Dissecting Idiosyncratic Income Risk

E Halvorsen
Statistics Norway

H Holter
U of Oslo

S Ozkan
U of Toronto

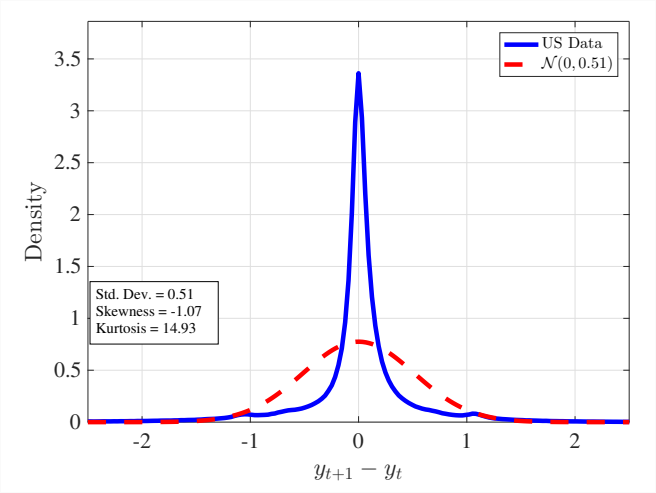
K Storesletten
U of Oslo

XIII REDg Workshop, CEMFI
November 23, 2018

Nonlinear/Non-Gaussian Earnings Dynamics

- Sparked interest in income dynamics: Guvenen *et al.* (2014, 2015), Arellano *et al.* (2017) etc.
- Non-Gaussian features of income shocks
  - Left skewness and excess kurtosis

Nonlinear/Non-Gaussian Earnings Dynamics



Nonlinear/Non-Gaussian Earnings Dynamics

- Sparked interest in income dynamics: Guvenen *et al.* (2014, 2015), Arellano *et al.* (2017) etc.
- Non-Gaussian features of income shocks
  - Left skewness and excess kurtosis
- Asymmetric/nonlinear mean reversion. Persistence differ by:
  - Current shocks change persistence of past ones (Arellano *et al.* (2017)).
  - positive vs negative changes; low vs high income workers

Nonlinear/Non-Gaussian Earnings Dynamics

- Sparked interest in income dynamics: Guvenen *et al.* (2014, 2015), Arellano *et al.* (2017) etc.
- Non-Gaussian features of income shocks
  - Left skewness and excess kurtosis
- Asymmetric/nonlinear mean reversion. Persistence differ by:
  - Current shocks change persistence of past ones (Arellano *et al.* (2017)).
  - positive vs negative changes; low vs high income workers
- New findings make their way into the quantitative macro literature:
  - McKay (2014), Kaplan *et al.* (2016), Golosov *et al.* (2016), De Nardi *et al.* (2016) and Wang *et al.* (2016)

Open Questions: Drivers of Non-Gaussian Features

Focus has been on annual individual labor income dynamics.

- What's driving skewness/kurtosis of earnings growth?
  Wages vs Hours?
- Does hourly wage dynamics exhibit non-Gaussian/ nonlinear features?
- What are the real-life events lead to large swings in earnings?

Open Questions: Insurance Against Tail Shocks

How much insurance against large earnings losses/gains from spouse and government?

- Do non-Gaussian features extend to household (husband+wife) earnings? After public insurance?
- For some questions nature of household income risk—before and after tax—is key.
- How about consumption growth distribution?

What Do We Do?

Use the Norwegian registry data to study above questions.

1. Show that patterns for annual earnings risk are remarkably similar to the US.
2. Study the role of wages vs hours in non-Gaussian properties of earnings changes.
   - Decompose earnings changes into hours and hourly wage growth.
   - Do wage and hours growth display non-Gaussian features?
3. Document the insurance against tail shocks of earnings through spouse's income and public insurance.
   - Distribution of after tax-after transfer household income growth.

Today

1. Data and Empirical Methodology
2. Earnings Growth Distribution
3. Changes in Hours vs Wages
4. Household Income Dynamics
5. Conclusion

Data and Empirical Methodology

Norwegian Registry Data

Norwegian Registry Data

- Administrative data covering the whole Norwegian population.
  - Derived from a combination of administrative registers such as annual tax records and employment register
- High quality because
  - Third-party reported: employers, banks, brokers, etc.
  - No attrition (unless someone emigrates).
- Family identifiers from the population register.
  - includes cohabitant couples.

Norwegian Registry Data: Base Sample

- Panel data between 1998 and 2014.
  - Income data goes back to 1993 but not hours.
- Today we focus on males.
  - We do the same analysis with women.
- We use ~20M year/individual observations in our analysis
- **Labor Earnings** for wage and salary workers including bonuses and other remunerations.
  - Business income for self-employed workers: no hours data.
- Deflate all values with the 2000 CPI.

Data and Empirical Methodology

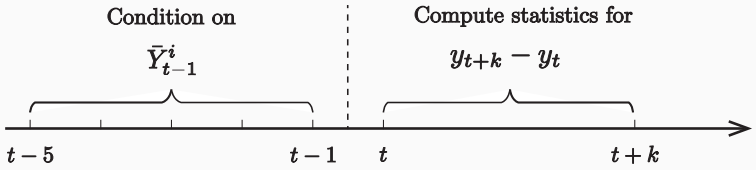
Methodology

Sample Selection

- Revolving panel of 25-60 year olds between 2003-2014.
- In year t select individuals participating in the labor market:
  - $Y_s^i > Y_s^{min}$ in $t-1$ and for 2 more years between $t-2$ and $t-5$.
  - Y_t^{min} is 5% of median earnings; approximately one quarter of full-time work at the half of the minimum wage.
- For every worker, compute recent wage earnings between $t-1$ and $t-5$, $\overline{Y}_{t-1}^i \equiv (\frac{1}{5}) \sum_{s=t-5}^{t-1} \left(\frac{Y_s^i}{d_{h_{i,s}}} \right)$.
  - Y_s^i : Total earnings in year s.
  - $d_{h_{i,s}}$: Average earnings in age $h_{i,s}$.

A Graphical Construct

- Divide the population into 3 age groups in $t-1$: 25–34, 35–44,..., 45–54.
- Within each age group rank individuals according to $\overline{Y}_{t-1}$ into 10 RE deciles.
- Within each age group, against each quantile of $\overline{Y}_{t-1}$ on the x-axis:
  - plot conditional distribution $\mathbb{F}\left(y_{t+k}-y_t|\overline{Y}_{t-1}\right)$ on the y-axis, $k=1,5$.

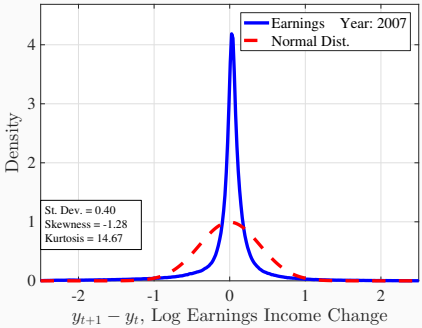


Earnings Growth Distribution

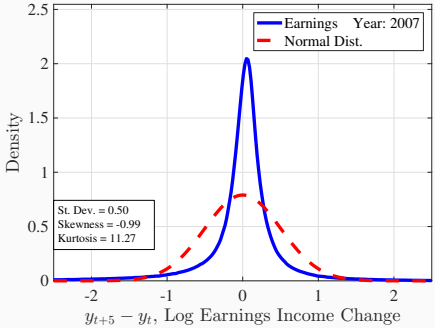
Norway vs US

Histogram of $y_{t+k} - y_t$

1-Year Growth



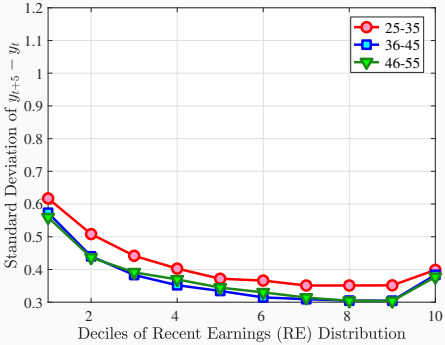
5-Year Growth



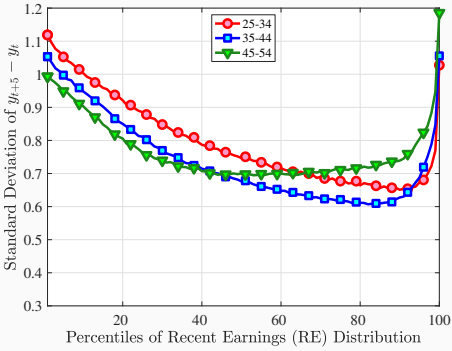
- Peaky center, narrow shoulders, long tails $\Rightarrow$ Excess kurtosis.
- Left tail longer than right tail $\Rightarrow$ Left (Negative) Skewness.

Standard Deviation of $y_{t+5} - y_t$

Norway Data



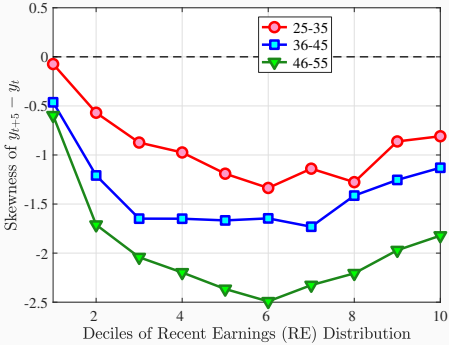
US Data



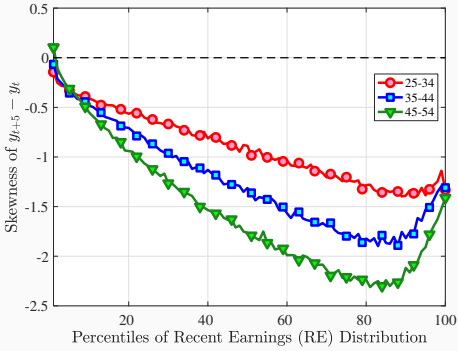
- Changes are smaller in Norway.
- RE and age variation are very similar in both countries.

Skewness of $y_{t+5} - y_t$

Norway Data



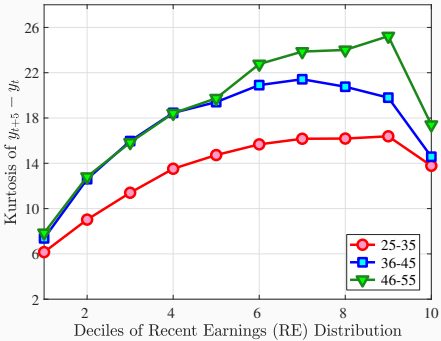
US Data



- In both economies, distributions are similarly left skewed.
- Left skewness increases by RE and age in a similar fashion.

Kurtosis of $y_{t+5} - y_t$

Norway Data



US Data

- 5-year earnings distribution exhibits higher excess kurtosis in Norway.
- Excess kurtosis follows hump-shaped pattern over RE in both.

Changes in Hours vs Wages

Hours Data

Employment Register-Administrative Data

- Hours data reported by employers between 2003 and 2014
  - On contractual working hours per week
  - Only for wage and salary workers w/ $\geq$ 4 hours/week contracts
  - No self-employed workers or freelancers
  - Cover 75% of population between 25 and 60.

Employment Register-Administrative Data

- Hours data reported by employers between 2003 and 2014
  - On contractual working hours per week
  - Only for wage and salary workers w/ $\geq$ 4 hours/week contracts
  - No self-employed workers or freelancers
  - Cover 75% of population between 25 and 60.
- Measurement error in Employment register:
  - fail to report employment spells correctly or update hour changes,
  - overtime hours are not included,
  - employers with irregular employments are more prone.

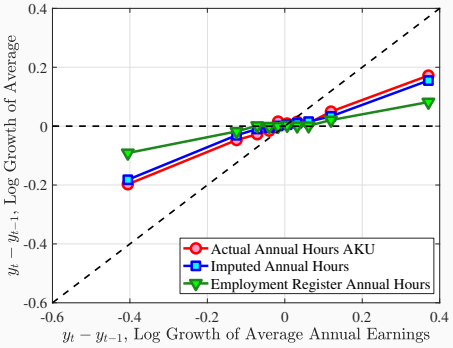
Employment Survey-AKU

- Survey data on employment and work hours
  - Measure of actual hours worked last week.
  - Better quality than register data.
- 3200 working-age individuals interviewed 8 quarters in a row.
- Compute annual hours as $h_{annual} = \sum_{t=1}^{4} 13 \times h_{actual}$
- Link observations to register data (data on annual wages, register hours, etc.)

Imputation of Hours in the Register Data

- Impute a better hours measure in administrative register data.
- Link observations to register data (data on annual wages, register hours, etc.)
- Regress the AKU hours on observables in the register data, e.g., register hours, sick days, unemp. spells, parental leave, etc.
- Estimate an hour measure in register data using the estimates of this regression.

Imputation of Hours in the Register Data



- Hours changes in register data are smaller than those from AKU.
- Imputation is doing fairly a good job in replicating the AKU measure.

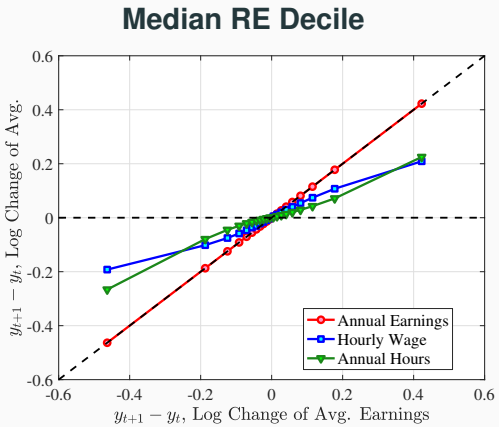
Changes in Hours vs Wages

Earnings Growth: Hours vs Wage

Annual Hours vs Hourly Wage

- Decompose changes in earnings to hourly wage or hours components.
- Group workers w.r.t. annual wage growth between $t-1$ and t, $\Delta e_{t,1}$ into 20 equally sized bins.
  - On top of conditioning on age in $t-1$ (young vs prime age) and past 5-year income (RE) deciles $\overline{Y}^{i}_{t-1}$.
  - e.g., a group of prime age men with median past income who experience 25 log points decline in earnings between $t-1$ and t.
- How much hourly wage and hours growth each group experience?

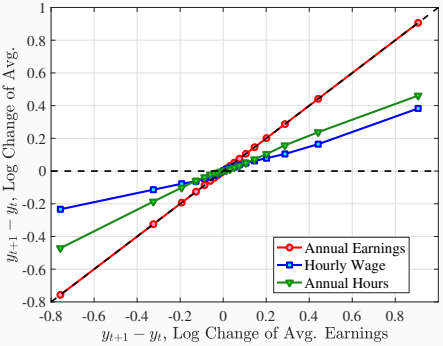
Hours vs Wage: Median RE



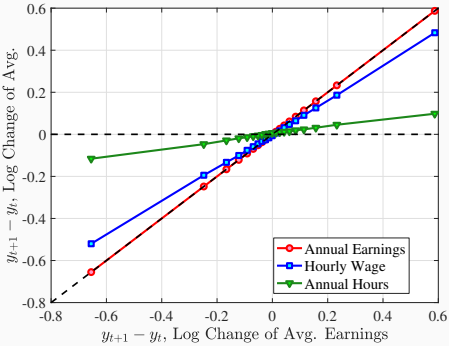
- Large earnings swings: hours and wage growth are equally important.
- Smaller earnings changes: wage growth is more important.

Hours vs Wage: Bottom vs Top RE

Bottom RE Decile



Top RE Decile

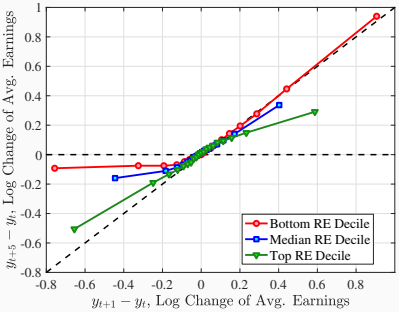


- For bottom RE group hours growth plays a more important role.
- For higher RE groups wage changes are main drivers of earnings growth. ▸ More RE Groups ▸ Average of Log Growth

Changes in Hours vs Wages

Dynamics of Hours and Wage Growth

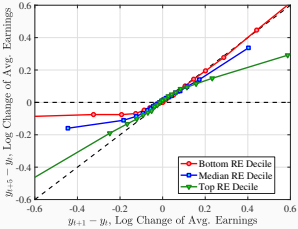
Asymmetric Mean Reversion: Dynamics of Earnings



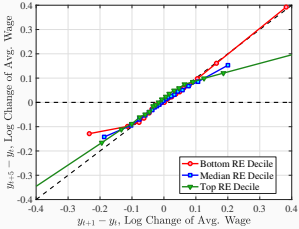
- For bottom (and median) RE group negative changes are transitory and positive changes are very persistent.
- The opposite is true for top RE group.

Asymmetric Mean Reversion:Hours vs Wages

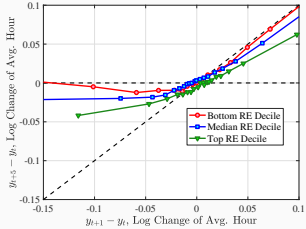
Earnings Growth



Wage Growth



Hours Change



- Wage changes are very persistent (except for top RE).
- Declines in hours are transitory and increases persistent (not so much for top RE).

Changes in Hours vs Wages

Distribution of Hours vs Wage Growth

Distribution of Hours vs Wage Growth

- Does hourly wage and annual hours growth distribution exhibit non-Gaussian/nonlinear features?
  - Plot their distributions and higher-order moments.
- How much of the left skewness and excess kurtosis of annual earnings growth are driven by changes in hourly wages vs hours?
  - Decompose skewness and kurtosis of earnings into hours and wage components.

Decomposing Higher-Order Moments

$$\underbrace{e_{t+k} - e_t}_{\Delta e_{t,k}} = \underbrace{w_{t+k} - w_t}_{\Delta w_{t,k}} + \underbrace{h_{t+k} - h_t}_{\Delta h_{t,k}}$$

- $\Delta e_{t,k}$: log annual wage growth between t and $t+k$
- $\Delta w_{t,k}$: log hourly wage growth between t and $t+k$
- $\Delta h_{t,k}$: log annual hours growth between t and $t+k$

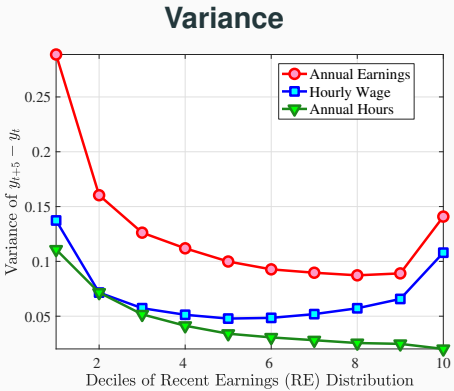
Skewness Decomposition

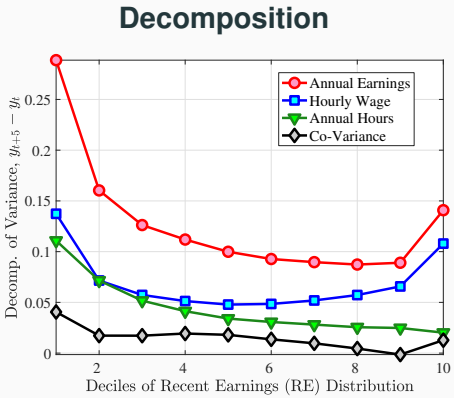
$$s_{\Delta e_{t,k}} = \left(\frac{\sigma_{\Delta w_{t,k}}}{\sigma_{\Delta e_{t,k}}}\right)^3 \times s_{\Delta w_{t,k}} + \left(\frac{\sigma_{\Delta h_{t,k}}}{\sigma_{\Delta e_{t,k}}}\right)^3 \times s_{\Delta h_{t,k}} + \text{co-}s_{\Delta w_{t,k},\Delta h_{t,k}}$$

Kurtosis Decomposition

$$\kappa_{\Delta e_{t,k}} = \left(\frac{\sigma_{\Delta w_{t,k}}}{\sigma_{\Delta e_{t,k}}}\right)^4 \times \kappa_{\Delta w_{t,k}} + \left(\frac{\sigma_{\Delta h_{t,k}}}{\sigma_{\Delta e_{t,k}}}\right)^4 \times \kappa_{\Delta h_{t,k}} + \text{co-}\kappa_{\Delta w_{t,k},\Delta h_{t,k}}$$

Variance of $y_{t+5} - y_t$ for Prime Age Male



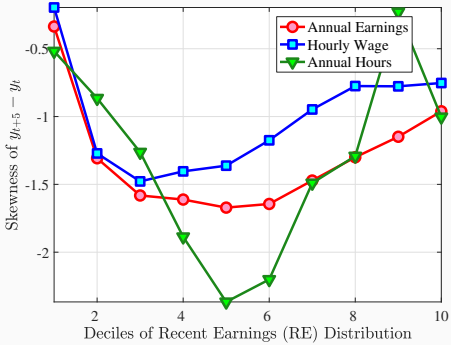


- Hourly wage is more volatile than hours especially above the median.
- Similar to the PSID (Heathcote *et al.* (2014)). ▸ 1-Year Growth Variance

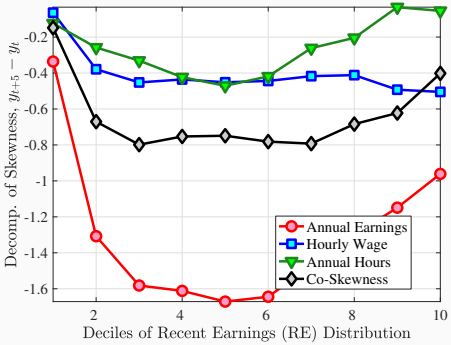
▸ 5-Year Growth Variance-Gaussian

Skewness of $y_{t+5} - y_t$ for Prime Age Male

Skewness



Decomposition

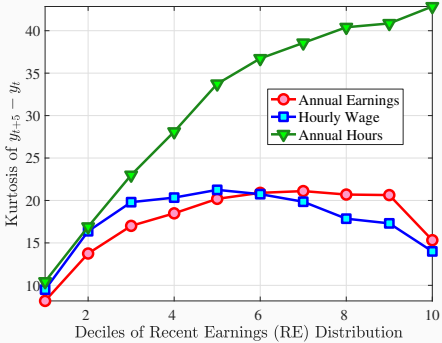


- Both hours and wage growth are left skewed.
- Wage growth and more importantly co-skewness are driving the left skewness of earnings growth.

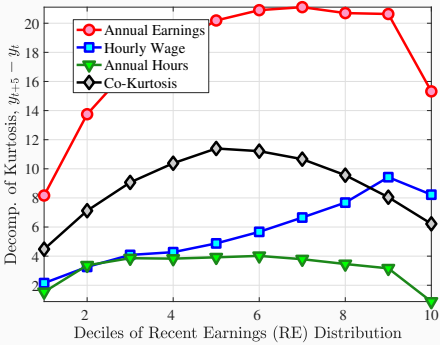
▸ 1-Year Growth Skewness ▸ 5-Year Growth Skewness-Gaussian

Kurtosis of $y_{t+5} - y_t$ for Prime Age Male

Kurtosis



Decomposition



- Wage and hours growth are both leptokurtic (especially hours growth).
- Excess kurtosis due to hourly wage dominates the hours.

▸ 1-Year Growth Kurtosis ▸ 5-Year Growth Kurtosis-Gaussian

Changes in Hours vs Wages

Earnings Swings and Important Life Cycle Events

Earnings Swings and Important Life Cycle Events

Event—in/out	1-Year Earnings Loss			1-Year Earnings Growth		
	> 0.5	$[0.5, 0.25)$	$[0.25, 0.0)$	$[0.0, 0.25)$	$[0.25, 0.5)$	≥ 0.5
Unemployment	8%	7%	2%	2%	7%	8%
Sickness	23%	21%	8%	8%	19%	20%
Part time	15%	13%	6%	8%	19%	23%
Parental leave	6%	9%	5%	6%	7%	5%
Firm change	19%	19%	10%	11%	21%	23%

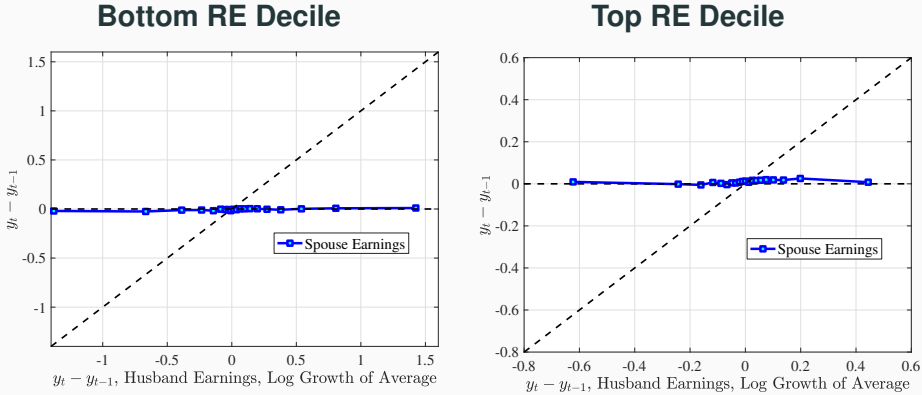
Household Income Dynamics

Insurance Against Tail Shocks

Insurance Against Tail Shocks

- How much insurance against tail shocks from
  - Spousal income & Government tax and transfers
  - After 1 year? After 5 years?
- **Capital income** includes positive interests, dividends and realized capital gains and losses.
  - excludes unrealized capital gains.
- **Tax and transfers** include UI, DI, SS pension, sickness benefits, paid maternity leave, money received on government activity program.
  - No in kind transfers: health care, daycare subsidies, schools, etc.
- **Imputed consumption** using the budget constraint of the household.

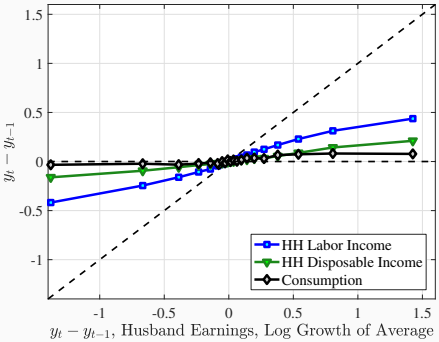
Spousal Insurance



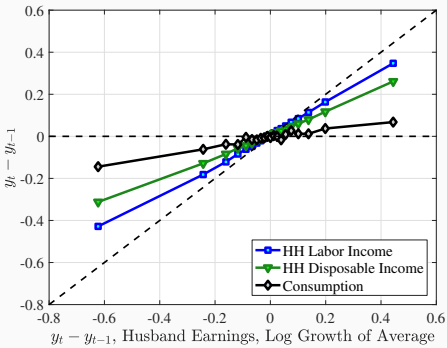
- No change in behavior of spouse or her earnings (not showing the SE income).

Public Insurance

Bottom RE Decile



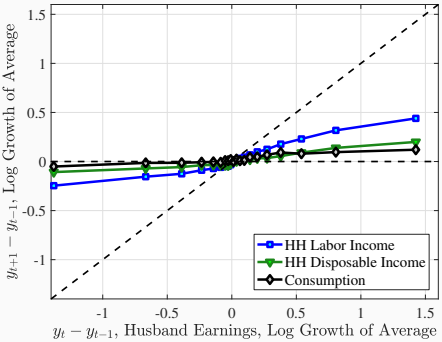
Top RE Decile



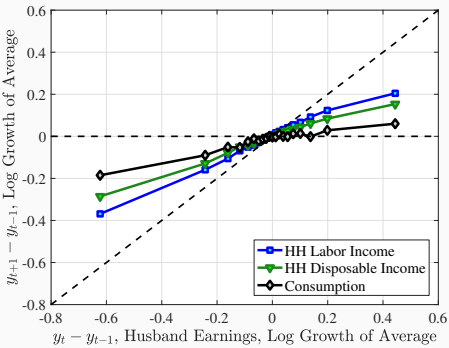
- Strong second earner effect (more so for low RE).
- Public insurance is much more helpful with tail shocks for low income.
- High RE can rely on self insurance for consumption.

Public Insurance, 1 Year Later

Bottom RE Decile



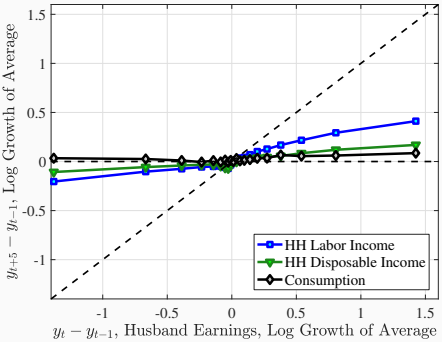
Top RE Decile



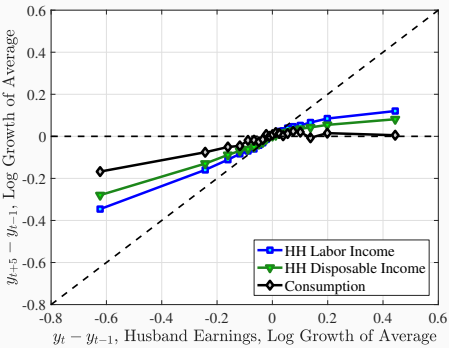
- After 1 year bottom RE see a very small decline in consumption (larger for top RE).
- Earnings losses are more persistent for top RE.

Public Insurance, 5 Years Later

Bottom RE Decile



Top RE Decile



- Earnings changes are more persistent for top RE (especially negative changes).
- After 5 years, top RE still hasn't recovered the losses between t and $t-1$.

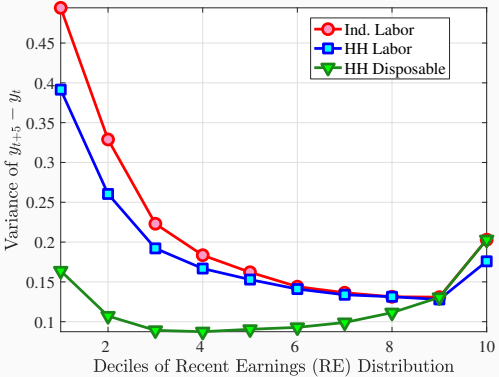
Household Income Dynamics

Distribution of Household Income Growth

Nature of Idiosyncratic Income Risk

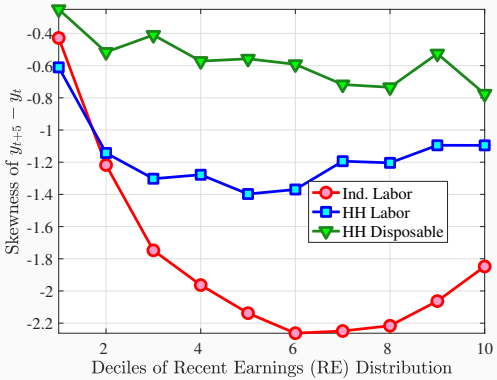
- Do non-Gaussian features of annual earnings growth distribution extend to
  - household (husband+wife) earnings?
  - After tax/after transfer disposable household income?
- For some questions nature of household income risk—before and after tax—is key.
- Plot their distributions and higher-order moments.

Variance of 5-Year Income Growth, $y_{t+5} - y_t$



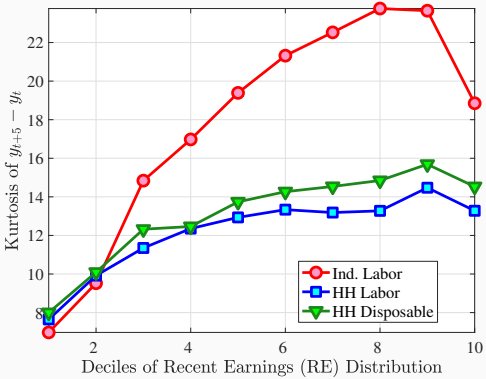
- HH labor is less volatile than individual labor.
- Taxes and transfers reduces variance substantially.

Skewness of 5-Year Income Growth, $y_{t+5} - y_t$



- Spousal income reduces negative skewness due to second earner effect (similar for the US, Pruitt and Turner (2018)).
- Public insurance reduces left tail further.

Kurtosis of 5-Year Income Growth, $y_{t+5} - y_t$



- HH labor and disposable income are still substantially leptokurtic, less so than individual earnings growth though.

Summary of Findings

1. Excess kurtosis and left skewness of earnings growth in Norway are remarkably similar to the US.

Summary of Findings

1. Excess kurtosis and left skewness of earnings growth in Norway are remarkably similar to the US.
2. Large earnings swings: wage $\gtrsim$ hours but more so for higher RE
   - Wages are important for skewness and kurtosis of earnings growth for higher RE

Summary of Findings

1. Excess kurtosis and left skewness of earnings growth in Norway are remarkably similar to the US.
2. Large earnings swings: wage $\gtrsim$ hours but more so for higher RE
   - Wages are important for skewness and kurtosis of earnings growth for higher RE
3. Spousal inc. reduces the variance and skewness of earnings growth
   - mainly through second earner effect (no behavior change)

Summary of Findings

1. Excess kurtosis and left skewness of earnings growth in Norway are remarkably similar to the US.
2. Large earnings swings: wage$\gtrsim$hours but more so for higher RE
   - Wages are important for skewness and kurtosis of earnings growth for higher RE
3. Spousal inc. reduces the variance and skewness of earnings growth
   - mainly through second earner effect (no behavior change)
4. Taxes/transfers provide insurance against tail shocks—more for low RE groups

Summary of Findings

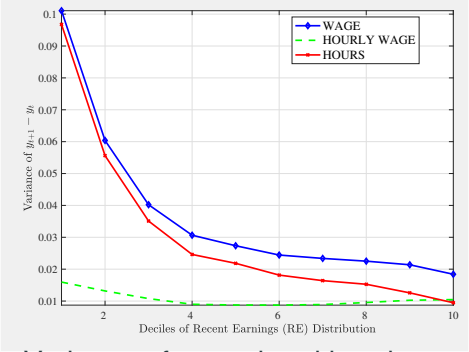
1. Excess kurtosis and left skewness of earnings growth in Norway are remarkably similar to the US.
2. Large earnings swings: wage$\gtrsim$hours but more so for higher RE
   - Wages are important for skewness and kurtosis of earnings growth for higher RE
3. Spousal inc. reduces the variance and skewness of earnings growth
   - mainly through second earner effect (no behavior change)
4. Taxes/transfers provide insurance against tail shocks—more for low RE groups
5. Even the disposable income growth exhibits long tails, less so then earnings.

September Sample

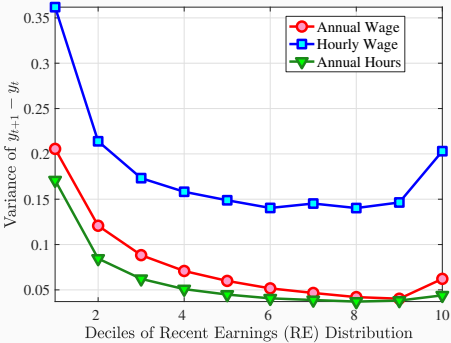
- Norway also surveys employers in **September** for more precise measure of hours.
  - An input to the annual wage negotiations between the unions and the employers,
  - For a sample of the largest private sector employers within each industry,
  - covering approximately 52% of firms and 70% of employees working in the private sector.
- Sample: Workers employed in a big firm two Septembers in a row and the past three Septs in the last 5 years.
  - no extensive margin in September
- Hourly wage=regular monthly wage/regular monthly hours

Variance of $y_{t+1} - y_t$ for Prime Age Male

September Sample



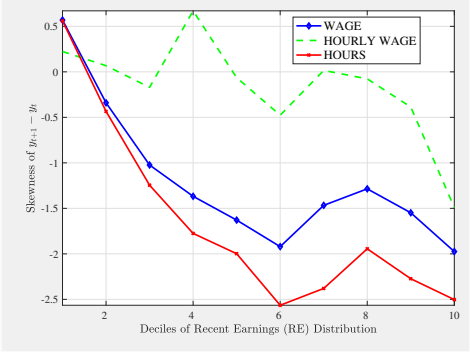
Employment Register



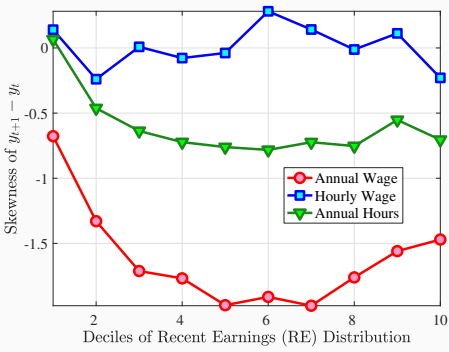
- Variance of annual and hourly wages are much smaller in September sample than Employment register.
- No overtime and bonuses are not included.

Skewness of $y_{t+1} - y_t$ for Prime Age Male

September Sample



Employment Register

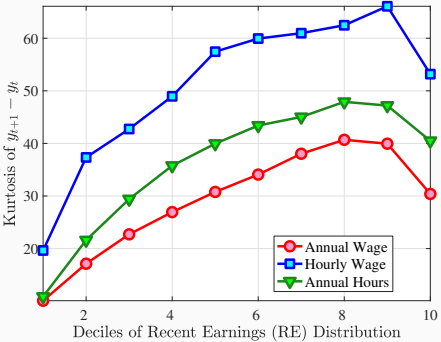


- Both samples display left skewness for hours growth and not so much for hourly wage growth.

Kurtosis of $y_{t+1} - y_t$ for Prime Age Male

September Sample

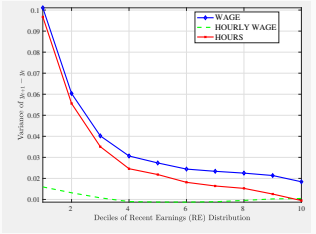
Employment Register



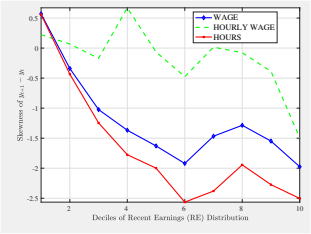
- September sample displays more excess kurtosis for both hours and hourly wage growth then employment register.

Higher Order Moments in September Sample

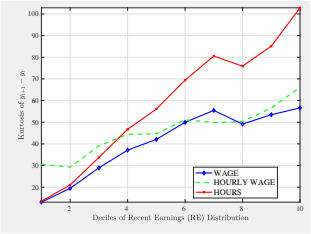
Variance



Skewness

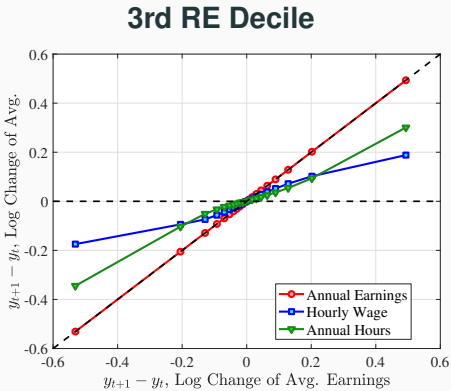


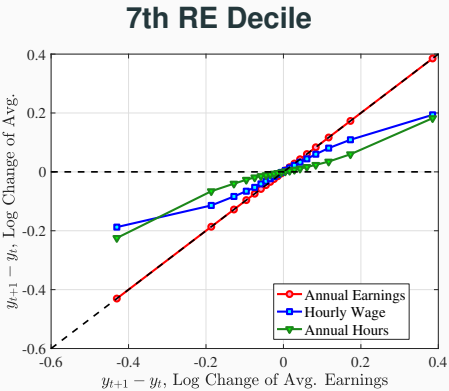
Kurtosis



- Variance of annual and hourly wages are much smaller in September sample than Employment register.
- Both samples display left skewness and excess kurtosis for both hours and hourly wage growth.

Hourly Wage vs Annual Hours: 3rd and 7th RE Groups



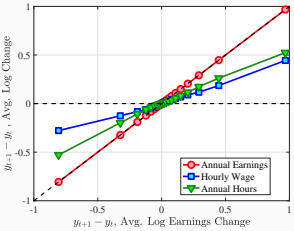


- Hourly wage growth plays a more important role for higher RE groups.

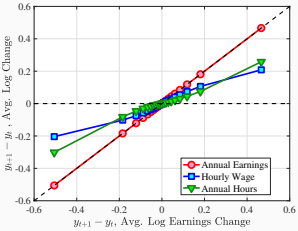
▸ Go back!

Hourly Wage vs Annual Hours: Average of Log Change

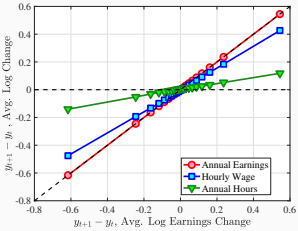
1st RE Decile



5th RE Decile



10th RE Decile



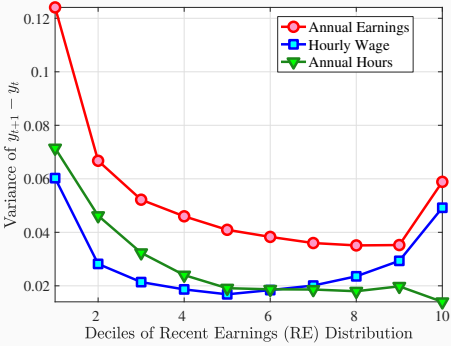
- Hourly wage growth plays a more important role lower RE groups.
- Wage changes drive earnings growth top RE groups. Go back!

Hourly Wage vs Annual Hours

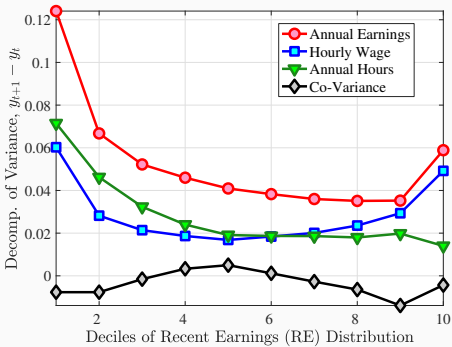
1-Year Moment Decomposition

Variance of $y_{t+1} - y_t$ for Prime Age Male

Variance



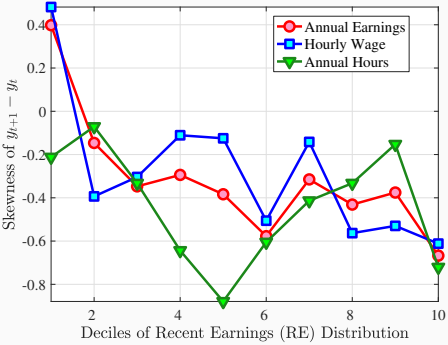
Decomposition



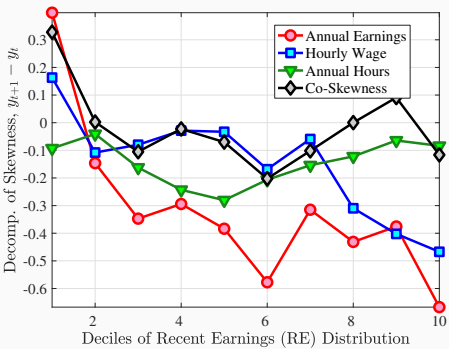
- Hourly wage is more volatile than hours above the median.
- Similar to the PSID (Heathcote *et al.* (2014)). ▸ 5-Year Growth Variance

Skewness of $y_{t+1} - y_t$ for Prime Age Male

Skewness



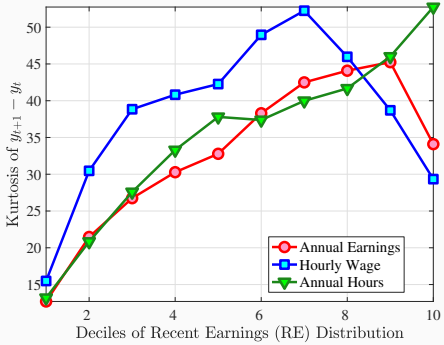
Decomposition



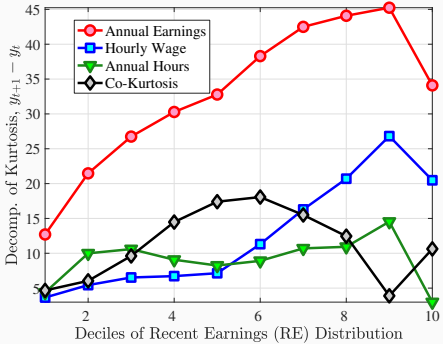
- Hours and wagre growth are left skewed.
- For top earners wage growth is key for left skewness of earnings growth. ▸ 5-Year Growth Skewness

Kurtosis of $y_{t+1} - y_t$ for Prime Age Male

Kurtosis



Decomposition



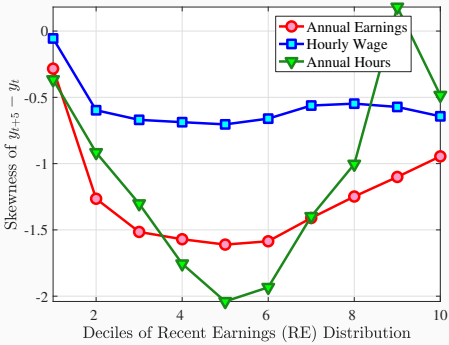
- Hourly wage and hours growth are both leptokurtic similar to earnings growth.
- Excess kurtosis due to hourly wage dominates the hours above the median. ▸ 5-Year Growth Kurtosis

Hourly Wage vs Annual Hours

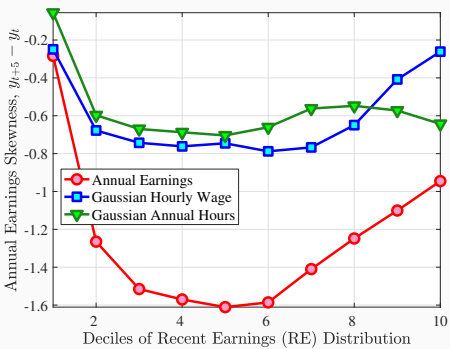
Gaussian Decomposition: 5-Year Growth

Skewness of $y_{t+5} - y_t$ for Prime Age Male

Skewness



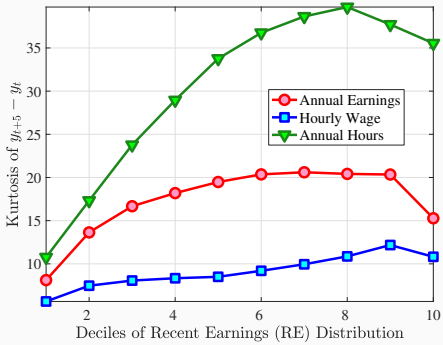
Decomposition



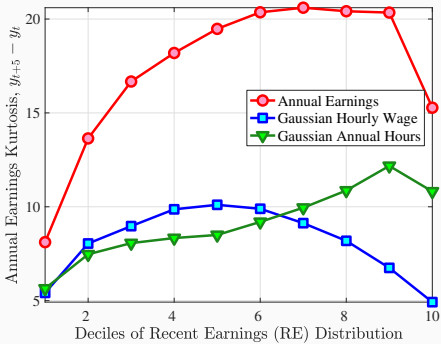
- Hours and wagre growth are left skewed.
- For top earners wage growth is key for left skewness of earnings growth. ▸ 5-Year Growth Skewness

Kurtosis of $y_{t+5} - y_t$ for Prime Age Male

Kurtosis



Decomposition



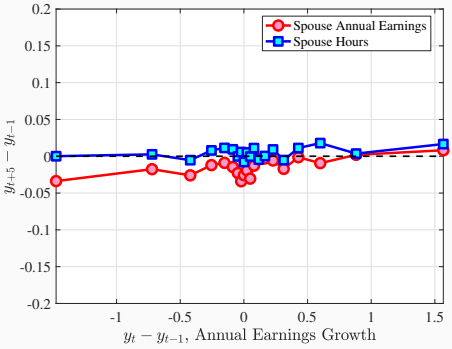
- Hourly wage and hours growth are both leptokurtic similar to earnings growth.
- Excess kurtosis due to hourly wage dominates the hours above the median. ▸ 5-Year Growth Kurtosis

Hourly Wage vs Annual Hours

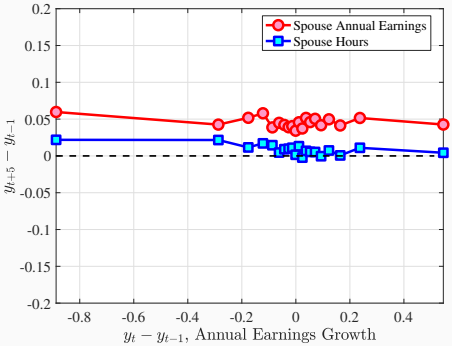
Spousal Insurance After 5 Years

Spousal Insurance, 5 Years Later

Bottom RE Decile



Top RE Decile



- Almost no change in behavior of spouse.
- For higher RE groups husband and wife's earnings changes are positively correlated.

References i

ARELLANO, M., BLUNDELL, R. and BONHOMME, S. (2017). Earnings and consumption dynamics: a nonlinear panel data framework. *Econometrica*, **85** (3), 693–734.

DE NARDI, M., FELLA, G. and PARDO, G. P. (2016). *The Implications of Richer Earnings Dynamics for Consumption, Wealth, and Welfare*. Working paper 21917, National Bureau of Economic Research.

GOLOSOV, M., TROSHKIN, M. and TSYVINSKI, A. (2016). Redistribution and social insurance. *American Economic Review*, **106** (2), 359–386.

GUVENEN, F., KARAHAN, F., OZKAN, S. and SONG, J. (2015). *What Do Data on Millions of U.S. Workers Say About Labor Income Risk?* Working Paper 20913, National Bureau of Economic Research.

References ii

—, OZKAN, S. and SONG, J. (2014). The Nature of Countercyclical Income Risk. *Journal of Political Economy*, **122** (3), 621–660.

HEATHCOTE, J., STORESLETTEN, K. and VIOLANTE, G. L. (2014). Consumption and labor supply with partial insurance: An analytical framework. *American Economic Review*.

KAPLAN, G., MOLL, B. and VIOLANTE, G. L. (2016). *Monetary Policy According to HANK*. Working paper, Princeton University.

MCKAY, A. (2014). *Time-Varying Idiosyncratic Risk and Aggregate Consumption Dynamics*. Working paper, Boston University.

WANG, C., WANG, N. and YANG, J. (2016). Optimal consumption and savings with stochastic income and recursive utility. *Journal of Economic Theory*.