

# Female labor supply and biased beliefs: a structural approach

Philipp Eisenhauer, Peter Haan, Boryana Ilieva,  
Annekatriin Schrenker, Georg Weizsäcker

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# Section 1

## Motivation

# Motivation: biased beliefs

- Key role of expectations for both individual and aggregate economic outcomes in a dynamic context: Manski (2004)
  - ▶ Biased beliefs can lead to erroneous choices with unexpected adverse consequences
- Identification of parameters on expectations important in structural models:
  - ▶ Elicitation of expectations, e.g., Delavande (2008) and Zafar (2013)
- In this paper: focus on expectations about returns to experience and part-time penalty
  - ▶ Empirical evidence for biased beliefs based on a representative survey
  - ▶ Identification and quantification of the effect of biased beliefs on labor market outcomes over the life-cycle

# Motivation: part-time penalty

- 37% of employed women in Germany work part-time in 2017, tendency rising
- Dynamic and highly persistent selection into part-time employment linked to persisting gender-specific inequalities, e.g., Gallego-Granados (2019)
- Part-time penalty: stagnating wage growth over the life-cycle for part-time employees, e.g., Manning and Petrongolo (2008), Blau and Kahn (2017)
- Blundell et al. (2016): part-time employment, in contrast to full-time employment, does not increase one's human capital stock

# Research questions

- ① Do women have biased expectations about returns to experience and about the part-time penalty?
- ② How do beliefs regarding the part-time penalty affect employment choices in a dynamic setting?
- ③ How can policy increase female employment and working hours when women have biased beliefs?

# Contribution

- We design survey questions in the SOEP-IS to elicit expectations about returns to experience in full-time and part-time employment in the short and the long run
- We provide empirical evidence about returns to experience and the part-time penalty based on SOEP data
- We exploit the elicited expectations data to identify biased expectations in a structural life cycle model
- We use the structural model to evaluate policy reforms when individuals have biased beliefs

# Findings

- ① Expected returns to experience in part-time and full-time work do not differ; there is no expected part-time penalty in experience
  - ▶ findings robust to different specifications
  - ▶ no strong heterogeneity in findings
- ② Reduced form evidence for part-time penalty in experience in Germany
  - ▶ findings robust to different specifications: fixed effects and control function
- ③ Biased expectation in structural estimation
- ④ Policy simulation: De-biasing reduces part-time choice rates in structural estimation



# Literature (Prelim.)

- beliefs in dynamic discrete choice models: Manski (2004), Delavande (2008), Zafar (2013)
- reduced form - Wolf (2002), Manning and Petrongolo (2008), Paul (2015), Gallego-Granados (2019) - part-time penalty is negligible after conditioning on past experience
- structural - Blundell et al. (2016), Adda, Dustmann, and Stevens (2017), Schneider (2017) - period experience accumulation in part-time only around 15% of full-time value

# Section 2

## Data

# Data - German Socio-Economic Panel (GSOEP)

Two related longitudinal annual surveys, representative of German HH  
**SOEP-Core** → estimate part-time penalty free of endogeneity/selection

- occup. biographies, employment, earnings, health, satisfaction etc.
- waves 1992-2016, N=169,635
- exploit panel dimension to estimate dynamic structural model

**SOEP-IS** → identify beliefs about in experience accumulation process

- selected SOEP-Core questions & additional innovative content Ex.
- innovative module 'Earnings', waves 2016-2017, N=737
- perceived/expected wage growth in full- and (!) part-time over next 10y

Females only, excl. civil servants, self-employed, in training, military/community service or marginal employment.

# Sample and socio-demographics wave 2016

|                        | Total  |       |                      | Fulltime |       |                      | Parttime |       |                      |
|------------------------|--------|-------|----------------------|----------|-------|----------------------|----------|-------|----------------------|
|                        | Core   | IS    | p-value ( $\Delta$ ) | Core     | IS    | p-value ( $\Delta$ ) | Core     | IS    | p-value ( $\Delta$ ) |
| Fulltime               | 0.47   | 0.49  | 0.66                 | 1.00     | 1.00  | .                    | 0.00     | 0.00  | .                    |
| Real Gross Hourly Wage | 15.74  | 16.25 | 0.36                 | 17.17    | 18.14 | 0.33                 | 14.35    | 15.53 | 0.06                 |
| Actual Working Hrs.    | 31.62  | 30.90 | 0.42                 | 41.70    | 42.76 | 0.06                 | 22.43    | 25.18 | 0.00                 |
| Contractual Hrs.       | 29.66  | 28.72 | 0.23                 | 38.30    | 39.27 | 0.01                 | 21.37    | 22.76 | 0.07                 |
| Age                    | 43.56  | 42.02 | 0.03                 | 42.21    | 42.04 | 0.89                 | 45.53    | 44.88 | 0.48                 |
| East Germany           | 0.17   | 0.15  | 0.23                 | 0.20     | 0.19  | 0.76                 | 0.15     | 0.16  | 0.89                 |
| Married                | 0.56   | 0.64  | 0.00                 | 0.41     | 0.51  | 0.03                 | 0.66     | 0.79  | 0.00                 |
| Children               | 0.35   | 0.34  | 0.72                 | 0.18     | 0.14  | 0.23                 | 0.41     | 0.44  | 0.49                 |
| German Nationality     | 0.79   | 0.77  | 0.49                 | 0.84     | 0.84  | 0.94                 | 0.80     | 0.79  | 0.96                 |
| Years of Education     | 12.25  | 12.24 | 0.92                 | 12.72    | 12.72 | 0.98                 | 12.03    | 12.24 | 0.22                 |
| Tenure                 | 9.64   | 9.72  | 0.89                 | 10.36    | 10.22 | 0.89                 | 8.99     | 10.11 | 0.18                 |
| Firm: Public Sector    | 0.25   | 0.28  | 0.36                 | 0.25     | 0.27  | 0.70                 | 0.25     | 0.29  | 0.25                 |
| Firm: Large Firm       | 0.47   | 0.48  | 0.86                 | 0.52     | 0.54  | 0.68                 | 0.42     | 0.46  | 0.47                 |
| N                      | 10,000 | 441   |                      | 2,559    | 138   |                      | 3,868    | 148   |                      |

*Note:* All estimates weighted.

**Table:** Socio-Demographic Characteristics (SOEP Core vs. SOEP IS, 2016)

# Sample and socio-demographics wave 2017

|                        | Total  |       |                      | Fulltime |       |                      | Parttime |       |                      |
|------------------------|--------|-------|----------------------|----------|-------|----------------------|----------|-------|----------------------|
|                        | Core   | IS    | p-value ( $\Delta$ ) | Core     | IS    | p-value ( $\Delta$ ) | Core     | IS    | p-value ( $\Delta$ ) |
| Fulltime               | 0.46   | 0.44  | 0.69                 | 1.00     | 1.00  | .                    | 0.00     | 0.00  | .                    |
| Real Gross Hourly Wage | 15.98  | 16.00 | 0.98                 | 17.41    | 16.72 | 0.38                 | 14.67    | 16.62 | 0.06                 |
| Actual Working Hrs.    | 31.27  | 29.88 | 0.21                 | 41.57    | 42.16 | 0.33                 | 22.34    | 24.88 | 0.05                 |
| Contractual Hrs.       | 29.43  | 27.72 | 0.09                 | 38.49    | 38.68 | 0.70                 | 21.16    | 22.42 | 0.24                 |
| Age                    | 43.69  | 41.57 | 0.01                 | 42.38    | 42.31 | 0.97                 | 45.30    | 43.65 | 0.21                 |
| East Germany           | 0.16   | 0.14  | 0.21                 | 0.21     | 0.26  | 0.26                 | 0.14     | 0.09  | 0.17                 |
| Married                | 0.57   | 0.66  | 0.00                 | 0.40     | 0.44  | 0.49                 | 0.67     | 0.74  | 0.12                 |
| Children               | 0.35   | 0.39  | 0.36                 | 0.18     | 0.17  | 0.82                 | 0.41     | 0.38  | 0.58                 |
| German Nationality     | 0.79   | 0.74  | 0.23                 | 0.84     | 0.91  | 0.08                 | 0.80     | 0.69  | 0.10                 |
| Years of Education     | 12.29  | 12.24 | 0.73                 | 12.69    | 12.63 | 0.77                 | 12.12    | 12.35 | 0.40                 |
| Tenure                 | 9.63   | 8.63  | 0.17                 | 10.19    | 10.58 | 0.76                 | 9.16     | 8.01  | 0.24                 |
| Firm: Public Sector    | 0.26   | 0.27  | 0.64                 | 0.26     | 0.32  | 0.25                 | 0.25     | 0.30  | 0.43                 |
| Firm: Large Firm       | 0.50   | 0.50  | 0.98                 | 0.56     | 0.55  | 0.87                 | 0.45     | 0.56  | 0.07                 |
| N                      | 11,324 | 303   |                      | 2,920    | 93    |                      | 4,321    | 101   |                      |

*Note:* All estimates weighted.

**Table:** Socio-Demographic Characteristics (SOEP Core vs. SOEP IS, 2017)

## Section 3

### Beliefs Elicitation

# Elicitation of beliefs in SOEP-IS

## Current working hours: (Ex. question to full-time working woman)

Suppose you continue to work full-time in the coming years, regardless of whether you are actually planning a work reduction or anything similar. Please think about full-time jobs that you can perform with your qualification. If, in reality, you are planning to reduce your workload, please still assume for the moment that you continue to work full-time in the next years.

What do you think is your gross monthly income ...

- in one year?
- in 2 years?
- in 10 years?

Probabilistic add-on (I)

# Elicitation of beliefs in SOEP-IS (cont'd)

## Hypothetical working hours: (Ex. question to full-time working woman)

Please imagine you were to switch to a part-time job from now on, working 20 hours per week. Please only consider part-time jobs that you could carry out with your current level of qualification.

- What gross monthly income do you expect to earn when working part-time at 20 hours per week? Probabilistic add-on (II)

Now suppose that you continue to work part-time in the coming years, working 20 hours per week.

What do you think is your gross monthly income ...

- in one year?
- in 2 years?
- in 10 years?

Probabilistic add-on (III)



# Expected wage growth by age, employment and education status

Table: Expected Wage Growth in Part-time and Full-time (in %)

|                          | 1 year    |           | 2 year    |           | 10 year   |           |
|--------------------------|-----------|-----------|-----------|-----------|-----------|-----------|
|                          | Full-Time | Part-Time | Full-Time | Part-Time | Full-Time | Part-Time |
| <b>All Females</b>       | 3.3       | 4.4       | 6.8       | 9.7       | 20.7      | 25.3      |
| <b>Employment Status</b> |           |           |           |           |           |           |
| Full-Time                | 5.1       | 4.7       | 9.4       | 10.1      | 26.3      | 25.7      |
| Part-Time                | 1.7       | 4.1       | 4.5       | 9.3       | 15.5      | 24.9      |
| <b>Education</b>         |           |           |           |           |           |           |
| Low                      | 4.5       | 3.0       | 7.8       | 7.9       | 19.4      | 20.9      |
| Medium                   | 2.6       | 3.7       | 6.1       | 8.3       | 19.1      | 24.4      |
| High                     | 5.1       | 7.7       | 9.1       | 15.5      | 27.1      | 30.6      |
| <b>Age</b>               |           |           |           |           |           |           |
| < 35 years               | 6.6       | 4.7       | 12.2      | 14.9      | 29.3      | 36.5      |
| 35-55 years              | 1.5       | 4.4       | 4.3       | 8.1       | 16.5      | 21.6      |
| > 55 years               | 4.1       | 3.4       | 6.2       | 5.3       | 20.2      | 17.0      |

Notes: SOEP Innovation Sample (2016-2017). Balanced panel (N=233 observations). Expected growth in hourly wages (in%), calculated in relation to observed hourly wage in the base period. Reported working hours used to calculate hourly wages in the observed employment state. For the hypothetical scenario, working hours used as defined in the questionnaire: 40 h per week full time, 20 h per week part-time.

# Expected wage growth by income level and region

**Table:** Expected Wage Growth in Part-time and Full-time (in %)

|                    | 1 year    |           | 2 year    |           | 10 year   |           |
|--------------------|-----------|-----------|-----------|-----------|-----------|-----------|
|                    | Full-Time | Part-Time | Full-Time | Part-Time | Full-Time | Part-Time |
| <b>All Females</b> | 3.3       | 4.4       | 6.8       | 9.7       | 20.7      | 25.3      |
| <b>Income</b>      |           |           |           |           |           |           |
| Low (<P25)         | 6.0       | 5.2       | 10.8      | 13.1      | 27.2      | 31.2      |
| Medium (P25-P75)   | 2.7       | 4.5       | 6.0       | 9.9       | 19.3      | 25.4      |
| High (>P75)        | 2.4       | 4.3       | 5.5       | 7.7       | 16.2      | 20.2      |
| <b>Region</b>      |           |           |           |           |           |           |
| East               | 2.0       | 3.5       | 5.5       | 6.7       | 17.3      | 18.6      |
| West               | 3.6       | 4.6       | 7.1       | 10.3      | 21.3      | 26.6      |

*Notes:* SOEP Innovation Sample (2016-2017). Balanced panel (N=233 observations). Expected growth in hourly wages (in%), calculated in relation to observed hourly wage in the base period. Reported working hours used to calculate hourly wages in the observed employment state. For the hypothetical scenario, working hours used as defined in the questionnaire: 40 h per week full time, 20 h per week part-time.

# Identification of the expected returns to experience

$$\ln \omega_{(n,e,p,t)} = \alpha_1 + \gamma_1 e + \alpha_2 p + \gamma_2 [p \cdot e] + X_{(n,t)}^{e=0} \beta + \delta_{(t)} + \epsilon_{(n,e,p,t)} \quad (1)$$

- $\omega_{(n,e,p,t)}$  hourly wage
- $n = 1 \dots N$  person identifier
- $e = \{0, 1, 2, 10\}$  additional experience in years
- $p = \{0, 1\}$  part-time indicator
- $t = 1 \dots T$  survey year,  $\delta_{(t)} = \{0, 1\}$  survey year indicator
- $\delta$  time fixed effects
- $X^{e=0} =$  socio-demographic and job-related controls<sup>1</sup>

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<sup>1</sup> part-time status, age, age sq., tenure, tenure sq., years of education, past unemployment, public sector indicator, firm size, region, nationality, marital status, number of children

# Estimated expected returns to experience

Estimating (1) using SOEP-IS yields

|                              | (I)                 | (II)                | (III)               | (IV)                | (V)                 | (VI)                |
|------------------------------|---------------------|---------------------|---------------------|---------------------|---------------------|---------------------|
| Dep.Var = $\ln w$            | POLS                |                     | FE                  | POLS                |                     | FE                  |
| $\gamma_1$ Full-time returns | 0.020<br>(0.002)*** | 0.019<br>(0.001)*** | 0.016<br>(0.001)*** | 0.018<br>(0.001)*** | 0.017<br>(0.001)*** | 0.015<br>(0.001)*** |
| $\gamma_2$ Part-time penalty | 0.001<br>(0.002)    | 0.000<br>(0.002)    | 0.003<br>(0.001)**  | -0.002<br>(0.002)   | -0.002<br>(0.002)   | 0.002<br>(0.001)    |
| Controls                     | no                  | yes                 | no                  | no                  | yes                 | no                  |
| Incl. $e = 0$                | yes                 | yes                 | yes                 | no                  | no                  | no                  |
| N                            | 2,636               | 2,554               | 2,636               | 1,859               | 1,799               | 1,859               |

Note: SOEP IS 2016-2017. Robust standard errors clustered at the person level in parentheses.

\*  $p < 0.05$ , \*\*  $p < 0.01$ , \*\*\*  $p < 0.001$  POLS= Pooled OLS. FE=Fixed Effects.

- individuals expect same returns to experience in part- and full-time
- causal estimate of expected part-time penalty

# Estimates by employment status and age

**Table:** Heterogeneity in Expected Returns to Experience

|                          | Full-Time Experience |            | Part-Time Experience |            | Mean Difference ( $\beta$ ) |         | N     |
|--------------------------|----------------------|------------|----------------------|------------|-----------------------------|---------|-------|
|                          | $\beta$              | s.e.       | $\beta$              | s.e.       | $\beta$                     | s.e.    |       |
| <b>All Females</b>       | 0.017                | (0.001)*** | 0.015                | (0.002)*** | -0.002                      | (0.002) | 1,799 |
| <b>Employment Status</b> |                      |            |                      |            |                             |         |       |
| Full-Time                | 0.019                | (0.002)*** | 0.015                | (0.003)*** | -0.004                      | (0.003) | 846   |
| Part-Time                | 0.015                | (0.002)*** | 0.014                | (0.002)*** | -0.000                      | (0.003) | 953   |
| <b>Age</b>               |                      |            |                      |            |                             |         |       |
| < 35 years               | 0.020                | (0.003)*** | 0.018                | (0.003)*** | -0.001                      | (0.003) | 421   |
| 35-55 years              | 0.016                | (0.001)*** | 0.016                | (0.002)*** | -0.000                      | (0.002) | 1,050 |
| > 55 years               | 0.015                | (0.005)**  | 0.006                | (0.004)    | -0.008                      | (0.007) | 328   |

*Notes:* GSOEP Innovation Sample (2016-2017). Dep.Var. = log expected gross hourly wage. Estimates from pooled OLS regression with baseline (t=0) controls for differences in employment status, age, education, tenure, years of unemployment, region, migrational background, firm size, public sector employment, marital status and number of children. Standard errors clustered at the person-level \*  $p < 0.05$ , \*\*  $p < 0.01$ , \*\*\*  $p < 0.001$ . Unbalanced panel, excluding t=0.

# Estimates by education, income, and region

**Table:** Heterogeneity in Expected Returns to Experience

|                    | Full-Time Experience |            | Part-Time Experience |            | Mean Difference ( $\beta$ ) |         | N     |
|--------------------|----------------------|------------|----------------------|------------|-----------------------------|---------|-------|
|                    | $\beta$              | s.e.       | $\beta$              | s.e.       | $\beta$                     | s.e.    |       |
| <b>All Females</b> | 0.017                | (0.001)*** | 0.015                | (0.002)*** | -0.002                      | (0.002) | 1,799 |
| <b>Education</b>   |                      |            |                      |            |                             |         |       |
| Low                | 0.009                | (0.003)**  | 0.007                | (0.005)    | -0.000                      | (0.006) | 196   |
| Medium             | 0.018                | (0.002)*** | 0.015                | (0.002)*** | -0.003                      | (0.002) | 1,254 |
| High               | 0.019                | (0.003)*** | 0.019                | (0.003)*** | -0.000                      | (0.003) | 349   |
| <b>Income</b>      |                      |            |                      |            |                             |         |       |
| Low (<P25)         | 0.020                | (0.004)*** | 0.010                | (0.004)*   | -0.010                      | (0.005) | 345   |
| Medium (P25-P75)   | 0.014                | (0.001)*** | 0.017                | (0.002)*** | 0.002                       | (0.002) | 942   |
| High (>P75)        | 0.014                | (0.001)*** | 0.014                | (0.002)*** | -0.000                      | (0.002) | 942   |
| <b>Region</b>      |                      |            |                      |            |                             |         |       |
| East               | 0.023                | (0.005)*** | 0.012                | (0.003)**  | -0.010                      | (0.006) | 310   |
| West               | 0.016                | (0.001)*** | 0.015                | (0.002)*** | -0.001                      | (0.002) | 1,489 |

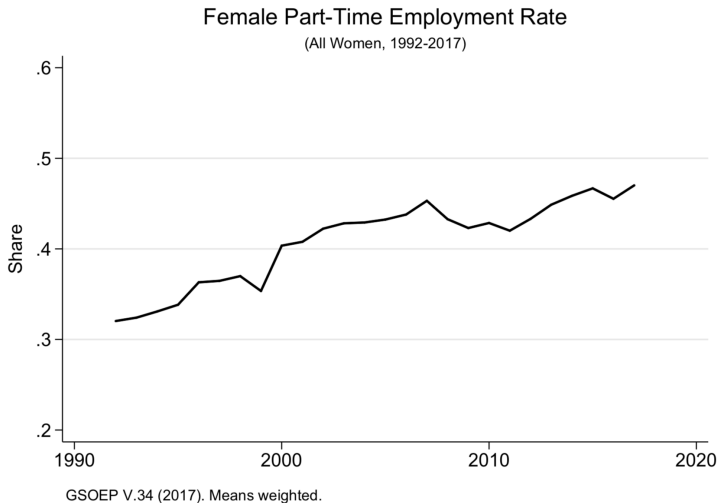
*Notes:* GSOEP Innovation Sample (2016-2017). Dep.Var. = log expected gross hourly wage. Estimates from pooled OLS regression with baseline (t=0) controls for differences in employment status, age, education, tenure, years of unemployment, region, migrational background, firm size, public sector employment, marital status and number of children. Standard errors clustered at the person-level \*  $p < 0.05$ , \*\*  $p < 0.01$ , \*\*\*  $p < 0.001$ . Unbalanced panel, excluding t=0.

## Section 4

### Reduced Form Evidence

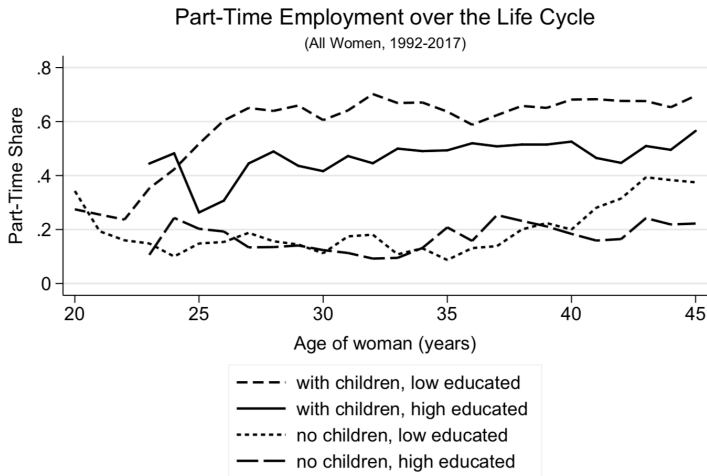
# Female part-time employment in Germany

- Size and trend of female part-time employment in Germany



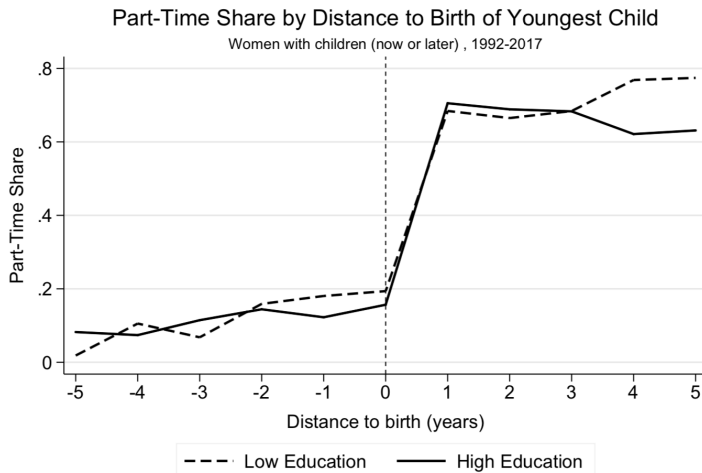


# Part-time shares by presence of children



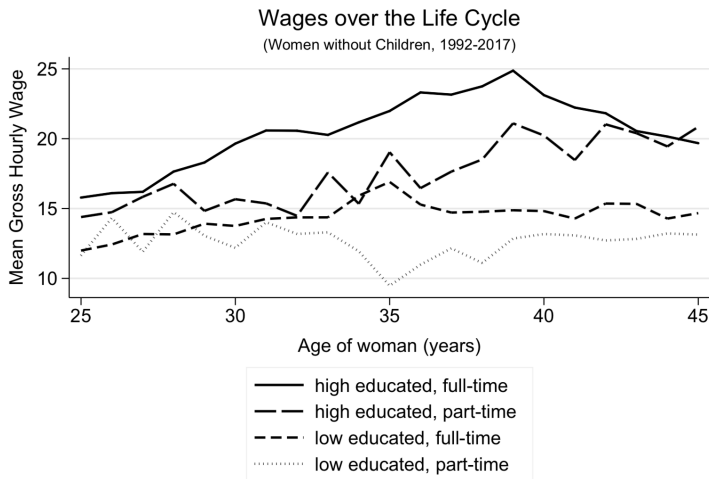
GSOEP V.34 (2017). Means weighted.

# Part-time share after first child



GSOEP V.34 (2017). Means weighted.

# Part-time penalty by education



GSOEP V.34 (2017). Means weighted.

# Part-time penalty over the life-cycle



GSOEP V.34 (2017). Own calculations. N=3185 at age 50. Pooled sample 1992-2017.

# Returns to experience in SOEP-Core

- SOEP-Core survey: tracks wages, hours, experience, occupation, education, family status, etc.
- Explore in how far realised returns to experience coincide with expectations
- Estimate realised returns to experience using SOEP-Core:

$$\ln \omega = \tilde{\alpha}_0 + \tilde{\gamma}_1 e(FT) + \tilde{\gamma}_2 e(PT) + X\tilde{\beta} + \tilde{\epsilon} \quad (2)$$

- ▶  $\omega$  hourly wage
- ▶  $e(FT)$  experience in full-time job (  $>32\text{h/week}$  ) in years
- ▶  $e(PT)$  experience in part-time job (  $>5\text{h}$  and  $<32\text{h/week}$  ) in years
- ▶  $X$  socio-demographic and job-related controls<sup>2</sup>

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<sup>2</sup> age, age sq., tenure, tenure sq., years of education, past unemployment, public sector indicator, firm size, region, nationality, marital status, number of children

# Specifications

- Pooled OLS regression
  - ▶ estimation potentially suffers from endogeneity and selection
- Fixed Effects
  - ▶ exploit variation from individuals who are observed in part-time and in full-time
  - ▶ accounts for endogeneity, but not selection effects
- Fixed Effects and Control Function
  - ▶ accounts both for endogeneity and selection effects by modelling the participation decision
  - ▶ instruments as in Costa-Dias (2018) or Hammer (2019): i) simulated out-of-work income, ii) simulated-income in part-time employment, iii) simulated income in full-time employment
  - ▶ instruments exploit variation in the tax and transfer system over time

# Estimation results SOEP-Core

- only full-time experience generates wage growth
- selection controlled for through fixed effects and control function

|                                  | (I)               | (II)              | (III)             | (IV)              | (V)               | (VI)               |
|----------------------------------|-------------------|-------------------|-------------------|-------------------|-------------------|--------------------|
| Dep.Var = $\ln \omega$           | POLS              |                   | FE                |                   | CF                |                    |
| $\tilde{\gamma}_1$ FT Experience | 0.02<br>(0.00)*** | 0.01<br>(0.00)*** | 0.03<br>(0.00)*** | 0.02<br>(0.00)*** | 0.05<br>(0.00)*** | 0.03<br>(0.01)***  |
| $\tilde{\gamma}_2$ PT Experience | 0.00<br>(0.00)*   | 0.00<br>(0.00)    | 0.01<br>(0.00)*** | 0.00<br>(0.00)    | 0.00<br>(0.00)*** | -0.05<br>(0.01)*** |
| Controls                         | no                | yes               | no                | yes               | yes               | yes                |
| Dep. Var. 1st diff.              | no                | no                | no                | no                | no                | yes                |
| N                                | 95,054            | 92,959            | 95,054            | 92,959            | 29,867            | 29,867             |

Note: SOEP Core 1992-2016. \*  $p < 0.05$ , \*\*  $p < 0.01$ , \*\*\*  $p < 0.001$

POLS= Pooled OLS. FE=Fixed Effects. CF=Control Function.

# Estimates by education

|                      | POLS    |           | Fixed Effects |           | N      |
|----------------------|---------|-----------|---------------|-----------|--------|
|                      | $\beta$ | s.e.      | $\beta$       | s.e.      |        |
| <b>All Females</b>   |         |           |               |           |        |
| Full-Time            | 0.01    | (0.00)*** | 0.02          | (0.00)*** | 98,653 |
| Part-Time            | 0.00    | (0.00)    | 0.00          | (0.00)    |        |
| <b>High Educated</b> |         |           |               |           |        |
| Full-Time            | 0.01    | (0.00)*** | 0.02          | (0.00)*** | 20,509 |
| Part-Time            | 0.00    | (0.00)    | 0.00          | (0.01)    |        |
| <b>Low Educated</b>  |         |           |               |           |        |
| Full-Time            | 0.01    | (0.00)*** | 0.02          | (0.00)*** | 26,859 |
| Part-Time            | 0.00    | (0.00)*   | 0.01          | (0.00)    |        |
| Controls             | yes     |           | yes           |           |        |



# Section 5

## Structural Framework

# Structural model incorporating beliefs

- Decisions in dynamic optimisation problems are based on expectations about associated future outcomes
- Estimate structural parameters including beliefs about labor market returns
  - ▶ given biased beliefs, preference parameters are estimated correctly, only if bias is explicitly included in model structure
  - ▶ rationality assumption nested in the beliefs bias framework
  - ▶ exploit elicited expectations about labor market returns for identification
- Perform counterfactual simulations to evaluate policies to increase female employment

# Outline of model components

- Lifespan and choice set:
  - ▶  $age_t : 17, \dots, 70$
  - ▶ education level as initial condition
  - ▶ choice variables:  $l_t \in \{N, P, F\}$  and  $c_t$
  - ▶ credit constraint; labor market frictions; tax and welfare system
- Unobserved heterogeneity:
  - ▶  $\theta = (\theta_p, \theta_f)$  - utility cost of work by individual type
  - ▶  $\nu_t$  - persistent productivity shock correlated with type
- Exogenous model components:
  - ▶ childbirth, marriage and divorce, male wages

# Decision problem

- At time  $t = 1, \dots, \bar{t}$ , individuals observe the state  $X_t \in X$  and choose an action  $l_t, a_t \in \{N, P, F\}, A$ 
  - ▶ finite, discrete time
  - ▶ discrete-continuous choice set
- Decision consequences: instantaneous utility  $u_t$  and state evolution to  $X_{t+1}$
- Individuals are forward looking and maximise total discounted utility

$$V_t(X_t) = \max_{\{c_\tau, l_\tau\}_{\tau=t, \dots, \bar{t}}} E\left\{\sum_{\tau=t}^{\tau=\bar{t}} \beta^{\tau-t} u(c_\tau, l_\tau; \theta, Z_\tau) | X_t\right\}$$

- Dynamic programming problem  $\rightarrow$  Bellman equation and backward induction

# Structural equations: Utility function

Flow utility:

$$u(c_t, l_t; \theta, Z_t) = \frac{(c_t/n_t)^\mu}{\mu} \exp\{U(l_t, \theta, Z_t)\}$$
$$U(l_t, \theta, Z_t) = \begin{cases} 0, & \text{if } l_t = N, \\ \theta_{(l_t)} + Z_t' \beta(l_t), & \text{if } l_t = P \text{ or } F, \end{cases} \quad (3)$$

where  $\beta(l_t) = \beta_F + \beta_P \cdot \mathbf{1}(l_t = P)$

- $c_t$  - consumption
- $n_t$  - equivalence scale
- $l_t \in \{N, P, F\}$  - female labor supply
- $\mu$  - risk aversion, inter-temporal substitution
- $\theta = (\theta_p, \theta_f)$  - utility cost of work
- $Z$  - marital status, presence of children, children in age group dummies, partner working indicator, interactions, etc.

# Structural Equations: Budget constraint

$$\begin{cases} a_{t+1} = (1+r)a_t + h_t w_t + m_t \tilde{h}_t \tilde{w}_t - T(l_t, X_t) - Q(t^k, h_t, \tilde{h}_t, m_t) - c_t, \\ a_{t+1} = \underline{a_s}, \end{cases} \quad (4)$$

with initial and terminal conditions  $a_0 = 0$  and  $a_{\tilde{t}+1} \geq 0$ .

- $r$  - risk free interest rate
- $(w, \tilde{w})$  - hourly rates of wife and husband
- $(h, \tilde{h})$  - working hours of wife and husband
- $\underline{a_s}$  - borrowing limit
- $T$  - tax and welfare transfer system
- $Q$  - childcare costs

# Structural equations: Female market wage equation

$$\begin{aligned} \ln w_t^m &= \gamma_{s,0} + \gamma_{s,1} \ln(e_t + 1) + \nu_t + \xi_t, \\ \ln w_t &= \ln w_t^m - \xi_t, \\ e_t &= e_{t-1}(1 - \delta_s) + g_s(l_{t-1}), \\ \nu_t &= \rho_s \nu_{t-1} + \zeta_t, \end{aligned} \tag{5}$$

where

- $\ln w_t^m$  - observed hourly wage rate
- $\xi_t$  - i.i.d. normal contemporaneous error
- $e_t$  - experience measured in years
- $\nu_t$  - individual AR (1) productivity process
- $s \in \{\text{low, middle, high}\}$  - level of education
- $\delta_s$  - per period depreciation rate
- $g_s(l_{t-1})$  - period rate of experience accumulation, with  $g_s(N) = 0$ ,  $g_s(F) = 1$  and  $g_s(P) \in [0, 1]$

# Beliefs in the female perceived wage equation

Recall: True experience accumulation:  $g_s(l_{t-1})$

$$e_t = e_{t-1}(1 - \delta_s) + g_s(l_{t-1})$$

Beliefs components: Perceived experience accumulation:  $\bar{g}_s(l_{t-1})$

$$e_t = e_{t-1}(1 - \delta_s) + \bar{g}_s(l_{t-1})$$

$$\bar{g}_s(l_{t-1}) = \alpha \cdot g_s(l_{t-1})$$

where:

- $\bar{g}_s(l_{t-1})$  - perceived experience accumulation from part-time employment
- Maintain normalisation:  $g_s(F) = 1$ ,  $g_s(N) = 0$
- $\alpha$  governs the degree of beliefs deviation from the true/realised returns to experience.



# Section 6

## Estimation and Simulations

# Estimation strategy

## Incorporating beliefs

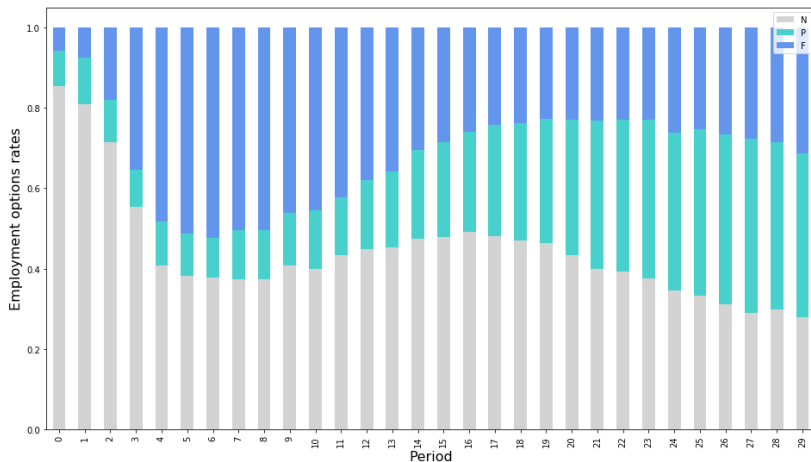
- $\alpha \rightarrow$  causal estimate of beliefs bias from SOEP-IS regression
- Construct moments from SOEP-IS and estimate  $\alpha$  alongside remaining structural parameters
- Estimation via Method of Simulated Moments (MSM) or Maximum Likelihood (ML)

## Estimation procedure

- Restricted sample:
  - ▶ only former GDR states, 1992-2014,  $N = 59,096$  from 15,874 individuals
- Set beliefs parameter to mimic result observed in SOEP-IS: no part-time penalty expected
- Estimate parameters via MSM, PY-BOBYQA
- Counterfactual simulation of rational expectations

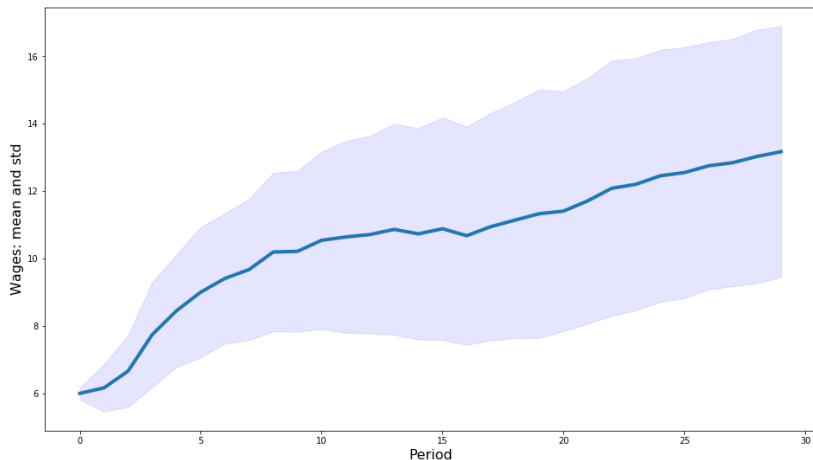
# Moments

## Age profiles of employment (and transition) rates (by education)



# Moments contd.

## Age profile of wage distribution



# Preliminary key result

Part-time penalty parameter estimates

|             |       |             |
|-------------|-------|-------------|
| $g_{s0}(P)$ | 0.159 | low educ    |
| $g_{s1}(P)$ | 0.200 | middle educ |
| $g_{s2}(P)$ | 0.173 | high educ   |

# Counterfactual simulations

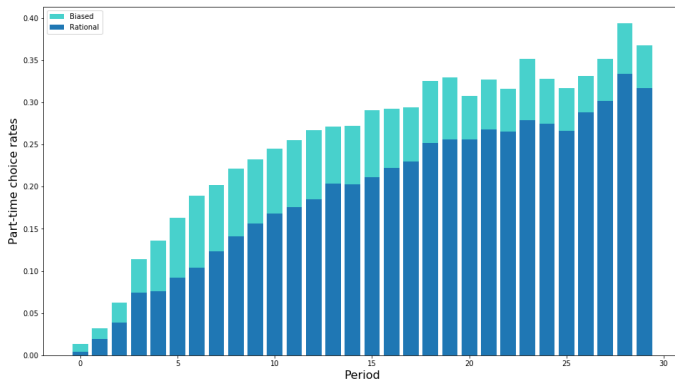
## ① Information treatment to de-bias individual expectations:

- ▶ More individuals work full-time: human capital  $\uparrow$ , wages  $\uparrow$ , state tax income  $\uparrow$
- ▶ Increase in unemployment: human capital  $\downarrow$ , wages  $\downarrow$ , state revenue  $\downarrow$

## ② Policy reforms targeting working incentive:

- ▶ In-work tax credits conditional on working hours
- ▶ Individual taxation
- ▶ Subsidised promotions for part-time workers to increase returns to part-time work

# Counterfactual simulation: de-biasing



## Section 7

## Conclusion



# Summary

Copy slide from Peter

# Previous innovative modules SOEP-IS

Examples:

- internalized gender stereotypes
- day reconstruction method (DRM)
- job pref's and willingness to accept job offer
- overconfidence in different life domains
- grit and entrepreneurship
- sickness presentism
- perceived discrimination
- expected financial market earnings
- epigenetic markers of stress
- separating systematic measurement error components using MTMM in longitudinal studies

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# Probabilistic add-on questions (I)

Current working hours: Future income

Probability lower income

How likely do you think it is that, in one year<sup>3</sup>, your full-time (*part-time*) job yields a gross income of *less* than  $X-20\%$  per month?

Probability higher income

How likely do you think it is that, in one year<sup>4</sup>, your full-time (*part-time*) job yields a gross income of *more* than  $X+20\%$  per month?

Please report your answer in percent. 0% means that you consider it impossible, 100% means that you are certain. You can use the percent values in between to graduate your answer.

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<sup>3</sup> ... in 2 years/ ... in 10 years

<sup>4</sup> ... in 2 years/ ... in 10 years

# Probabilistic add-on questions (II)

Hypothetical working hours: Today

Probability lower income

How likely do you think it is that a part-time (*full-time*) position at 20 (40) hours per week yields a gross income of *less* than  $X-20\%$  per month?

Probability higher income

How likely do you think it is that a part-time (*full-time*) position at 20 (40) hours per week yields a gross income of *more* than  $X+20\%$  per month?

Please report your answer in percent. 0% means that you consider it impossible, 100% means that you are certain. You can use the percent values in between to graduate your answer.

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# Probabilistic add-on questions (III)

## Hypothetical working hours: Future income

### Probability lower income

How likely do you think it is that, in one year<sup>5</sup>, your part-time (*full-time*) job yields a gross income of *less* than  $X-20\%$  per month?

### Probability higher income

How likely do you think it is that, in one year<sup>6</sup>, your part-time (*full-time*) job yields a gross income of *more* than  $X+20\%$  per month?

Please report your answer in percent. 0% means that you consider it impossible, 100% means that you are certain. You can use the percent values in between to graduate your answer.

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<sup>5</sup> ... in 2 years/ ... in 10 years

<sup>6</sup> ... in 2 years/ ... in 10 years