Dissecting Idiosyncratic Income Risk

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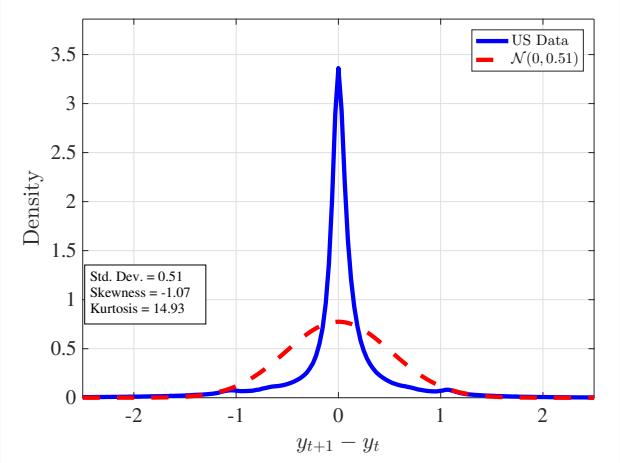
Nonlinear/Non-Gaussian Earnings Dynamics

- Sparked interest in income dynamics: Guvenen *et al.* (2015); Arellano *et al.* (2017); De Nardi *et al.* (2019); Guvenen *et al.* (2014); Busch *et al.* (2015), ...
- Non-Gaussian features of income shocks
  - Left skewness and excess kurtosis

Nonlinear/Non-Gaussian Earnings Dynamics



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  - positive vs negative changes; low vs high income workers; age
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- Asymmetric/nonlinear mean reversion. Persistence differ by:
  - positive vs negative changes; low vs high income workers; age
  - Current shocks change persistence of past ones.
- New findings make their way into the quantitative macro literature:
  - De Nardi *et al.* (2016), McKay (2014), Kaplan *et al.* (2016), and Golosov *et al.* (2016), Busch and Ludwig (2017)...

Open Questions: Drivers of Non-Gaussian Features

Focus has been on annual individual/household earnings dynamics; except for recent work by De Nardi *et al.* (2019); Busch *et al.* (2019).

- 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 that 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.

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  - Y_t^{min} is 5% of median earnings; approximately one quarter of full-time work at the half of the minimum wage.

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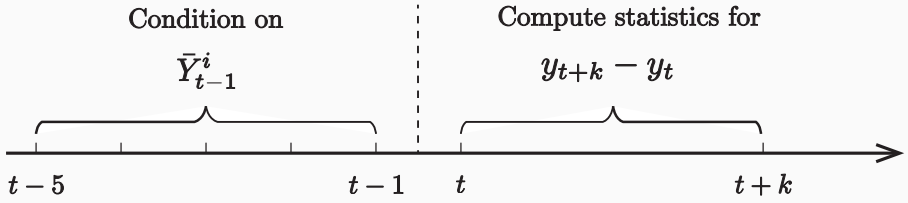
- For every worker, compute recent wage earnings between $t-1$ and $t-5$, $\overline{Y}_{t-1}^i \equiv (\frac{1}{5}) \sum_{s=t-5}^{t-1} \left(\frac{Y_s^i}{d_{h_{i,s}}} \right)$.
  - Y_s^i : Total earnings in year s.
  - $d_{h_{i,s}}$: Average earnings in age $h_{i,s}$.

A Graphical Construct

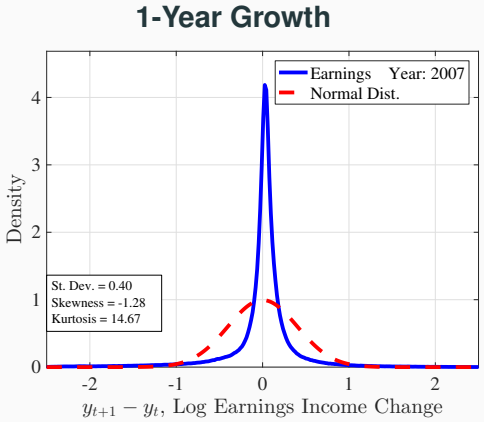
- Divide the population into 3 age groups in $t-1$: 25–34, 35–44, 45–54.
- Within each age group rank individuals according to $\overline{Y}_{t-1}$ into 10 RE deciles.
- Within each age group, against each quantile of $\overline{Y}_{t-1}$ on the x-axis:
  - plot conditional distribution $\mathbb{F}\left(y_{t+k}-y_t|\overline{Y}_{t-1}\right)$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

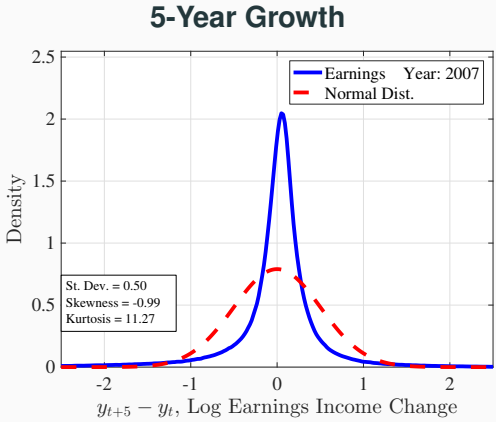


Earnings Growth Distribution

Norway vs US

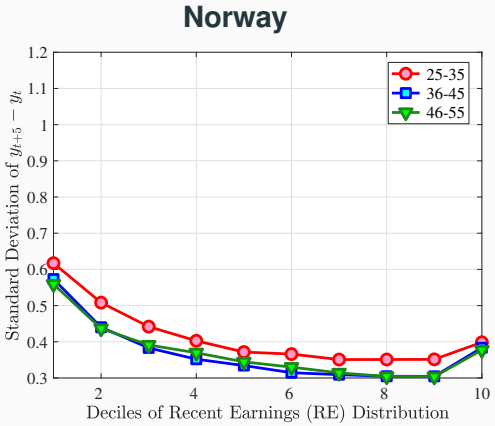
Histogram of $y_{t+k} - y_t$

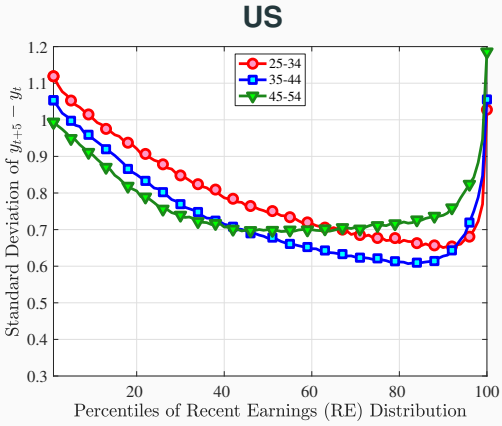




- Peaky center, narrow shoulders, long tails $\Rightarrow$ Excess kurtosis.
- Left tail longer than right tail $\Rightarrow$ Left (Negative) Skewness.

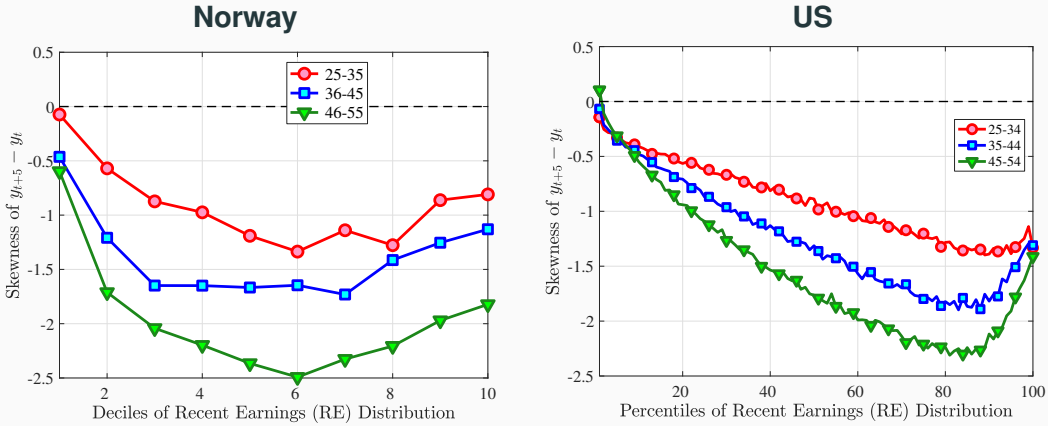
Standard Deviation of $y_{t+5} - y_t$





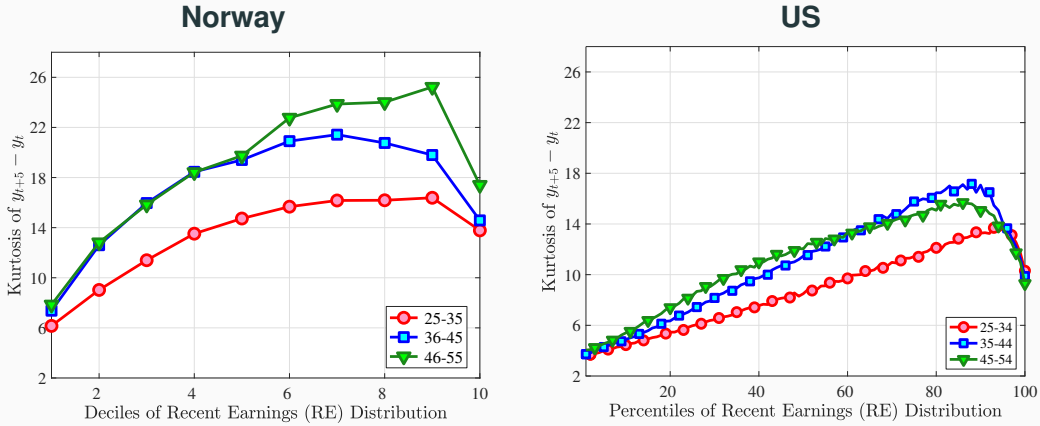
- Changes are smaller in Norway.
- RE and age variation are very similar in both countries.

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



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

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



- 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, employment duration and sector
  - Only for wage and salary workers w/ $\geq$ 4 hours/week contracts
  - No self-employed workers or freelancers
  - Cover 77% of population between 25 and 60.

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  - Cover 77% 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

- Norwegian Labor Force Survey (AKU) 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 $h_{annual} = \sum_{t=1}^{4} 13 \times h_{actual}$
- The same individuals are present both in the AKU and in the register data.
  - Link observations to register data (data on annual wages, register hours, etc.)

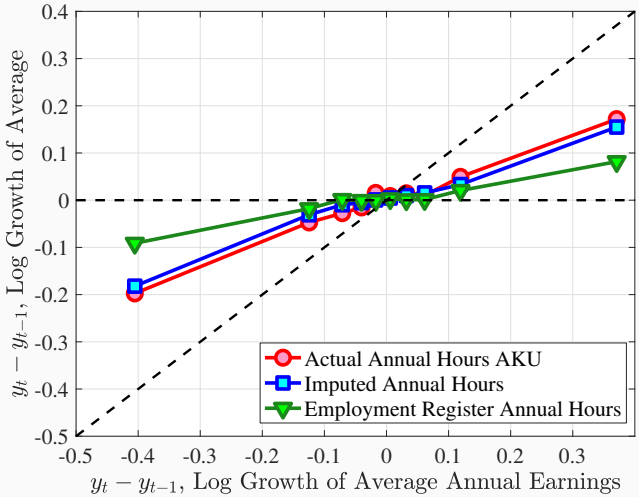
Imputation of Hours in the Register Data

- Impute a better hours measure in administrative register data.
- We sort individuals in 4 bins with approximately 300 individuals per year based on RE
- For each quantile we estimate a linear regression using the individuals that are present both in the AKU and in the register data

$$h_{annual} = \beta X + \epsilon \tag{1}$$

- X: contracted hours, sickness days, parental leave days, unemployment days, part time, sector, wage, and education.
- The estimated coefficients are used to impute actual work hours for the individuals that are not present in the Labor Force Survey.

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.

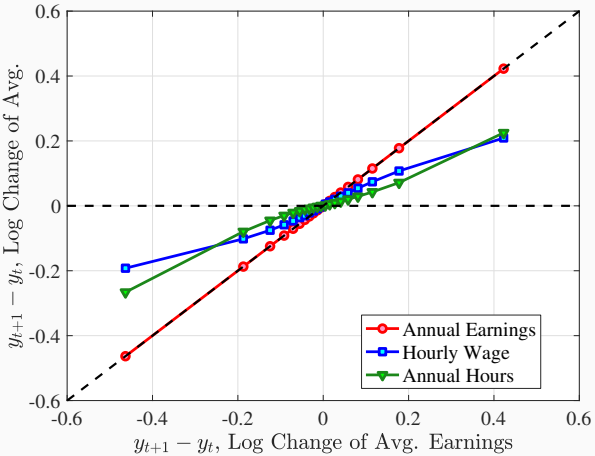
Changes in Hours vs Wages

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 $\overline{Y}^{j}_{t-1}$.
  - 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?

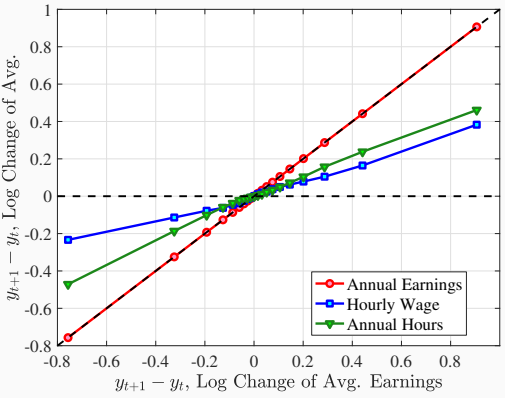
Hours vs Wage: Median RE Decile



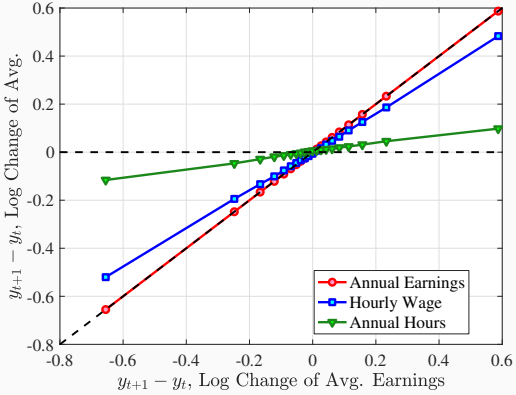
- Large earnings swings: hours and wage growth are equally important.
- Smaller earnings changes: wage growth is more important.

Hours vs Wage: Bottom vs Top RE Deciles

Bottom RE



Top RE

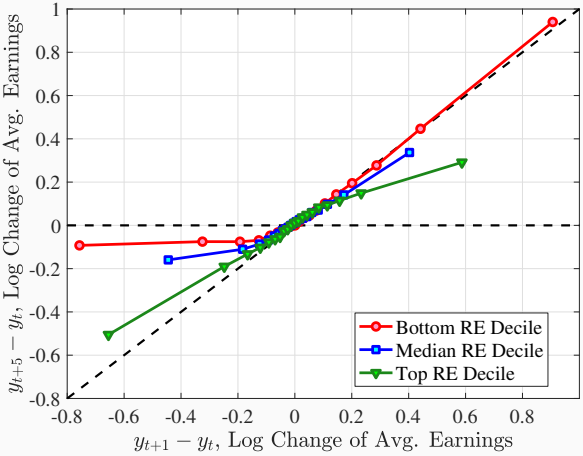


- For bottom RE group hours growth plays a more important role. ▸ More RE Groups
- For higher RE groups wage changes are main drivers of earnings growth. ▸ Avg. Log Grwth

Changes in Hours vs Wages

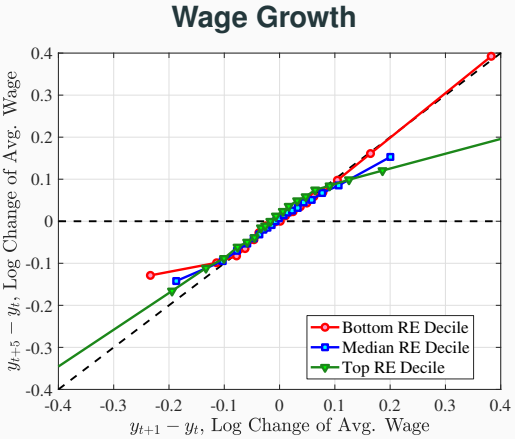
Dynamics of Hours and Wage Growth

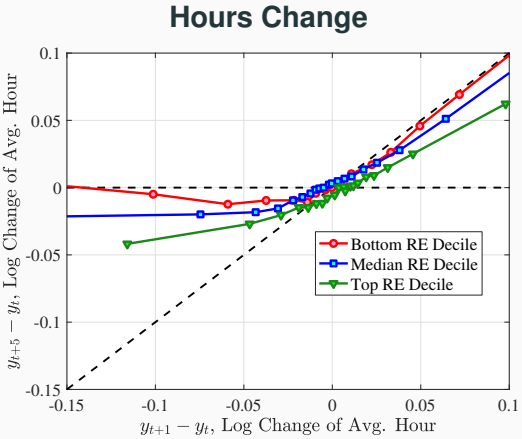
Asymmetric Mean Reversion: Dynamics of Earnings



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

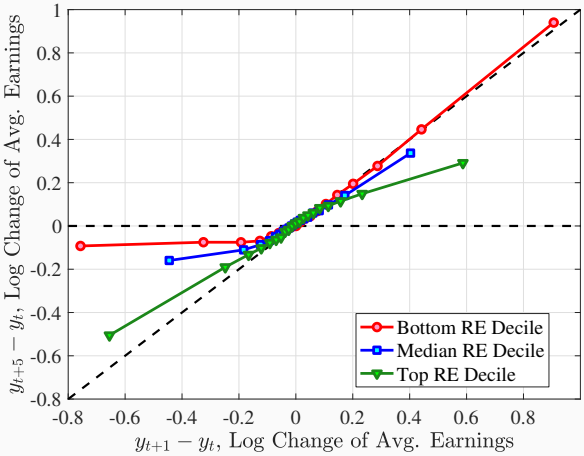
Asymmetric Mean Reversion: Hours vs Wages





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

Asymmetric Mean Reversion: Earnings



- **Low-income:**
  - negative: transitory hours declines
  - positive: persistent hours & wage increases.
- **High earners:**
  - negative: persistent wage declines
  - positive: transitory wage rises.

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 change 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 earnings 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 $t+k$

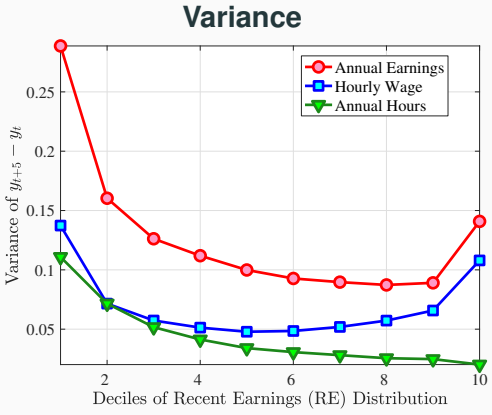
Skewness Decomposition

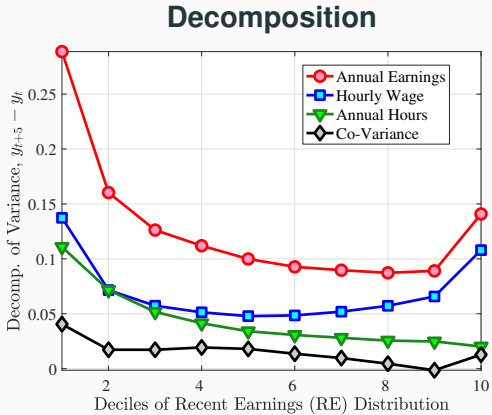
$$s_{\Delta e_{t,k}} = \left(\frac{\sigma_{\Delta w_{t,k}}}{\sigma_{\Delta e_{t,k}}}\right)^3 \times s_{\Delta w_{t,k}} + \left(\frac{\sigma_{\Delta h_{t,k}}}{\sigma_{\Delta e_{t,k}}}\right)^3 \times s_{\Delta h_{t,k}} + \text{co-}s_{\Delta w_{t,k},\Delta h_{t,k}}$$

Kurtosis Decomposition

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

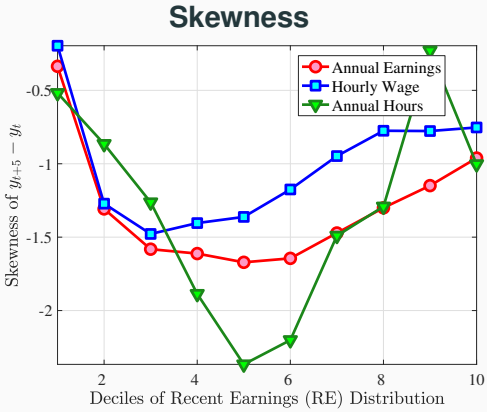
Variance of $y_{t+5} - y_t$ for Prime Age Male

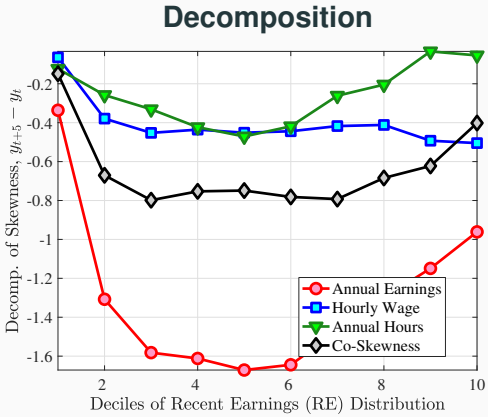




- Hourly wage is more volatile than hours especially above the median.
- Similar to the PSID (Heathcote *et al.* (2014)). ▸ 1-Year Growth Variance ▸ 5-Year Growth Variance-Gaussian

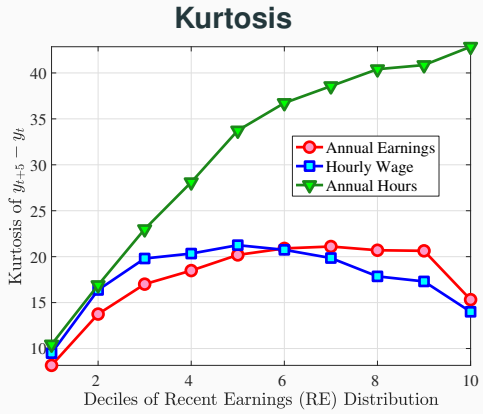
Skewness of $y_{t+5} - y_t$ for Prime Age Male

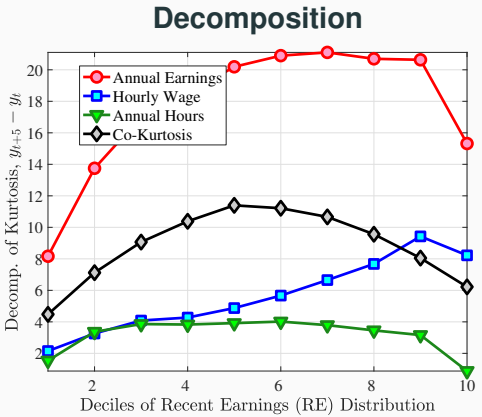




- Both hours and wage growth are left skewed.
- Wage growth and more importantly co-skewness are driving the left skewness of earnings growth. ▸ 1-Year Growth Skewness ▸ 5-Year Growth Skewness-Gaussian

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





- 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%

Changes in Hours vs Wages

Stayers vs Switchers

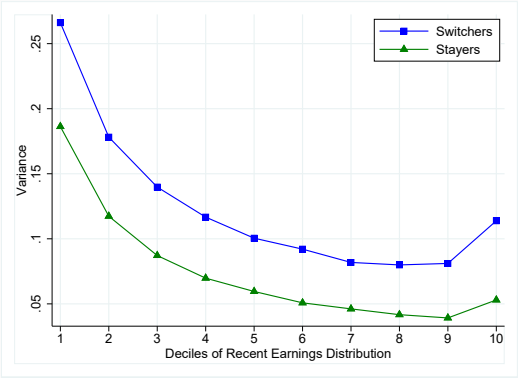
Stayers vs Switchers

- One of the key events leading to both large positive and negative earnings shocks is a change of employer (e.g., EE or EUE).
- How do the earnings shock distributions of job-stayers and job-switchers differ?
- Define a job-stayer as an individual who stays with the same employer in year t or t+1.
  - Everybody else are switchers.
- Quantify the role of stayers and switchers in higher-order moments of earnings growth. For example, for skewness:

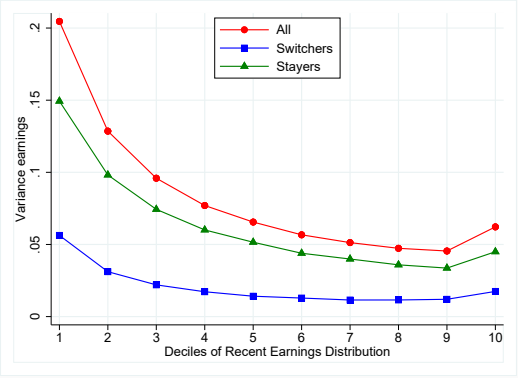
$$skew\left(\Delta y\right) = \frac{1}{\left(std\left(\Delta y\right)\right)^3}\left(\underbrace{\int_{\{i \in S_1\}} \left(\Delta y_i - E\left(\Delta y\right)\right)^3 dF\left(\Delta y\right)}_{\text{skewness due to } \textit{Stayers}} + \underbrace{\int_{\{i \in S_2\}} \left(\Delta y_i - E\left(\Delta y\right)\right)^3 dF\left(\Delta y\right)}_{\text{skewness due to } \textit{Swicters}}\right)$$

Variance: Stayers vs Switchers

Variance of $y_{t+1} - y_t$



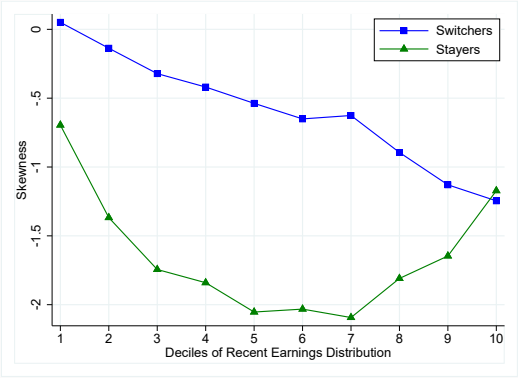
Decomposition



- As expected switchers experience a more volatile wage growth.
- Swicther contribution to overall volatility is low because there are fewer of them.

Skewness: Stayers vs Switchers

Skewness of $y_{t+1} - y_t$



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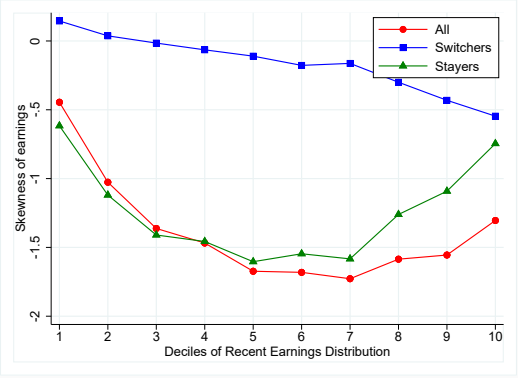
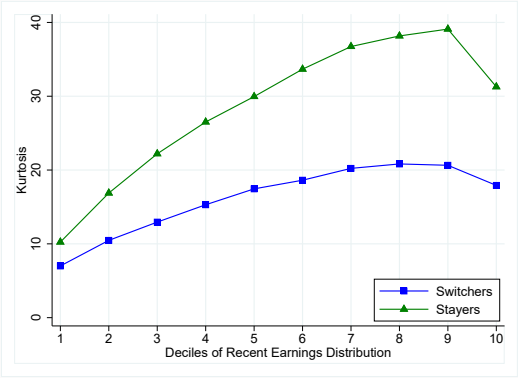


- Stayer face a more left skewed dist'n because of sick days (substitute for unemp).
- Skewness of earnings driven mainly by stayers.

Kurtosis: Stayers vs Switchers

Kurtosis of $y_{t+1} - y_t$



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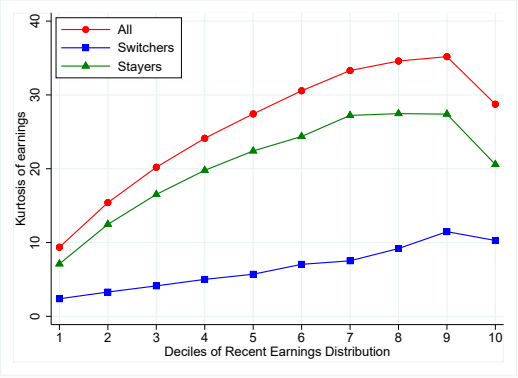


- Earnings growth for stayers is more leptokurtic (similar to the US).
- Excess kurtosis due to mainly for stayers.

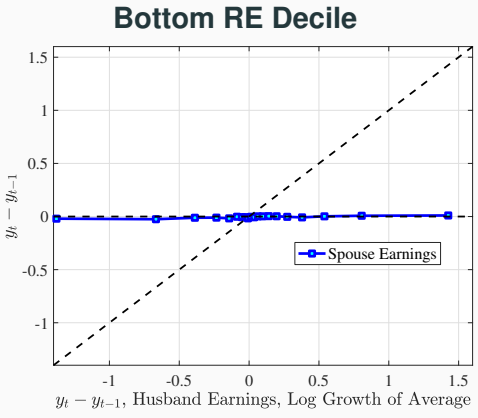
Household Income Dynamics

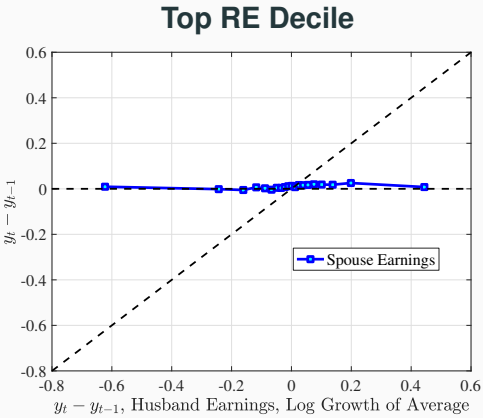
Insurance Against Tail Shocks

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

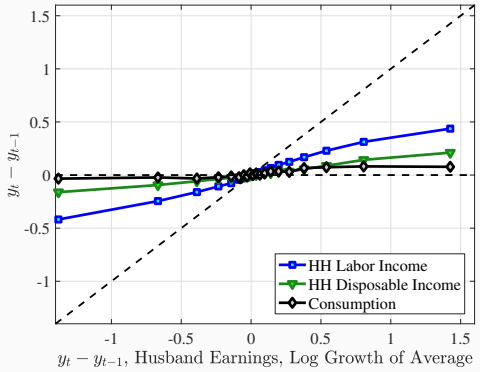




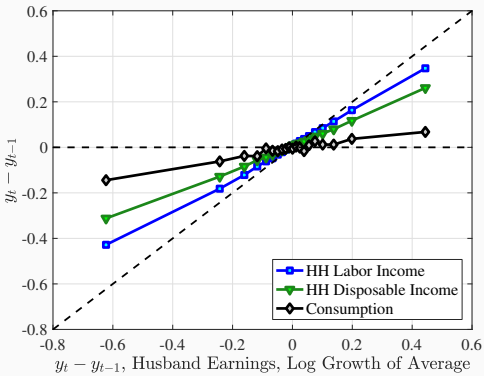
- No change in behavior of spouse or her earnings (not showing the SE income).

Public Insurance

Bottom RE Decile

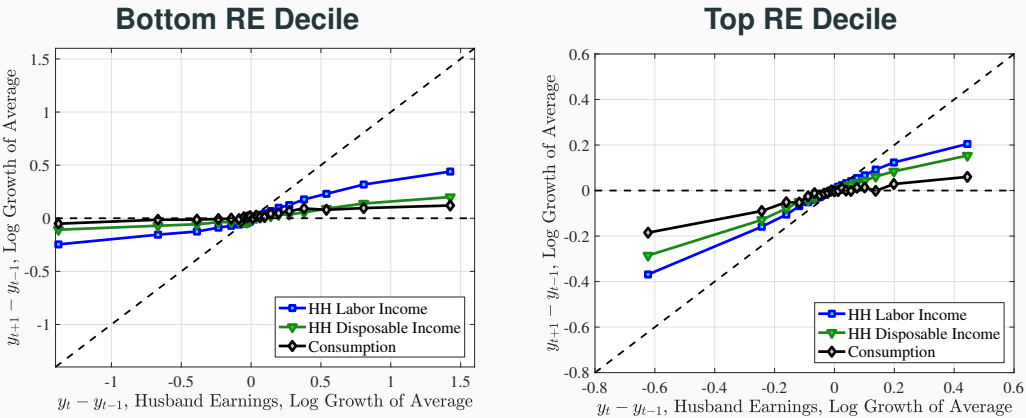


Top RE Decile



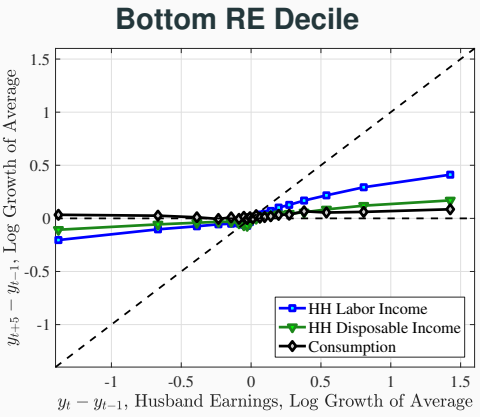
- Strong second earner effect (more so for low RE).
- Public insurance is much more helpful with tail shocks for low income.
- High RE can rely on self insurance for consumption.

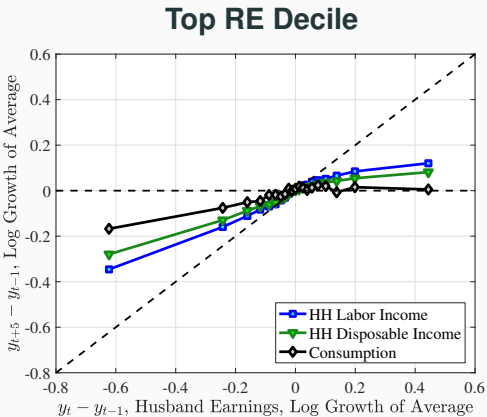
Public Insurance, 1 Year Later



- 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





- 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 $t-1$.

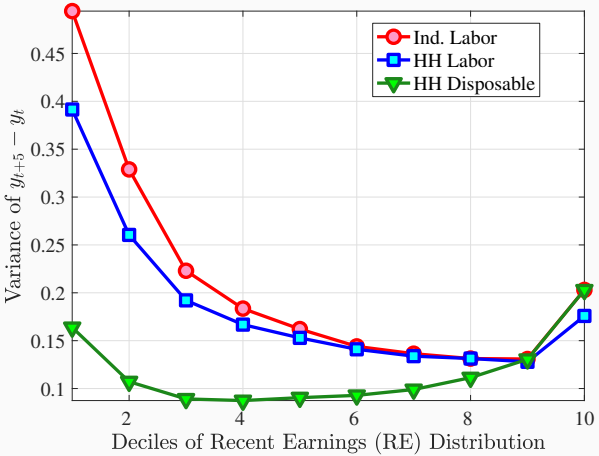
Household Income Dynamics

Distribution of Household Income Growth

Nature of Idiosyncratic Income Risk

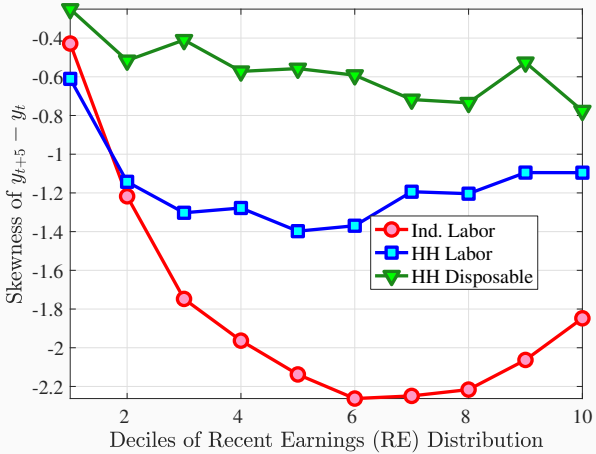
- Do non-Gaussian features of annual earnings growth distribution extend to
  - household (husband+wife) earnings?
  - After tax/after transfer disposable household income?
- For some questions nature of household income risk—before and after tax—is key.
- Plot their distributions and higher-order moments.

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



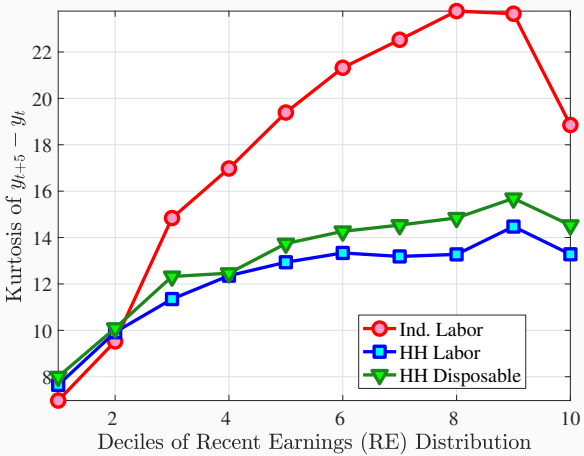
- HH labor is less volatile than individual labor.
- Taxes and transfers reduces variance substantially.

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

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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.

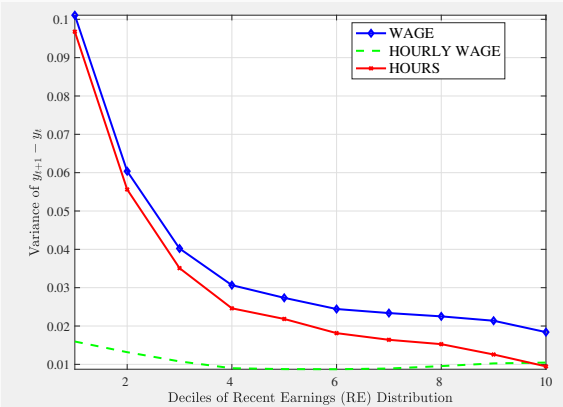
THANK YOU!

September Sample

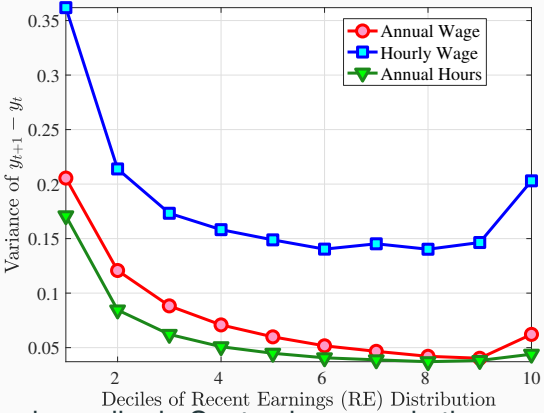
- Norway also surveys employers in **September** for more precise measure of hours.
  - An input to the annual wage negotiations between the unions and the employers,
  - For a sample of the largest private sector firms within each industry,
  - covering approximately 52% of firms and 70% of employees 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
  - thus overtime and bonuses are not included Go back!

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

September Sample



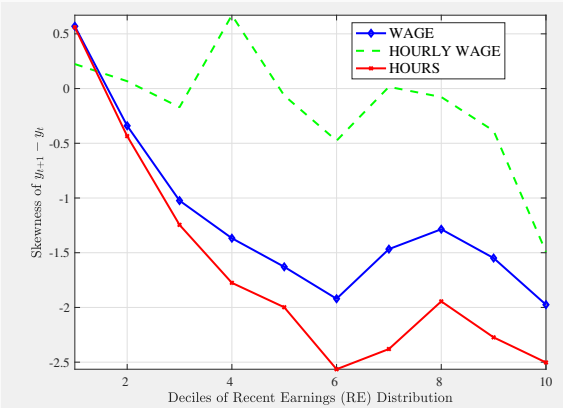
Employment Register



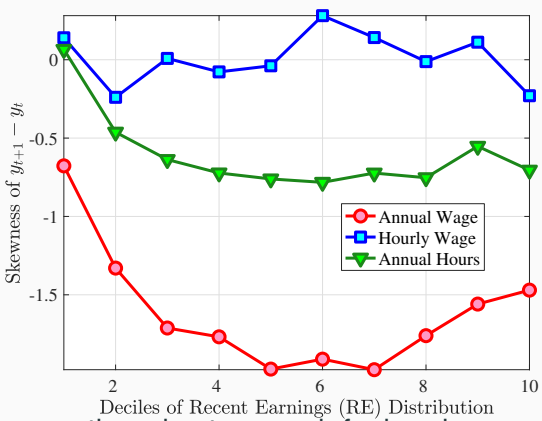
- Variance of annual and hourly wages are much smaller in September sample than Employment register.
- No overtime and bonuses are not included.

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

September Sample



Employment Register

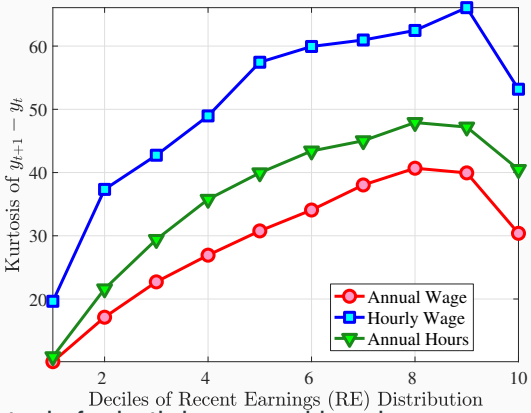


- Both samples display left skewness for hours growth and not so much for hourly wage growth.

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

September Sample

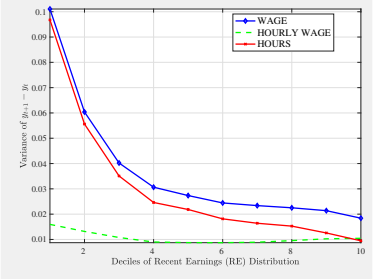
Employment Register



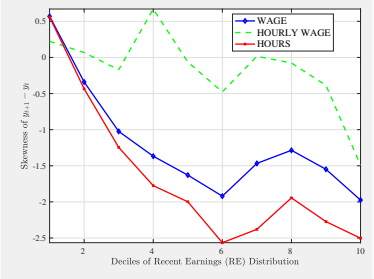
- September sample displays more excess kurtosis for both hours and hourly wage growth then employment register.

Higher Order Moments in September Sample

Variance



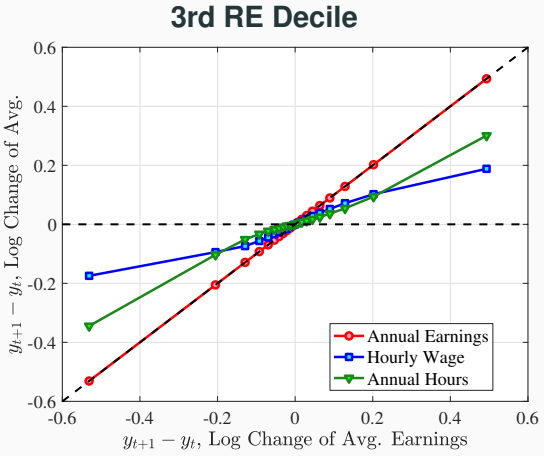
Skewness

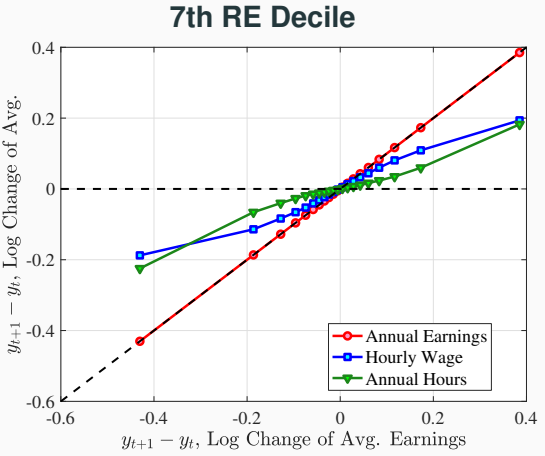


Kurtosis

- 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

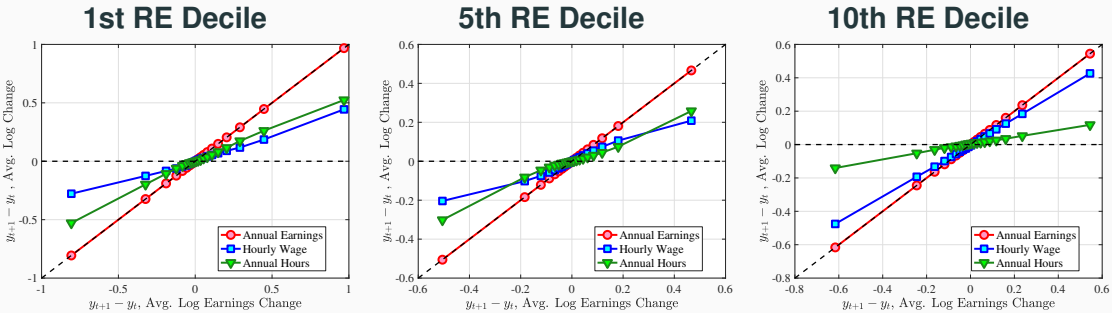




- Hourly wage growth plays a more important role for higher RE groups.

▸ Go back!

Hourly Wage vs Annual Hours: Average of Log Change



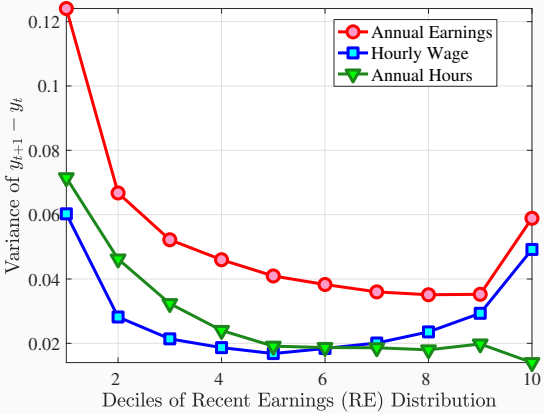
- Hourly wage growth plays a more important role lower RE groups.
- Wage changes drive earnings growth top RE groups. Go back!

Hourly Wage vs Annual Hours

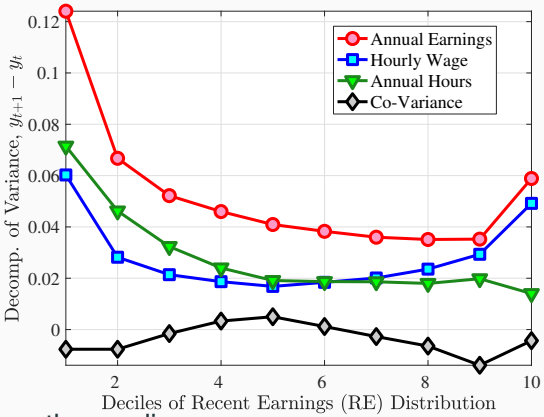
1-Year Moment Decomposition

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

Variance



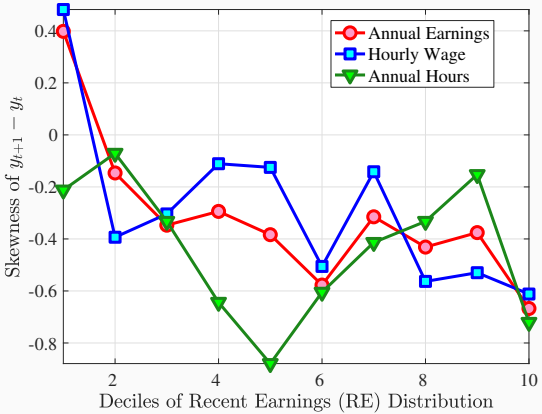
Decomposition



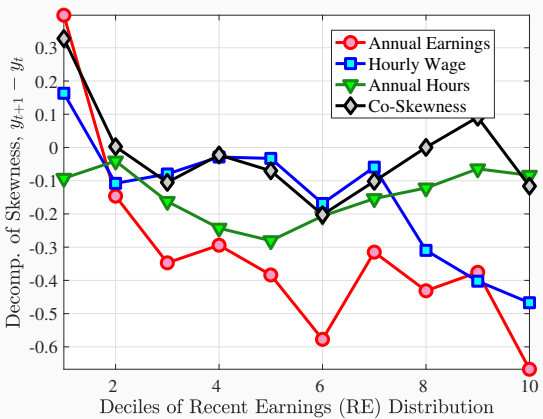
- Hourly wage is more volatile than hours above the median.
- Similar to the PSID (Heathcote *et al.* (2014)). ▸ 5-Year Growth Variance

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

Skewness



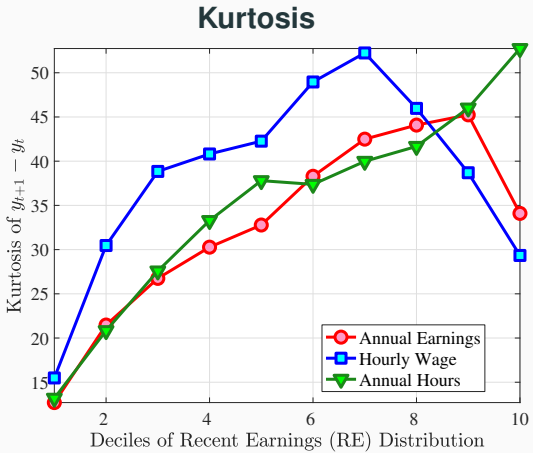
Decomposition

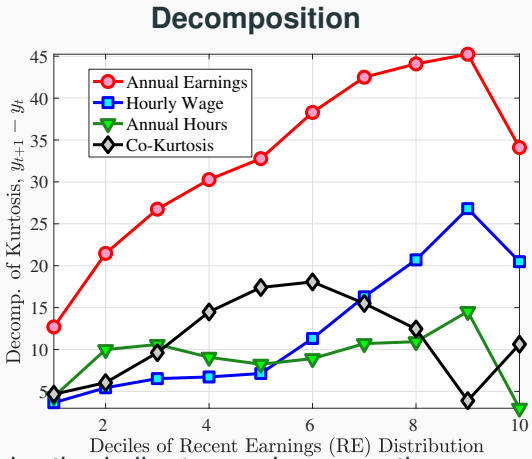


- Hours and wagre growth are left skewed.
- For top earners wage growth is key for left skewness of earnings growth.

▸ 5-Year Growth Skewness

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





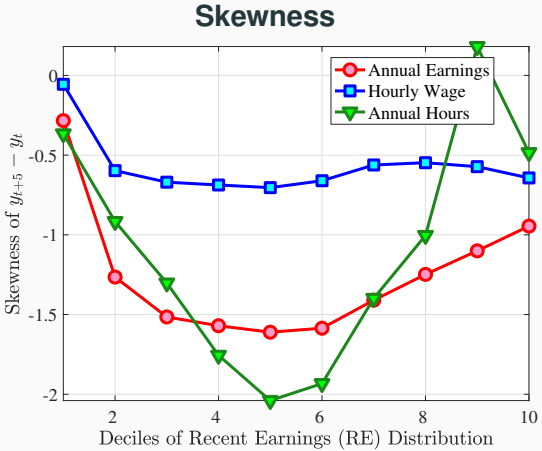
- Hourly wage and hours growth are both leptokurtic similar to earnings growth.
- Excess kurtosis due to hourly wage dominates the hours above the median.

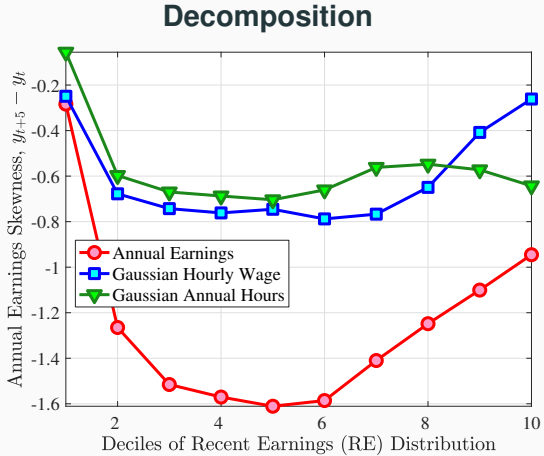
▸ 5-Year Growth Kurtosis

Hourly Wage vs Annual Hours

Gaussian Decomposition: 5-Year Growth

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





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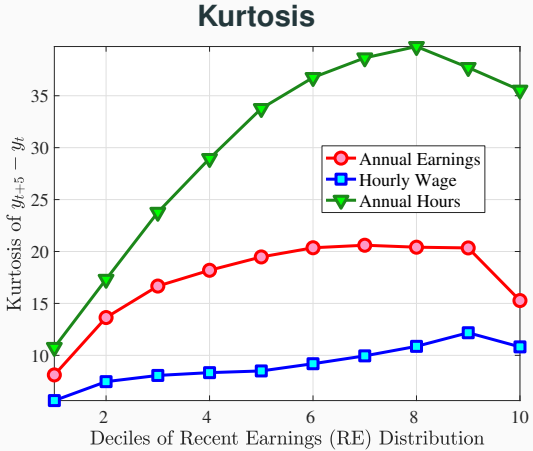

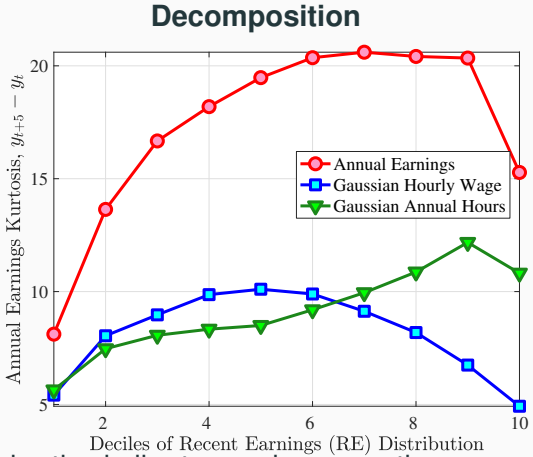

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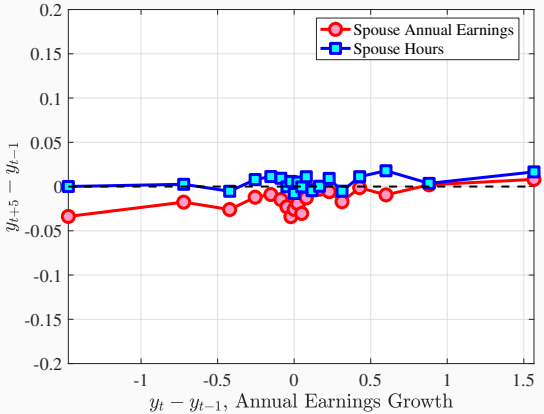
Hourly Wage vs Annual Hours

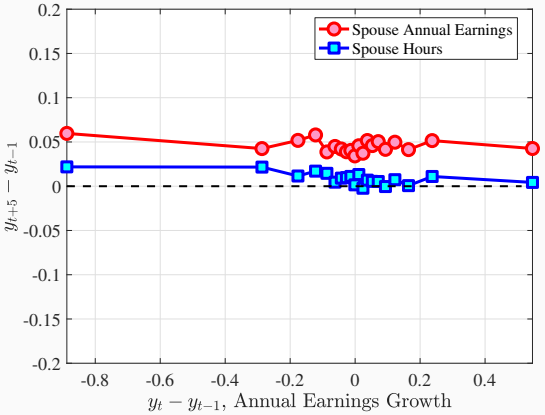
Spousal Insurance After 5 Years

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.

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