# Measuring Income Risk in German Labor Market

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**Abstract**

This paper estimates the idiosyncratic labor income risk in Germany using GSOEP data. We decompose the income risk into transitory and permanent components, and employ the EWMD estimation and various moment conditions. Three income measurea are applied here: household total annual labor income, individual annual earning and individual wage rate. For all three measures, the volatility of individual earning is more transitory rather than persistent. Among them, individual wage rate looks most stable with lowest estimated risks than the other two. Besides, we also discover that East German residents and females are two groups with considerably higher income risks, compared to West Germans and males, respectively. Moreover, education might bring more income uncertainty. Finally, we find that public transfer payments, social security pension system and unemployment benefit reduce the income risks of individuals.

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**One-page Abstract**

Advances in recent research have shown that the patterns of individual labor income risks have great influence on human behavior and design of social insurance schemes. Therefore, to obtain plausible empirical estimates of idiosyncratic income risks becomes crucial. This paper is motivated by the observation that very few empirical studies focus on Germany and is aimed to construct more plausible estimates of labor income uncertainty using German Socio-Economic Panel Study (GSOEP) data. We define the labor income risk as unpredictability of income and refers to income variability from an ex ante perspective. In this sense, income risk is estimated by the (conditional) variance of individual income. And it is divided into two components: risk to permanent income and risk to transitory income. In particular, the permanent component of income represents the stochastic trend of innovative income and has persistent power, while transitory innovation is the deviation of income from trend. The distinction here is important since individuals consume out certain proportion of permanent shock, when the transitory shock could be self-insured by saving and dis-saving and has less effect on the consumption smoothing and welfare. Econometrically, we suppose that $u_{it} = \omega_{it} + \epsilon_{it}$, and $\omega_{it} = \omega_{it-1} + \eta_{it}$, where $u_{it}$ is the residual of Mincerian income regression, and $\omega_{it}$ and $\epsilon_{it}$ are the permanent and transitory components correspondingly. Furthermore, the permanent component $\omega_{it}$ is supposed to be a random walk. Hence, $\sigma_\eta^2$ and $\sigma_\epsilon^2$ are defined as the permanent and transitory income risks. We employ EWMD estimation to generate the $\hat{\sigma}_\eta^2$ and $\hat{\sigma}_\epsilon^2$. We apply three labor income measures here: household total annual labor income, individual annual labor income and individual hourly wage rate. For all three measures, the volatility of individual labor income is more transitory rather than persistent. Among them, individual wage rate looks most stable with lowest estimated risks than the other two. Put differently, household labor earning is more volatile than individual wage rate, but in the similar range to individual labor earning. The time trend of estimated permanent risks is fairly stable. Yet, transitory risks have more volatilities than permanent ones. Besides, we also discover that East German residents have significantly higher income risks than West Germany for both permanent and transitory component. Females of our sample have significantly riskier income process than males of both permanent and transitory senses. Moreover, education might bring more income uncertainty, when we compare the persistent and transitory income risks of three sub-samples w.r.t. education levels. Finally, we find that social security system, such as unemployment insurance and pensions, could reduce the income risks of individuals.

# 1 Introduction

Recently, much of the literature has shown the importance of measuring idiosyncratic income risk in labor market. From the welfare point of view, the patterns of earning uncertainty are concerned to analyze the impact on human behavior and design of social insurance schemes. Particularly, in the theory of precautionary saving, where there is no perfect insurance and human capital markets, and where individuals have idiosyncratic income risks and maximize the expected utility of the whole life time through choosing consumption and asset holding for each period, the nature of income risk has profound effects on the consumption-savings decision of individuals, which in turn plays a central role in individual welfare. The pioneering study of Aiyagari (1994, 1995) shows that income risk has influence on the determination of wealth inequality and income taxation, when individuals cannot fully insure away their idiosyncratic risks and can only self-insure by borrowing and lending money. Deaton (1991) provides an analysis that the ability of individuals to self-insure and the precautionary saving motives are sensitive to the feature of microeconomic labor income process and income uncertainty. Constantinides and Duffie (1996) argue that idiosyncratic income risk has impact on the asset pricing and could explains risk premium in a specification using power utility. Moreover, Krusell and Smith (1999) and Krebs (2007) claim that individual income risk causes the welfare cost of business cycles. Krebs (2003) proves that a reduction in uninsurable idiosyncratic labor income risk increases human capital investment, growth and welfare by a significant amount. The estimation of labor income risk also has considerable policy implication that once the human capital choice is endogenized, the government policy, like severance payment to displaced workers, increases growth and welfare. On the other hand, existing evidence suggests that individual's earnings uncertainty is substantial in reality and has a significant correlation to other economic state variables of aggregate or individual level, such as Carroll and Samwick (1998) find that precautionary saving are positively correlated with income uncertainty, and significant amount of saving is attributable to the extra uncertainty[1].

Clearly, all these studies heavily rely on obtaining plausible empirical estimates of income risks. The labor income risk is defined as unpredictability of income and refers to income variability from an ex ante perspective, there-

[1]Carroll and Samwick (1998) discover that idiosyncratic income risk generates between 39% and 46% of saving

fore it accompanies people whenever their future income stream deviates from its expected future path, and is idiosyncratic to them. In general, it lasts over the whole working period of individuals. In this sense, income risk is estimated by the (conditional) variance of individual income. And it is divided into two components: risk to permanent income and risk to transitory income. The permanent component of income is the stochastic trend of innovative income and has persistent power over the remaining length of working life, while transitory innovation is defined as the deviation of income from the common trend. Hence, individuals consume out certain proportion of permanent shock rather than transitory one. The distinction here is important since the transitory shock could be self-insured by saving and dis-saving, thus has less effect on the consumption smoothing and welfare. In contrast, the permanent shock has more persistent and substantial effect on future consumption and asset holding. Aiyagari (1994) argues that the contribution of persistent earning shocks to (aggregate) savings is quite large, compared to the transitory shock in the sense that household consumption responds on a one-to-one basis to permanent income shocks but is nearly insensitive to transitory income shocks. Kuhn (2008) shows that welfare loss of incomplete insurance market is substantial, when permanent income risk presents.

Working with the data Panel Study of Income Dynamics (PSID), a bulk of research estimates the income risk in US, such as Carroll and Samwick (1997), who provide a fundamental and intuitive method to estimate the income shocks. They define income risk as the variance of (unpredictable) changes in individual income, and disentangle permanent shock and transitory shock. The logarithm of permanent income is assumed to be a random walk. Both permanent shock and transitory shock are white noise. Thus, they derive the moment condition that the variance of $n$-year income difference is linearly increasing with $n$. Based on standard OLS regression, they generate the estimated permanent deviation is 14.5%, and of the transitory deviation is about 21% for US over 1981-1987 sample period with the income measure as the total household non capital income. They also compare the income risks for different occupation groups, industries and education levels. Hubbard, Skinner, and Zeldes(1994) also employs this method and estimates the the shock to permanent labor income of US in years 1983-1987 is 15.8% in average.

Another study by Storesletten, Telmer and Yaron (2004) is basically in the similar line, except for that they emphasize the macroeconomic factor,

that is, how idiosyncratic income shock varies over the business cycle. A life-cycle effect is also included in their model. They specify idiosyncratic risk as $ARMA(1,1)$ process with a regime-switching component in the conditional variance, which is identified by using macroeconomic data to classify each year as either a contraction or an expansion. They conclude that the income risk is both strongly persistent and countercyclical. Their estimates of the conditional standard deviations of the persistent shock are roughly 21% in a recession and 12% in an expansion.

Except for permanent and transitory income, Meghir and Pistaferri (2004) add a third component, measurement error into income process, which has partial persistent power. They suppose this measurement error as an MA(q) process, and model the labor income as a parsimonious ARCH process with both observable and unobserved heterogeneity.

In addition, based on longitudinal quarterly data of Mexican workers (ENEU data) in 21 different industries, Krebs, Krishna and Maloney (2006) assume that the permanent individual income risks are time-variant and industry-specific, and develop a GMM estimation of shocks. They find that the annualized permanent income deviation in Mexico is around 18%, and varies among different manufacturing sectors[2].

Our research was motivated by the observation that the stylized facts concerning income process in German labor market are less well-documented. Fuchs-Schündeln and Schündeln (2005) and Bartzsch (2008) measure earning uncertainty and provide evidence of precautionary saving in Germany. Fuchs-Schündeln and Schündeln (2005) consider only two types of individuals: ones with low-risk job and others with high-risk job. According to the calibration in Carroll and Samwick (1997, 1998) of PSID data, they set the variances of the income of low-risk job equal to 0.0095 and for high-risk job, they set the variance at value of 0.013 as the measurement of labor income risk. Clearly, the drawback of estimates here is due to the patttern and magnitude of income uncertainty in US and Germany might differ

[2]Krebs et al(2006) also investigates the empirical relationship between trade policy and income risk according to Fernandez and Rodrik (1990) and Melitz (2002) and analyze the corresponding welfare cost. Their estimates suggest that the magnitude of the effects of macroeconomic shocks on income risk is significantly altered by the tariff level.

a lot[3]. Bartzsch (2008) does more careful work and uses five alternatives as the measures of income risk: logarithm of the variance of the detrended logarithm of labor income, logarithm of the variance of detrended labor income, variance of the detrended logarithm of labor income, scaled variance of detrended labor income and scaled square difference in detrended labor income, divided by the length of penal to yield annual rate[4]. However, the measurement above is still implausible, because it is an all-in risk measurement which doesn't disentangle permanent income risk that consumers react to. Fuchs-Schündeln, et al(2009) move one step further. They estimate the transitory and permanent components of innovative wage rate and household labor income. They extract transitory risk from covariance of growth rate of wage rates and household earnings, and specify permanent component through eliminating transitory part from variance of growth rate. Their result shows that shocks to wage rate and household earnings become more permanent. The permanent shocks to both wage rate and household labor income increase over time, especially after the German reunification, while the transitory parts are relatively stable. From the estimation method, they overestimate the permanent income risk and generate fairly high variance of permanent component, which is inconsistent with most existing evidence.

This paper is aimed to make use of more complete set of moment conditions of difference variables including not only growth rate but also higher order difference of individual incomes, and construct more plausible estimates of labor income uncertainty based on German Socio-Economic Panel Study (GSOEP) data, particular for permanent risk. We apply three labor income measures here: household total annual labor income, individual annual labor income and individual hourly wage rate. We also investigate possible factors, which affect idiosyncratic income risk, such as human capital, gender, region, etc. We report several stylized facts. Firstly, for all three measures, the volatility of individual labor income is more transitory rather than persistent. Among them, individual wage rate looks most stable with lowest estimated risks than the other two. Secondly, East German residents have significantly higher income risks than their West contemporaries for both permanent and transitory component. Females of our sample have significantly riskier income process than males of both permanent and transitory senses. Thirdly, education might bring more income uncertainty, when

[3]Fuchs-Schündeln and Schündeln (2005) makes a slight adjustment for the estimate of low-risk job.

[4]Therefore, the last measure, which is named $risk - global$ in Bartzsch (2008) is an overall measure of labor income risk over sample period.

we compare the persistent and transitory income risks of three sub-samples w.r.t. education levels. Finally, we find that public transfer payments, social security pension system and unemployment benefit reduce the income risks of individuals. The reminder of the paper is organized as follow. In section 2, the data structure is summarized, section 3 describes the estimation procedure, and section 4 compares individual earning uncertainty among different subgroups. Section 5 analyzes the policy effect of public transfer payments, social security pension and unemployment benefit scheme on individual income process. Section 6 discusses possible extension in future, and section 7 concludes.

# 2 Data

## 2.1 Labor Income Measures

The data used in this study are drawn from the 1984-2006 GSOEP (waves A through W). The GSOEP is a longitudinal survey of private households and persons in Germany and contains information from annual interviews of 60,000 individuals. In GSOEP, household is a relatively broader definition of family including not only married couples but also living together partners and family members who are non-relatives. The household head is defined as the oldest working male in this family, if presents.[5] Three labor income measures are employed here: household total annual labor income, individual annual earning and individual hourly wage rate. Individual labor income in GSOEP is defined as the summation of wages and salaries from all employment including training, primary and secondary jobs and self-employment, plus income from bonuses, over-time, and profit sharing. Furthermore, household labor income here is the combined labor income of all individuals in the household 16 years of age and older. Finally, individual hourly earning is generated as individual labor income divided by annual working hours. Individual annual working hours is calculated by multiplying the average working hours per week by total working weeks in this year and adding together the estimated annual hours of full-time, part-time (including marginal), vocational training and short work.[6]

[5]More precisely, the household head is defined as the oldest working male in the family, if presents. If only female members work, head is the oldest working female. This definition is different from the original definition in GSOEP, where the head is defined as the person who knows best about the general conditions under which the household acts and is supposed to answer the household questionnaire each year.

[6]There is potential measurement error in the working hours variable, due to the data imputation procedure in GSOEP, which tends to overestimate individual working times,

## 2.2 Data Selection

We include subsamples 'Residents in the East and West', 'Foreigners', 'Immigrants', 'Refreshment' and 'Innovation' of GSOEP.[7], and only concentrate on analyzing household heads, who are supposed to be the main earner in the household. And the household heads in working period, namely in age between 25 to 60 are considered, that is, the household heads who are still studying or already retired are dropped. Furthermore, since some families report unreliable low wage rate, we set the threshold of individual hourly earning as half of lowest hourly payment of unskilled worker.[8] Lastly, self-employed people are not involved and we discuss self-employment separately in section 4, since they have special income process, which might reflect not only the volatility of individual level from labor market but also the aggregate risk from asset market. This selection process leads to sample of 14,430 individuals and 92,431 individual-year observations. Table b1 provides a summary description and composition of the sample.

The East resident subsample starts from 1992. From year 1992 to 2006, West residents take a percentage of 75%. In total, West households take about 81% as shown in Table b1. Given the definition of household head, the female-headed families in our sample are mostly single women. The families with a working husband dominate in Germany, which take a large percentage of 68%. According to different education levels, we separate total sample into 3 groups, that is, high school dropouts, high school graduates and people with more than high school degree[9]. Among that, household heads with high school degree take the largest proportion, 65% of sample.[10] The mean individual in our sample is a 40 years old person, has a family of three members and receives 12 years of education. She works about 2000 hours and earns 30,000 euros each year. Her family has annual income of

since it considers employment status for calculating hours worked regardless vacation and sick leave.

[7]'Oversampling of high income' subsample is eliminated in order to reduce potential selection bias.

[8]Because there is no unified legal minimum wage in Germany, we use half of the wage paid by the local McDonald's restaurants to unexperienced employee, as the threshold. Put differently, the individuals reporting wage rate lower than 3 euros per hour are excluded.

[9]The third group mainly consists of college graduates. People who obtain additional training after high school are also in this group.

[10]Education level with high school graduation includes upper secondary school degree giving access to university studies (Abitur) and other equivalent educations, such as certificate of aptitude for specialized short-course higher education (Fachhochschulreife), apprenticeship (Lehre), specialized vocational school (Berufsfachschule).

around 40,000 euros in average.

### 2.3 Time Trends of Labor Income and Income Inequality

Figure 1 illustrates the time trend of average earnings. Household total income, individual labor earnings and wage rates present similar time patterns: they all increase stably in 1980s. However, after the German reunification, which is 1990 politically, but 1991 or 1992 in our data, there is a dramatic decrease of incomes and a stable but slightly increase afterwards.[11] The lower right panel of figure 1 describes the average annual hours worked of our sample reduces from 2150 hours per year to 2000 hours per year in two decades[12].

[Figure 1 about here]

Figure 2 and figure 3 indicate that the income inequality under all three labor income measures has been increased strongly in last two decades, which is the cross-sectional variance of $y_{it}$ and $u_{it}$ in each year. The time patterns of variance of household and individual (residual) labor incomes closely resemble: both grow almost in the same slope until 2005 and decline in last two years. Individual wage rates has more fluctuations before 1990s and increase gradually afterwards, but still appears yearly growth in all.

[Figure 2 and 3 about here]

## 3 Estimation of Income Risks

### 3.1 First-stage Regression

In this section, we employ the approach that each individual derives her expectations about the future income from a projection based upon her ob-

[11] This observation is in line with the time trend of per capita disposal income reported in Fuchs-Schündeln, et al(2008), where they conclude that there was healthy income growth in West Germany before unification, and only dismal growth in post-unification Germany.

[12] This is consistent with the observation of Alesina et al. (2005), Blanchard (2004), Gordon (2004), and Prescott (2004), that there is a decline of work effort in European countries and the working hours in Germany reduce in last forty years.

servable and predictable characteristics in the first stage regression of labor income.

Consider the following labor income process of individual $i$ in time $t$:

$$y_{it} = \alpha_t + X_{it}\beta_t + u_{it} \tag{1}$$

There are three labor income measures for $y_{it}$ as mentioned in section 2, that is, logarithm of household annual total real labor income, logarithm of individual earning, and logarithm of individual wage rate per hour. $\alpha_t$ is a calendar year effect including year dummies and reflects the macroeconomic environment, for instance, business cycle effect. Hence, aggregate risk is captured by $\alpha_t$. $X_{it}$ is the vector of all observable and demographic characteristics of individuals that have significant effect on labor earning: gender, age, region, family size, education and experience. $\beta_t$ are year-specific coefficients under implicit assumption that the effect of individual characteristics on earning differs among time periods. $u_{it}$ is the innovative part of individual labor income, which is idiosyncratic and unpredictable ex ante. The return to observable characteristics varies with calendar time in a very general way.

The first-stage regression provides the estimated parameters $\hat{\alpha}_t$, $\hat{\beta}$ and predicts the residuals $\hat{u_{it}}$. Table b2 gives the estimated parameters in the labor income regression.

## 3.2 Estimation of Income Risks

We distinguish the income uncertainty into risk to permanent income and risk to transitory component, and the variances of permanent and transitory components are estimated as the measure of income risk in Germany. That is, the unpredictable part of income $u_{it}$ is decomposed into the permanent component $\omega_{it}$ and transitory innovation $\epsilon_{it}$. The permanent component $\omega_{it}$ is assumed to be a random walk.

$$u_{it} = \omega_{it} + \epsilon_{it} \tag{2}$$

$$\omega_{it} = \omega_{it-1} + \eta_{it} \tag{3}$$

Besides, permanent labor income risk in reality differs across time periods due to the macroeconomic factor, e.g., business cycle[13], openness of trade[14], or any policy reform on labor market. From this point of view, $\eta_{it}$ and $\omega_{it}$ are not i.i.d normally distributed over time, but dependent on time, i.e.,

$$\eta_{it} \sim N(0, \sigma^2_{\eta,t}) \tag{4}$$

$$\epsilon_{it} \sim N(0, \sigma^2_{\epsilon,t}) \tag{5}$$

$\eta_{it}$ and $\epsilon_{it}$ are independent with each other at all leads and lags.

$cov(\eta_{it}, \eta_{is}) = 0, \forall t \neq s, cov(\epsilon_{it}, \epsilon_{is}) = 0, \forall t \neq s, cov(\eta_{it}, \epsilon_{is}) = 0, \forall t, s.$

Hence, the moment condition reads

$$V(\triangle_n u_{it}) = \sigma^2_{\eta,t+1} + ... + \sigma^2_{\eta,t+n} + \sigma^2_{\epsilon,t} + \sigma^2_{\epsilon,t+n} \tag{6}$$

With this moment restrictions, we estimate $\eta_{it}$ and $\epsilon_{it}$ using equally weighted minimum distance (EWMD) estimation. Additionally, for specifying the transitory and permanent risks in the first and last period, we impose further initial conditions:

$$\sigma^2_{\epsilon,0} = \sigma^2_{\epsilon,1} \tag{7}$$

$$\sigma^2_{\epsilon,T-1} = \sigma^2_{\epsilon,T} \tag{8}$$

# 4 Empirical Results

## 4.1 Total Sample 1983 - 2005

In this section, we present the estimates of labor income risks summarized in table 1. For both of transitory and permanent components, individual labor earning is riskier than individual wage rate, but in the similar range to household labor income. The average estimated permanent risk of household labor income is 12.43%, and transitory risk estimate is 27.31%, which are

[13]Storesletten, et al (2004) argues that the conditional variance of these shocks is countercyclical, increasing during contractions and decreasing during expansion.

[14]Krebs, Krishna and Maloney (2005) finds that the trade policy has a significant short run effect on income risk.

fairly close to the estimates of individual earning uncertainty, 11.63% and 29.36% correspondingly. The estimated permanent risk to individual wage rate has the mean of value 8.81%, which takes approximately 80% of permanent risk to individual earning. In other words, the other 20% of permanent individual earning uncertainty probably has its origins in the variation of working hours. In addition, the average estimate of transitory risk to individual labor income is 29.36%, which is larger than the estimated transitory risk to individual wage rate of value 25.77%.

Take the mean-valued household earning and individual wage rate as example to further illustrate the estimated permanent income risk. That is, this household earns around 40,000 euros per year, and the average permanent shock this family faces is 11.63% of 40,000 euros, 4,732 euros, in next year. Similarly, the person who's paid the mean individual wage rate, 15 euros per hour, then she faces a permanent loss or gain of 8.81% of 15 euros, 1.32 euros per hour, on her wage rate next year. In other words, individual wage rate is much more stable than household and individual earning in Germany. The difference between individual labor earning risk and wage rate fluctuation is roughly due to the variation of individual working time. In principle, the volatility of individual earnings has two sources, 9%in 12% comes from the variance of wage rate; the left part, around 3% has its origin of change of working hours. As observed below, the difference between income risks to household labor income and individual earning is quite limited. This implies that only a small fraction of risk to household labor earning is attributed to the change of family composition. Likewise, it is not observed in our study that labor participation decisions of housewives mainly cause the volatility of household total earning.

Table 1: **Total Sample 1983 - 2005**

| | **HH labor income** | **Ind. earning** | **Wage rate** |
|---|---|---|---|
| Sample mean | | | |
| Permanent risk $\bar{\sigma}_\eta$ | 0.1243 | 0.1163 | 0.0881 |
| Transitory risk $\bar{\sigma}_\epsilon$ | 0.2731 | 0.2936 | 0.2577 |

Figure 4 presents the time trends of HP-filtered estimates of transitory and permanent risks to all three labor income measures, where transitory income risk is higher than permanent one in each year for all three labor income measures. Before reunification, West Germany didn't have growth of permanent income risks. After including East subsample from year 1991, the permanent risks to household labor income, individual earnings and wage rate have been increasing gradually. Furthermore, reunification seems to increase transitory risk to labor income as well. For household total labor income and individual earning, permanent risks decreased until early 1990s, then started to grow afterwards. The two upper panels in figure 4 indicate that there were uptrends for the permanent risks to household and individual earnings before 2003, which is similarly observed by Fuchs-Schündeln et al(2009). Meanwhile, the permanent risks to household income, as shown in the left upper panel of figure 4, have slight decreased in last two or three years. The lower panel in figure 4 illustrates that permanent risks to individual wage rate is relatively smaller, and it also slightly declines in late 1980s and early 1990s, but stably increases after year 1991.

[Figure 4 about here]

It's also observed in figure 4 that there was a peak of permanent risk after 2000 for household labor income, while permanent risk to individual earning reached its peak before 2000. There are several possible reasons of the difference between the time trends of permanent risks to household labor income and individual earning, for example, the change of family composition, time trend of labor force participation, etc. On the other hand, transitory shocks have more volatilities than permanent ones. Transitory risks to household and individual labor earning raise until the mid-1990s and then decline. For wages, there was an earlier peak of transitory risks in 1980s.

## 4.2 East vs West Germany

So far, we treat East and West individuals symmetrically, however, income process in East and West Germany differ due to historical and institutional factors. In this section, we go through the estimation procedure as stated in section 3 for East and West samples separately to specify the distinction between income processes of East and West Germans. Our sample consists of 80% West and 20% East households, and the descriptive statistics are summarized in table b3. Table 2 below illustrates the average of annual estimates, where we notice that labor income process in East Germany is much more volatile than in West. East Germans have remarkably larger earning

uncertainty than West Germans for both permanent and transitory components. Permanent risk of individual wage rate in West Germany has mean value 6.62% over the time period, and East is 10.35% in average. That is to say, the shocks to individual wage rate of East residents is more persistent than West. The difference of income processes of East and West Germans is consistent to the observation that East Germany has higher unemployment rate and saving rate than West contemporaries.

Table 2: **East vs West Germany**

| | | **HH labor income** | **Ind. earning** | **Wage rate** |
|---|---|---|---|---|
| Sample mean | | | | |
| Permanent risk | East | 0.1444 | 0.1326 | 0.1072 |
| $\bar{\sigma}_\eta$ | West | 0.1213 | 0.1261 | 0.0833 |
| Transitory risk | East | 0.2630 | 0.3035 | 0.2210 |
| $\bar{\sigma}_\epsilon$ | West | 0.2708 | 0.2889 | 0.2564 |

Figure 5 and 6 describe the time trends of HP-filtered estimates of labor income risks in East and West. For both transitory and permanent risks, East and West Germany exhibit different time patterns. The transitory income risk declines after late 1990s for individual earning and wage rate of East Germans, and their household labor income seems to have more transitory risk after year 2000. The permanent risks to all three income measures have a decreasing trend over the whole time period in East, except for there is a small peak of permanent risk to household labor income right after year 2000 and reduction afterwards. West Germans have fairly similar time patterns of income risks to total sample: transitory risk to household labor income decreased after mid-1990, and for individual earning and wage rate, it decreases after around year 2000; and permanent risks didn't grow before reunification, and increase afterwards. Individual earning and wage rate have increasing persistent risk in last couple of years, meanwhile the permanent risk to household labor income has opposite trend.

[Figure 5 and 6 about here]

## 4.3 Female vs Male Labor Force

As observed in many countries, females have more complicated pattern of labor force supply and income process than male workers (See, e.g. Jaumotte(2005)). Besides common factors, i.e., education, experience, labor market conditions, there are other factors in determining female labor force participation. Firstly, women's labor supply decision is highly dependent on the income amount of their partners, if present. Secondly, labor market policies, such as childcare subsidies, child benefits, paid parental leaves, have strong effect on the labor participation decision of females who have very young children. Thirdly, female labor participation rate is also influenced by tax incentives to share market work between spouses dependent on the tax treatment of second earners of actual fiscal policy. Finally, other factors affect mothers' working decision, for instance, the cost of day care, concerns about child well-being, availability of a part-time job and culture. Hence, the income processes of females and males have different features. To clarify the responding properties of the income processes of female and male labor force, we estimate the labor income risk for females and males respectively. Male-headed households are in the majority of our sample, which have proportion of nearly 70%.

Table 3: **Female vs Male Labor Force**

| | | **HH labor income** | **Ind. earning** | **Wage rate** |
|---|---|---|---|---|
| Sample mean | | | | |
| Permanent risk | Female | 0.1822 | 0.1860 | 0.1410 |
| $\bar{\sigma}_\eta$ | Male | 0.1149 | 0.1055 | 0.0900 |
| Transitory risk | Female | 0.3414 | 0.3940 | 0.2758 |
| $\bar{\sigma}_\epsilon$ | Male | 0.2368 | 0.2433 | 0.2425 |

We observe from the estimates that female heads have higher variance than males. The estimated variance of both transitory and permanent components of female heads are considerably larger than males as depicted in table 3. More precisely, if one family has female head, it faces 13% higher transitory risk and 3.5% higher permanent risk to household annual labor income than male-headed one in average. The females in our sample are basically single women and women living with a not working partner or children, they have 15% more transitory earning risk and 8% more permanent

earning than male workers. The gap of wage rate volatility is relatively small, that is, transitory risk of females' wage rate is 3.2% higher and permanent risk is 5.1% higher than males. Figure 9 and 10 show the time patterns of estimated income risks of females and males from year 1983 to 2005. Permanent risks to household labor income, individual earning of females declined before reunification, but slightly increase after early 1990s. For all three income measures, females have declining trend of permanent risks after year 2000. However, for male workers, permanent risks to individual earning and wage rate grow a little bit since year 2000. But similar to females, the permanent risks to males' labor income decreased before reunification and increase afterwards for all three income measures.

[Figure 9 and 10 about here]

## 4.4 Comparison of Different Education Levels

In this section, we allow for education-specific differences for understanding the properties of stochastic income process generated by different education levels. That is, we allocate individuals into three groups according to their education level with respect to high school, namely, high school dropouts (LHS hereafter), high school graduates including other equivalent diploma (HS hereafter), and people with degrees more than high school (MHS hereafter).[15] The average of estimates of income risks w.r.t. education levels is documented in table 4, where the permanent income risks is nonlinear w.r.t. years of schooling.

People with high school and not receiving more education or training have lowest permanent risk, compared to high school dropouts and college graduates. Consider a typical high school graduate who receives necessary training and stays at the same work position during the most working time of her life, the income risk for her is relatively low. However for a college graduate who has more skill and is more adaptive and flexible to new jobs and positions, the excess volatility of labor income possible comes from switching jobs or getting promotion. Meanwhile, people with limited training, say, without high school graduation or enough professional training, mostly work part-time or for a short term. Thus, the income process of high school dropouts has more fluctuations. This observation implies that increase of human capital investment does not necessarily reduce the uninsurable income risk. In

[15]Due to the particularity of German education system, high school dropouts here are defined as people who only graduate from intermediate secondary school.

Table 4: **Comparison of Different Education Levels**

| | | **HH labor income** | **Ind. earning** | **Wage rate** |
|---|---|---|---|---|
| Sample mean | | | | |
| Permanent risk | LHS | 0.1544 | 0.1514 | 0.0830 |
| $\bar{\sigma}_\eta$ | HS | 0.1082 | 0.1111 | 0.0641 |
| | MHS | 0.1200 | 0.1461 | 0.0901 |
| Transitory risk | LHS | 0.3103 | 0.3063 | 0.2136 |
| $\bar{\sigma}_\epsilon$ | HS | 0.2578 | 0.2619 | 0.2078 |
| | MHS | 0.2099 | 0.2162 | 0.2094 |

other words, people with higher educational level and higher income face higher permanent income risks as well, since education is positively related to income. In contrast to permanent risk, transitory income risk decreases as the years of schooling increases.

# 5 Policy Evaluation

*Household Public Transfer Payments*

Besides labor income, most households receive certain amount of public transfers. For example, student grants, maternity benefits, unemployment benefits, unemployment assistance, subsistence allowance and transition are paid at individual level in the household. Housing allowances, child benefits, nursing care insurance, direct housing subsidy, subsistence assistance, support for special circumstances, social assistance for elderly and unemployment benefit II[16] are paid at household level. To evaluate the policy outcome of public transfer payments, we construct another household income measure that is the combination of household total labor income and the public transfers received at the entire household level and accepted by all the family members at individual level and exclusion of the federal taxes paid by entire family in each year. Since there are different regulations of transfer payments for

[16]Unemployment benefit II was first paid in year 2005 and instead of unemployment assistance. For avoiding potential problem generated by different regulation of unemployment benefit II and unemployment assistance, we exclude year 2005 in the analysis of policy effect.

Table 5: **Policy Evaluation**

| | **West** | | **East** | |
|---|---|---|---|---|
| | $\bar{\sigma}_\eta$ | $\bar{\sigma}_\epsilon$ | $\bar{\sigma}_\eta$ | $\bar{\sigma}_\epsilon$ |
| `HH labor income` | *0.1193* | 0.2700 | *0.1504* | 0.2608 |
| *- HH taxes* | | | | |
| *+ public transfer* | *0.1048* | 0.1872 | *0.1058* | 0.1483 |
| *- social security taxes* | | | | |
| *+ security pension* | *0.1156* | 0.2618 | *0.1334* | 0.2523 |
| `Ind. earning` | *0.1223* | 0.2928 | *0.1433* | 0.3084 |
| *+ unemployment benefit* | *0.1143* | 0.2575 | *0.1144* | 0.2176 |

East and West households, we analyze the policy effect separately for East and West Germany. As revealed in table 5 public transfers lower household income uncertainty for both permanent and transitory components, specially for East households. The permanent household income decreases by 4.5% for East families, while permanent income risk of West families declines about 1.5% after public transfers paid.

*Social Security Pensions*

Households receive old-age, disability, and widowhood social security pensions.[17] We eliminate the social security taxes from the household total labor income and incorporate the security pension income received by the family members, and estimate the stochastic process of this income measure. Table 5 indicates that social security doesn't reduce the permanent income risks as public transfers. When incorporating social pension payment, the permanent income risk to East families decreases approximately 1.7%, and permanent risk to West ones is only 0.4% lower than before receiving security pensions.

*Unemployment Benefits*

In Germany, workers with more than certain amount income should pur-

[17]In Germany, social security pensions consists of payments of the German Pension Insurance (GRV), Miner's social Insurance (Knappschaft), Civil Servant Pension (Beamtenpension), War Victim Benefits (Kriegsopferversorgung), Farmer's Benefits and accident pension (GUV).

chase unemployment insurance as fixed percentage of his income. When they are unemployed, they receive unemployment benefit within certain period, which is dependent on the payment duration. After unemployment benefit is running out and they are still in unemployment,unemployment assistance is paid at the lower living standard.[18]To discuss the welfare consequence of such unemployment insurance scheme, we estimate the permanent and transitory risks to another income measure, which is the summation of individual earning and unemployment insurance payment. Table 5 suggests that unemployment benefit reduces individual labor income risk for both permanent and transitory components. With unemployment benefit and assistance, the permanent risk to individual earnings lowers by around 3%, and transitory one declines by about 9% in East Germany. Furthermore, permanent income is reduced about 1%, transitory risk decreases 4% for insured workers in West Germany.

In all, transfer payments, social security pension system and unemployment insurance lower income risks for East and West Germans. Particularly, East Germans benefits more than their contemporaries.

[Figure 7 and 8 about here]

# 6 Extension: Income Process with MA(1) Component

## 6.1 Model Specification

Recently, many revealed empirical evidences suggest that there is third component in labor income process. For example, Heathcote, et al(2008) discover that the estimates of income risks are sensitive to the application of moment conditions. Meghir and Pistaferri (2005) model the income process as ARCH process in US. Therefore, in this section we relax the assumption about labor income process further. The innovative labor income $u_{it}$ here has three components, i.e., permanent one $\omega_{it}$ as AR(1) process, measurement error $\epsilon_{it}$ as white noise component, and transitory one $m_{it}$ with some persistent power in limited periods, which we specify as MA(1) process.

$$u_{it} = \omega_{it} + m_{it} + \epsilon_{it} \tag{6.1}$$

[18]In 2005 unemployment assistance is no longer relevant, given that unemployment assistance has been replaced by unemployment benefit II.

$$\omega_{it} = \omega_{it-1} + \eta_{it} \tag{6.2}$$

MA component $r_{it}$ has some persistent power.

$$m_{it} = r_{it} + \theta r_{it-1} \tag{6.3}$$

$\epsilon_{it} \sim N(0, \sigma^2_{\epsilon,t})$, $\eta_{it} \sim N(0, \sigma^2_{\eta,t})$, $r_{it} \sim N(0, \sigma^2_r)$.
$r_{it}$ is supposed to be white noise, therefore, time independent distributed.

## 6.2 Moment Conditions

$$u_{it} = \omega_{it} + r_{it} + \theta r_{it-1} + \epsilon_{it} \tag{6.4}$$

$$u_{it+1} = \omega_{it} + \eta_{it+1} + r_{it+1} + \theta r_{it} + \epsilon_{it+1} \tag{6.5}$$

Hence,

$$\triangle_1 u_{it} = u_{it+1} - u_{it} = \eta_{it+1} + r_{it+1} + (\theta - 1) r_{it} - \theta r_{it-1} + \epsilon_{it+1} - \epsilon_{it} \tag{6.6}$$

and

$$\triangle_n u_{it} = u_{it+n} - u_{it} = \eta_{it+1} + ... + \eta_{it+n} + r_{it+n} + \theta r_{it+n-1} - r_{it} - \theta r_{it-1} + \epsilon_{it+n} - \epsilon_{it}. \tag{6.7}$$

Therefore, the moment conditions read

$$V(\triangle_1 u_{it}) = \sigma^2_{\eta,t+1} + 2(1+\theta^2)\sigma^2_r + (-2\theta)\sigma^2_r + \sigma^2_{\epsilon,t+1} + \sigma^2_{\epsilon,t} \tag{6.8}$$

and

$$V(\triangle_n u_{it}) = \sigma^2_{\eta,t+1} + ... + \sigma^2_{\eta,t+n} + 2(1+\theta^2)\sigma^2_r + \sigma^2_{\epsilon,t+n} + \sigma^2_{\epsilon,t}. \tag{6.9}$$

The moment condition 6.8 and 6.9 are over-identified equation system with parameters$\{\sigma^2_{\eta,t}, \sigma^2_{\epsilon,t}, \sigma^2_r, \theta\}$. Therefore, we apply EWMD to generate the consistent estimates of parameters.

## 6.3 Estimation

[To be added]

# 7 Conclusion

[To be added]

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# A Step-by-step data selection

The 1983-2005 GSOEP data contains information on 60,487 individuals with 473,950 observations. We first drop the oversampling of high income subsample, which leads to sample of 56,758 individuals and 460,721 observations. The we keep individuals between 25 and 60 years old, and select only household heads. This step leaves us a sample of 17,531 individuals with 125,636 observations. We also exclude observations without education or individual earning or household labor income or individual working time information. Then we have 15,605 spells. Lastly, we eliminate observations with hourly wage rate under threshold and self-employed people, which leaves us with final sample of 14,454 individuals and 92,671 observations. When we discuss East and West Germany separately in section 4, we also drop families who ever move from East(West) to West(East) during year 1983 to 2005, where East German sample indeed has 2,746 individuals and 15,986 observations while West German sample includes 11,515 households and 75,044 observations. We do not consider year 2005 in section 5 of policy evaluation for avoiding the potential problem due to the policy reform taking place in 2005.

# B Descriptive statistics and first stage regression

Table B.1: **Summary of Selected GSOEP Data (1983-2005)**

| **Variable** | **Mean** | **(Std. Dev.)** | **Min** | **Max** |
|---|---|---|---|---|
| Male (percent) | 68.11 | . | . | . |
| West (percent) | 81.00 | . | . | . |
| High school (percent) | 64.87 | . | . | . |
| Age | 41.87 | (9.58) | 25 | 60 |
| Family size | 2.88 | (1.35) | 1 | 13 |
| Education | 11.94 | (2.69) | 7 | 18 |
| Ind. working hrs | 2057.22 | 626.75 | 13 | 5965 |
| Ind. earning | 29611.42 | (18294.58) | 56.5213 | 711663 |
| HH labor income | 41538.44 | (24249.5) | 56.5213 | 719263.4 |
| Indi. wage rate | 14.90 | (13.86) | 3 | 834.15 |

Note: labor income measures are in unit of euros in year 2000.

Table B.2: **First-stage Regression**

| **Regressor** | **Coefficient** | **(Std. Dev.)** |
|---|---|---|
| *Constant* | -4.229 | (0.027) |
| *Gender dummy* | 0.177 | (0.003) |
| *Age* | 0.041 | (0.001) |
| $Age^2/100$ | -0.039 | (0.002) |
| *Education* | 0.058 | (0.000) |
| *Family size* | 0.013 | (0.001) |
| *Region dummy* | 0.398 | (0.003) |

Note: coefficients are w.r.t. pooled sample.

Table B.3: **East vs West Germany**

| **Variable** | **Sample mean** | **(Std. Dev.)** |
|---|---|---|
| *West* | | |
| Education | 11.751 | (2.73) |
| Family size | 2.899 | (1.39) |
| Ind. working hrs | 2053.122 | (615.347) |
| Ind. earning | 31438.095 | (18957.64) |
| HH labor income | 42844.063 | (24696.001) |
| Ind. wage rate | 15.899 | (15.293) |
| *East* | | |
| Education | 12.717 | (2.368) |
| Family size | 2.852 | (1.157) |
| Ind. working hrs | 2071.02 | (646.272) |
| Ind. earning | 21182.978 | (11274.524) |
| HH labor income | 35603.876 | (20096.078) |
| Ind. wage rate | 10.503 | (6.982) |

Note: labor income measures are in unit of euros in year 2000.

# C EWMD estimation

Altonji and Segal (1996) suggests that the EWMD estimator using identity weighting matrix is superior to the two-stage GMM estimator using optimal weighting matrix when the small sample bias is taken into account. In particular, from the residuals computed in (1), the variance of $\triangle_n u_{it}$ is estimated by $\hat{V}(\triangle_{n_t} u_{it})$, therefore the objective function is

$$min \sum_{t} \sum_{1}^{T-t} [\hat{V}(\triangle_{n_t} u_{it}) - (\sigma^2_{\eta,t+1} + ... + \sigma^2_{\eta,t+n_t} + \sigma^2_{\epsilon,t} + \sigma^2_{\epsilon,t+n_t})]^2, \qquad \text{(C.1)}$$

where $T$ is the time length of panel. Here we have in maximum $T-1+...+1 = \frac{T(T-1)}{2}$ moment conditions, which are more than the number of estimated parameters ($\hat{\sigma}^2_{\eta,2}$,..., $\hat{\sigma}^2_{\eta,T}$, $\hat{\sigma}^2_{\epsilon,1}$,..., $\hat{\sigma}^2_{\epsilon,T}$). So this minimization problem, which is solved as the equation system of ($\sigma^2_{\eta,2}$,..., $\sigma^2_{\eta,T}$, $\sigma^2_{\epsilon,1}$,..., $\sigma^2_{\epsilon,T}$), is over-identified.

# D Self-employment sample

In this section, we discuss the income process of self-employment in particular. Self-employed people earn not only labor income but also asset income. Thus, the earning uncertainty of self-employment is not only idiosyncratic risk, but also aggregate risks, and both labor and asset market volatilities are reflected in the income process of self-employed people. Table d1 files the permanent and transitory income risk estimates of self-employment subsample, which are obviously larger than the estimates of other occupations shown in table 1. Particularly, the permanent component of individual earning is 8% higher and household income has 2% higher permanent risk than other occupations. Table d2 contains the estimates of income risks when including self-employment in total sample. Not surprisingly, household and individual earnings have higher permanent and transitory risks than without self-employment.

# E Figures

Table D.1: **Income risks to self-employment**

| | **HH labor income** | **Ind. earning** |
|---|---|---|
| Sample mean | | |
| Permanent risk $\bar{\sigma}_\eta$ | 0.1333 | 0.1887 |
| Transitory risk $\bar{\sigma}_\epsilon$ | 0.3286 | 0.3686 |

Table D.2: **Estimates of total sample including self-employment**

| | HH labor income | Ind. earning |
|---|---|---|
| Sample mean | | |
| Permanent risk $\bar{\sigma}_\eta$ | 0.1158 | 0.1201 |
| Transitory risk $\bar{\sigma}_\epsilon$ | 0.2712 | 0.2747 |

Figure 1: **Mean of Log Labor Incomes 1983-2005**

Figure 2: **Log Income Dispersion 1983-2005**

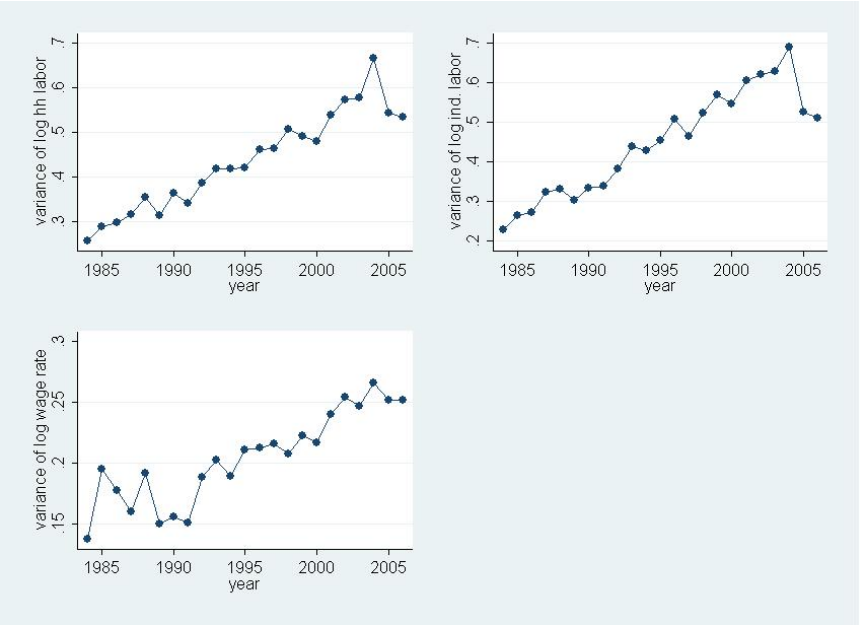



Figure 3: **Residual Income Dispersion 1983-2005**

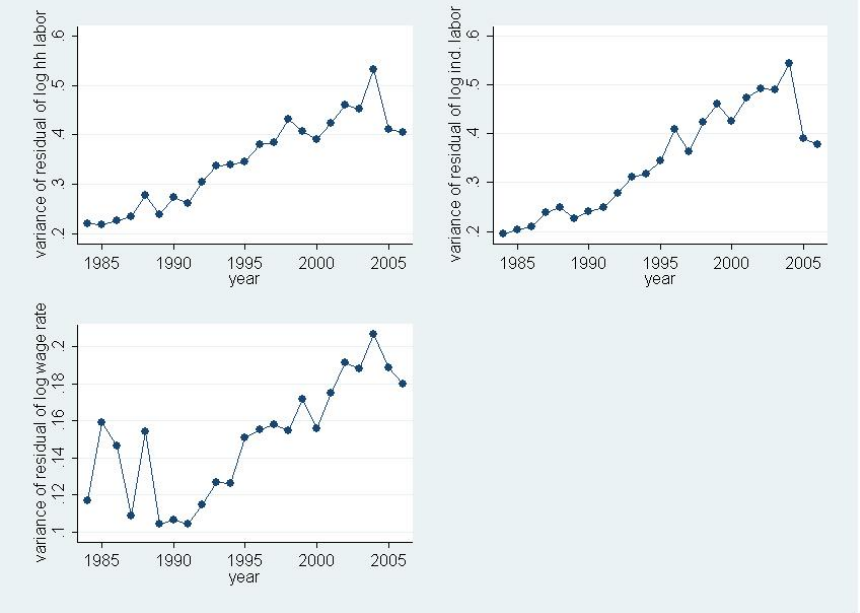
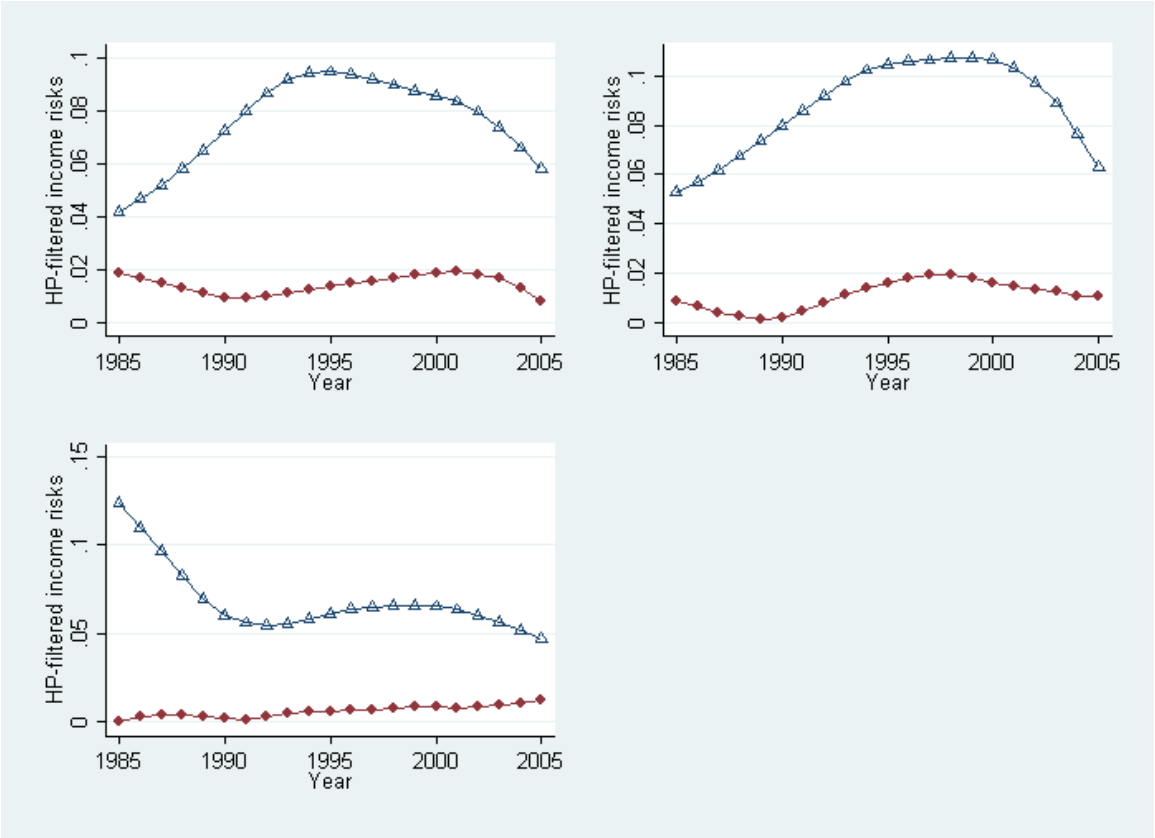
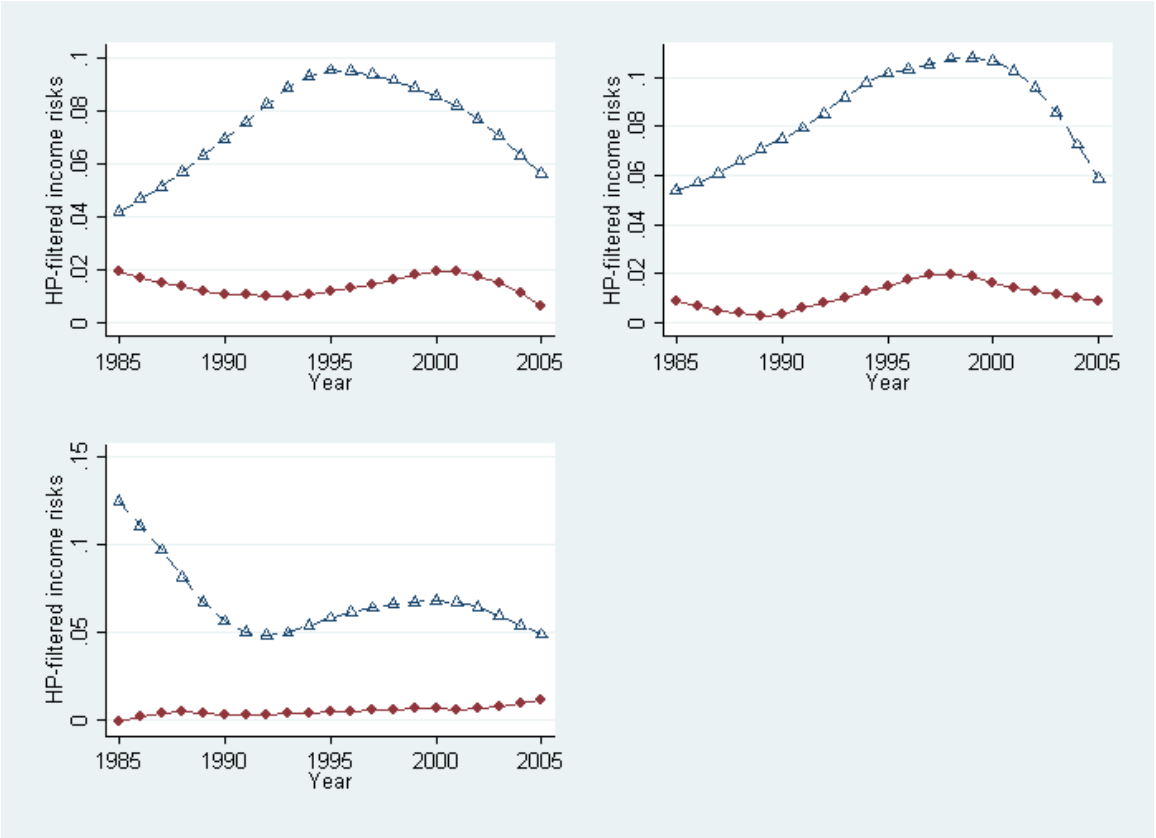


Figure 4: **Total Sample 1983 - 2005**



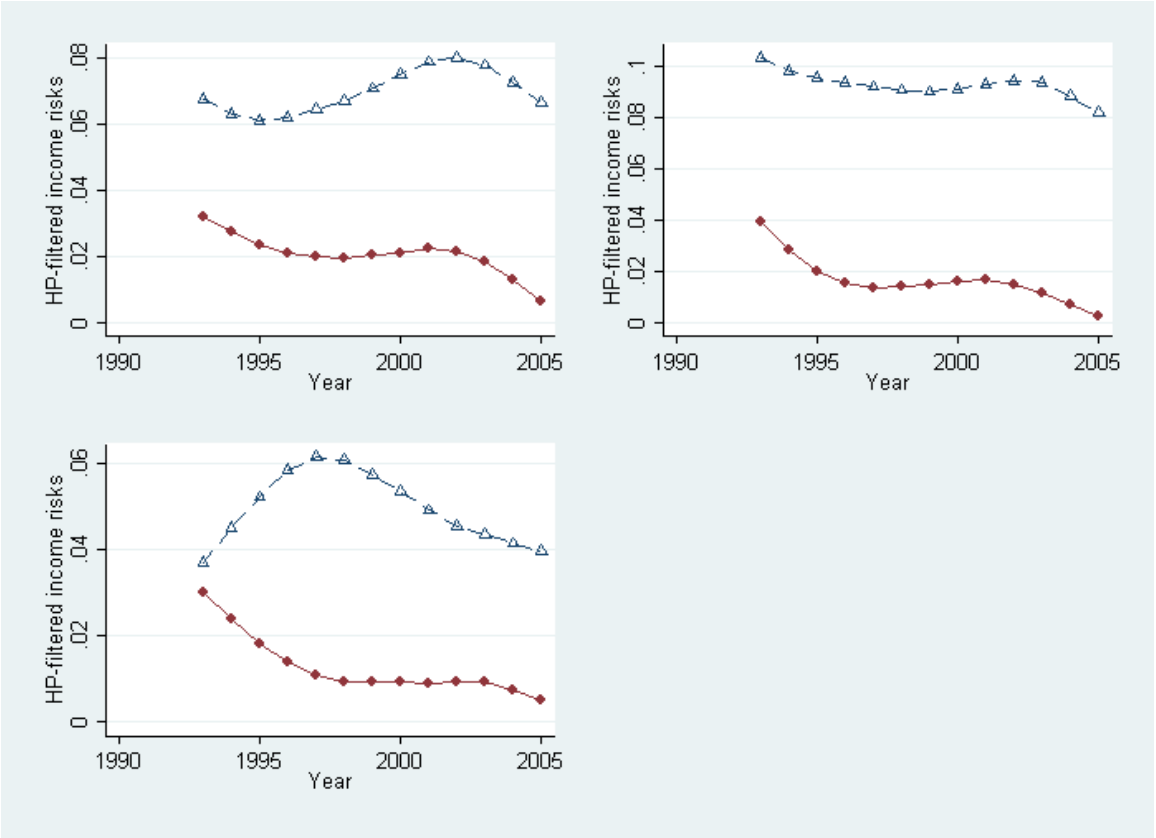

Note: the hollow triangles represent the HP-filtered ($\lambda = 6.25$) yearly estimates of transitory risks ($\hat{\sigma}_{\epsilon,t}$) to labor income, and the red dots are the HP-filtered yearly estimates of permanent risks ($\hat{\sigma}_{\eta,t}$) to labor income. The left upper panel reports the time trend of estimated risks to household labor income. The right upper panel describes the estimates of income risks to individual earning. The lower panel plots estimated income risks to individual hourly wage rate.

Figure 5: **West Germany 1983 - 2005**



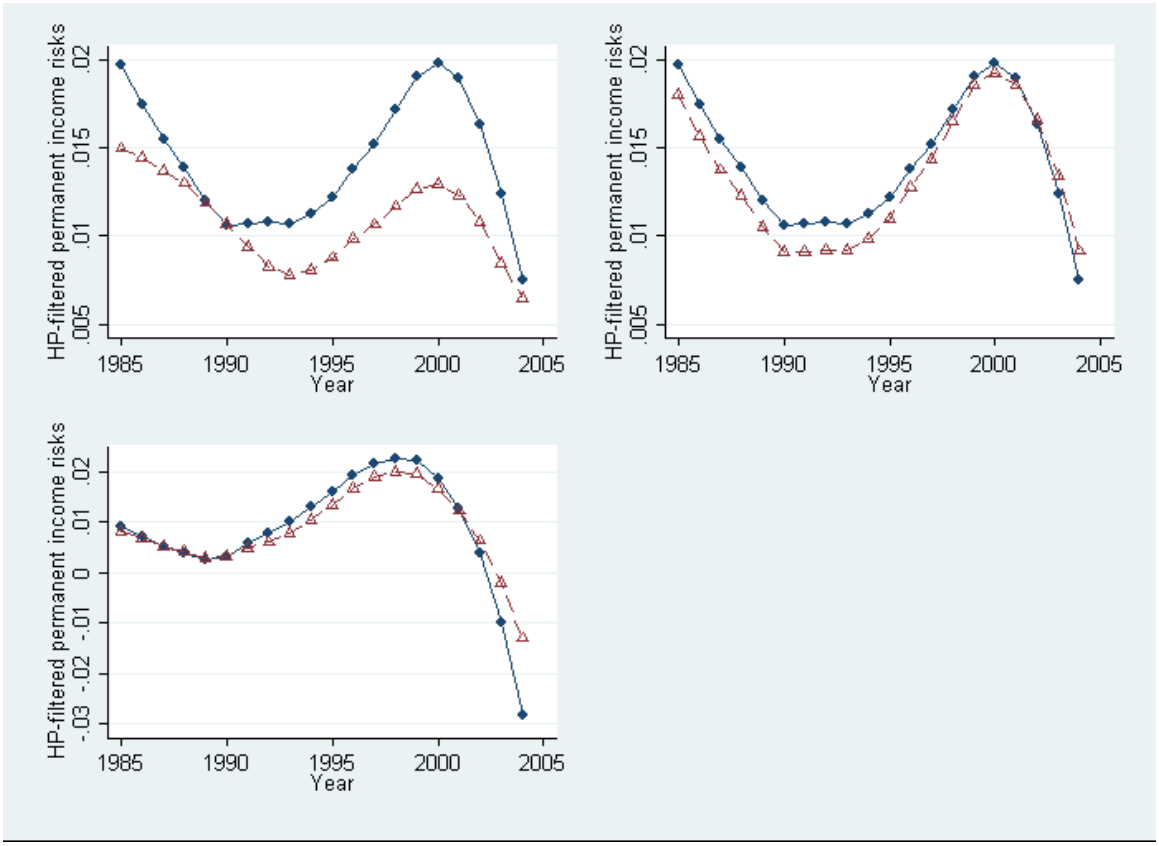

Note: the hollow triangles represent the HP-filtered ($\lambda = 6.25$) yearly estimates of transitory risks ($\hat{\sigma}_{\epsilon,t}$) to labor income of West Germans, and the red dots are the HP-filtered yearly estimates of permanent risks ($\hat{\sigma}_{\eta,t}$) to labor income of West Germans. The left upper panel reports the time trend of estimated risks to household labor income; the right upper panel describes the estimates of income risks to individual earning, and the lower panel plots estimated income risks to individual hourly wage rate in West Germany.

Figure 6: **East Germany 1991 - 2005**



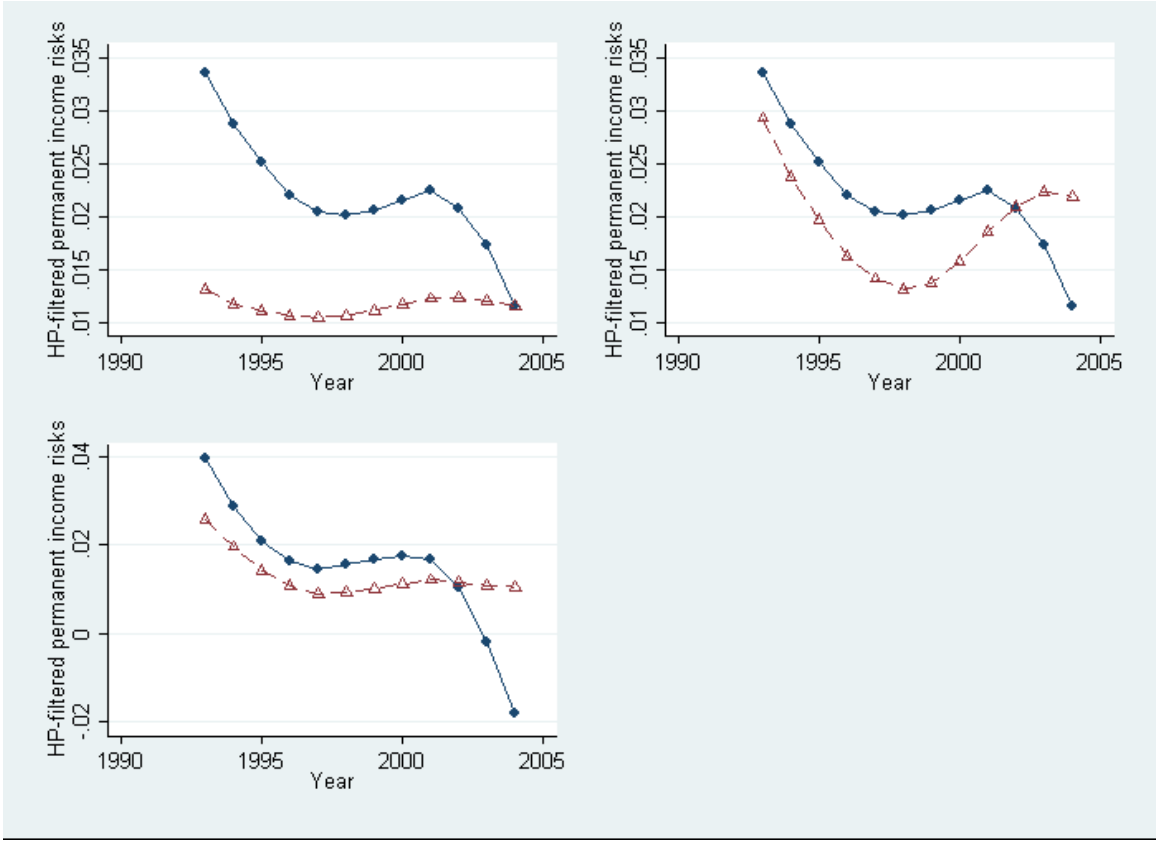

Note: the hollow triangles represent the HP-filtered ($\lambda = 6.25$) yearly estimates of transitory risks ($\hat{\sigma}_{\epsilon,t}$) to labor income of East Germans, and the red dots are the HP-filtered yearly estimates of permanent risks ($\hat{\sigma}_{\eta,t}$) to labor income of East Germans. The left upper panel reports the time trend of estimated risks to household labor income; the right upper panel describes the estimates of income risks to individual earning, and the lower panel plots estimated income risks to individual hourly wage rate in East Germany.

Figure 7: **Policy Evaluation in West Germany**



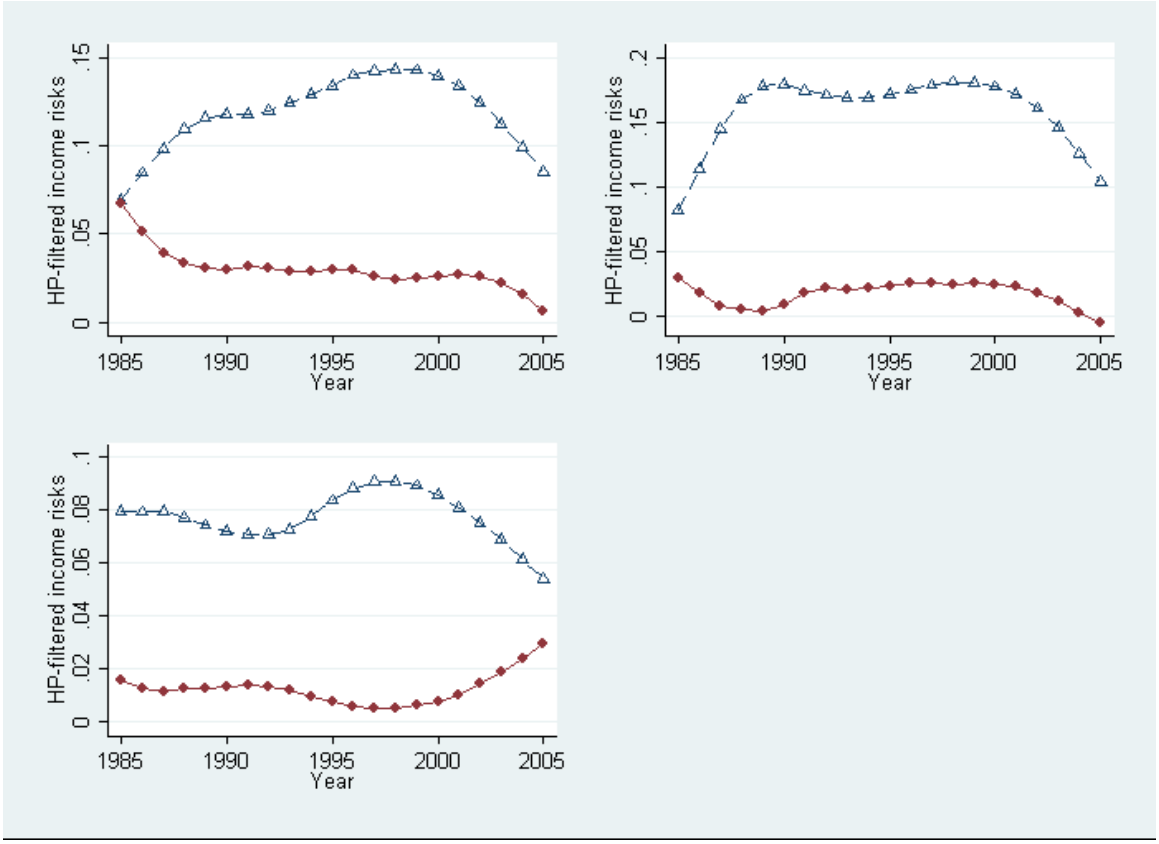

Note: the green dots are the HP-filtered ($\lambda = 6.25$) yearly estimates of permanent risks ($\hat{\sigma}_{\eta,t}$) to original labor income measures; the red hollow triangles report estimated permanent risk to individual income after transfer, security pension or unemployment benefit payments. The left upper panel reports reduction the permanent risks to household labor income due to public transfer payment; the right upper panel describes the effects of social security pension income on permanent household income risks, and the lower panel indicates the influence of unemployment benefit on permanent individual earning risks in West Germany.

Figure 8: **Policy Evaluation in East Germany**



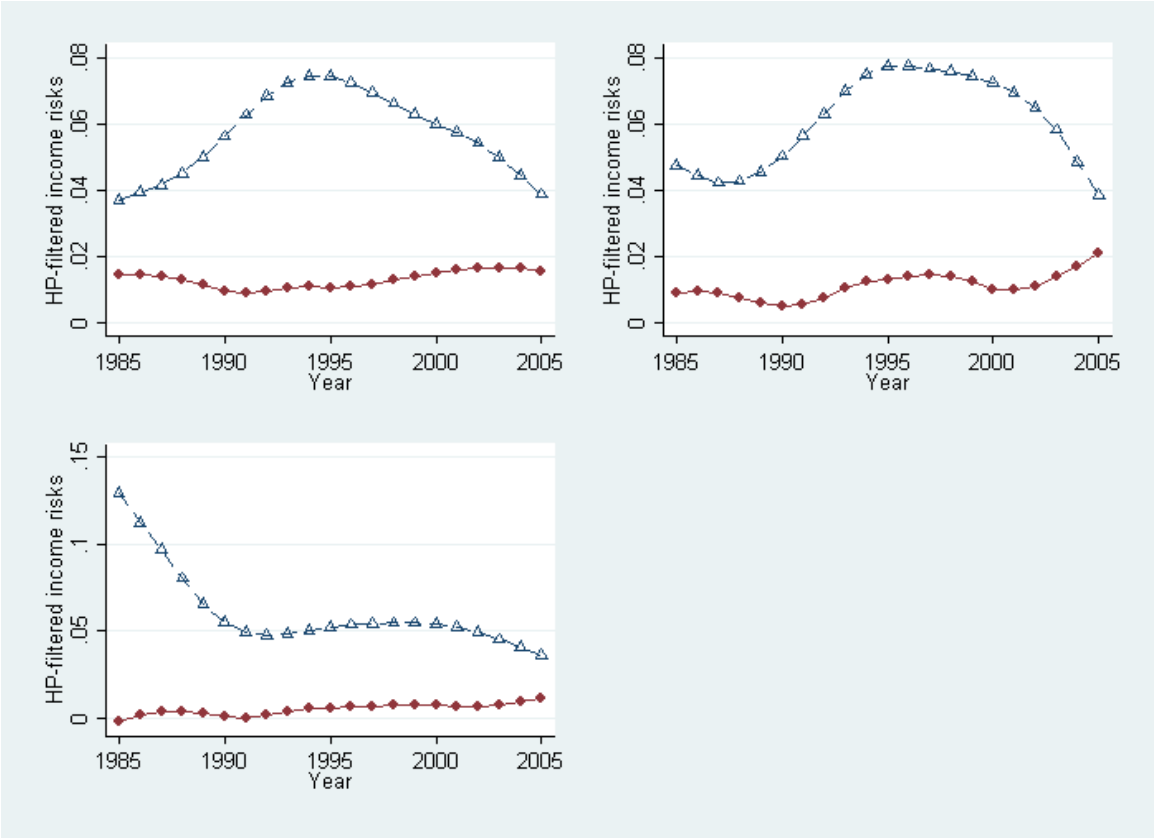

Note: the green dots are the HP-filtered ($\lambda = 6.25$) yearly estimates of permanent risks ($\hat{\sigma}_{\eta,t}$) to original labor income measures; the red hollow triangles report estimated permanent risk to individual income after transfer, security pension or unemployment benefit payments. The left upper panel reports reduction the permanent risks to household labor income due to public transfer payment; the right upper panel describes the effects of social security pension income on permanent household income risks, and the lower panel indicates the influence of unemployment benefit on permanent individual earning risks in East Germany.

Figure 9: **Female Labor Force in Germany 1983 - 2005**




Note: the hollow triangles represent the HP-filtered ($\lambda = 6.25$) yearly estimates of transitory risks ($\hat{\sigma}_{\epsilon,t}$) to labor income of females, and the red dots are the HP-filtered yearly estimates of permanent risks ($\hat{\sigma}_{\eta,t}$) to labor income of females. The left upper panel reports the time trend of estimated risks to household labor income; the right upper panel describes the estimates of income risks to individual earning, and the lower panel plots estimated income risks to individual hourly wage rate of female labor force.

Figure 10: **Male Labor Force in Germany 1983 - 2005**




Note: the hollow triangles represent the HP-filtered ($\lambda = 6.25$) yearly estimates of transitory risks ($\hat{\sigma}_{\epsilon,t}$) to labor income of males, and the red dots are the HP-filtered yearly estimates of permanent risks ($\hat{\sigma}_{\eta,t}$) to labor income of males. The left upper panel reports the time trend of estimated risks to household labor income; the right upper panel describes the estimates of income risks to individual earning, and the lower panel plots estimated income risks to individual hourly wage rate of male labor force.