. Moreover, the variables are equivalence weighted by the modified OECD scale. Due to limitations in the data it cannot be differentiated between children younger and older than 14 years. Therefore all children younger than 18 years are weighted with 0.3.

Table 6: Sample Selection

Reason for exclusion	# dropped	# remain
Initial Sample	-	203,674
Latino Subsample	12,343	191,331
Head not in Working Age	41,915	149,416
Change in Family Head	28,350	121,066
Missing Values	3,611	117,455
Income Outliers	2,162	115,293

As it is only available in a couple of years, I exclude the Latino subsample, but keep the immigrant sample. I also keep the SEO-subsample and correct for the oversampling by using longitudinal family weights through the whole sample. Further, I exclude households headed by persons younger than 25 years or older than 65 years in order to circumvent problems caused by households still in education or already retired. Along the lines of Blundell et al. (2008) I drop households whose head changes during the sample and those with a missing value for educational attainment of the head or for the state of residence. Finally, I exclude households with an outlier value for household net income. An outlier is defined as an income that grows

<sup>10</sup> Available under: <http://simba.isr.umich.edu/default.aspx>

<sup>11</sup> Available under: <http://users.nber.org/~taxsim/>

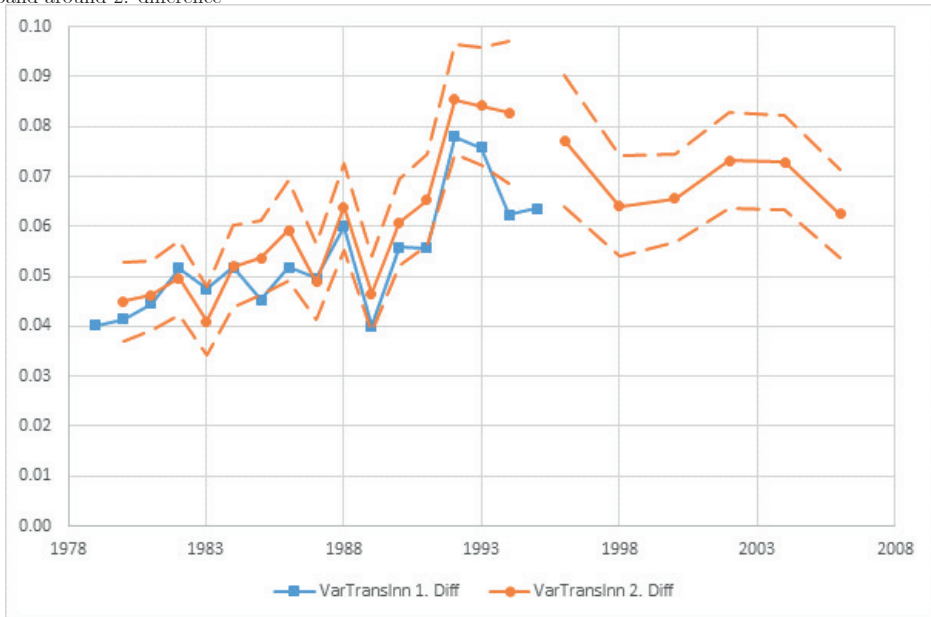
more than 500% or less than -80% compared to the previous year or is in total lower than 100\$ a year. Table 6 summarizes how many observations have been dropped in every step.

In an additional robustness check I analyzed how the main results of the paper change if a minimum length of being in the dataset is introduced for the households. All households appearing less than ten times in the data were dropped. The development of transitory variances hardly differed from the full sample. Permanent variances were found to increase more steeply for all subgroups. However, the relation between the increases of the different subgroups remained the same as for the full sample. Thus, the major findings of the paper remain unchanged. The results are available from the author upon request.

## Appendix A2: Comparability of First and Second Difference Results

Does the use of second differences produce different results than first differences for the variances of permanent and transitory innovations? The advantage of the second differences is that they expand the sample horizon considerably. However, it is possible to compute the variances by the well-established procedure using first differences up to 1995 and compare the results. Figure 9 shows the comparison with a 95% confidence band around the new series using the second differences.

Figure 9: Comparison of transitory innovation variance from 1. and 2. differences, 95-percent confidence band around 2. difference



Transitory variances obtained from first differences line up closely with the ones obtained from second differences. The values for first differences are mostly within the 95% confidence band of the values for second differences. The general trend and the timing of up- and downswings are also very similar. This shows that

the right specification concerning the transitory income shock has been chosen. If the true transitory income process had been an  $MA(q)$ -process, variances obtained from first and second differences under the erroneous assumption of a pure idiosyncratic transitory shock would need to differ significantly.

As we have seen above transitory variances derived from window-averaging also line up closely to the ones from first- and second-differences. This again indicates that the parametric income model and the order of the transitory shock component chosen fit the data reasonably well.

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