Tägliche Arbeitszeitmuster und Einkommensverteilung –
Ein Treatment-Effekt Ansatz mit den Daten der deutschen Zeitbudgeterhebung

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Central question:

Consequences of working hour arrangements with regard to
daily timing and fragmentation of work time on income

Requirement: Demanding daily labour market information

A particular contribution of daily time use information and FDZ
'Zeitbudgeterhebung' to Labour market research and policy

Timing, Fragmentation of Daily Work and Income Inequality –
An Earnings Treatment Effects Approach

1   Data: The German Time Budget Survey 2001/02

2   Daily Working Hour Arrangements – Timing and Fragmentation of Work:
       Descriptive Results

3   Timing and Fragmentation of Work and Earnings:
       Microeconomic Model and Microeconometrics
       by a Treatment Effects Approach

The German Time Budget Survey 2001/02

Respondents: Persons ten years and older, German
                                          population in private households

Quoted sample, four times the year

No. of households: 5,171

No. of persons with diaries: 11,962

Method: Time diaries in three consecutive days,
                                          ten minutes interval

No. of diaries: 35.813

The German Time Budget Survey 2001/02

Main activity with additional information about…

Simultaneous activity

Location of main activity

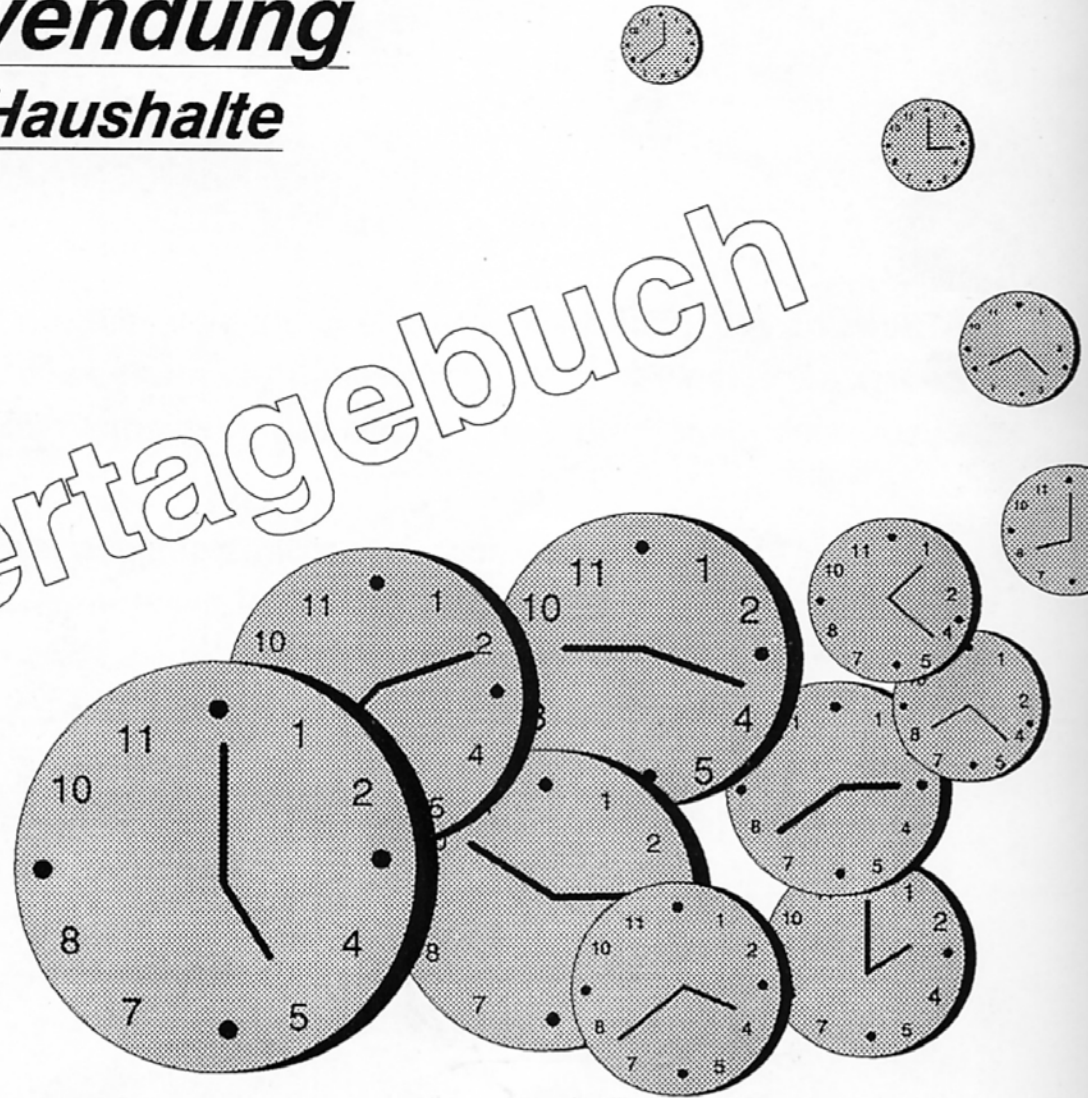With/without children

With/without other household members

With/without other person

Personal questionnaire

Household questionnaire

- 11 -

| Hauptaktivität ausgeübt für: eigenen Haushalt (z.B. Hausarbeit, Freizeit, Erwerbstätigkeit) = 1 / anderen Haushalt = 2 / eigenen und anderen Haushalt = 3 / soziale Dienste/Ehrenamt = 4 | Ort der Hauptaktivität: zu Hause ausgeübt (auch auf dem zum Haus gehörenden Grundstück) = 1 / nicht zu Hause ausgeübt = 2 | Kreuzen ⊠ Sie bitte an, mit wem Sie die Zeit verbrachten? (Mehrere Angaben sind möglich) |

Uhrzeit von – bis	Hauptaktivität	Gleichzeitige Aktivität	für wen	wo	Kindern	anderen Haushaltsmitgliedern	Verwandten, Nachbarn, Freunden	Kollegen, Mitschülern	sonstigen Personen	Ich war allein	
			ausgeführt								
13.30-13.35	Fahrt mit dem Auto zum		3	2						X	11
13.35-13.40	Einkaufszentrum		3	2						X	11
13.40-13.45			3	2						X	11
13.45-13.50	Lebensmitteleinkauf für die		3	2						X	11
13.50-13.55	Familie und die Nachbarin		3	2						X	16
13.55-14.00			3	2						X	16
14.00-14.05	Fahrt mit dem Auto nach		3	2						X	16
14.05-14.10	Hause	Kindergeburtstag geplant	3	2						X	17
14.10-14.15			3	2						X	17
14.15-14.20	mit Söhnen über Schulerlebnisse		1	1	X						17
14.20-14.25	gesprochen	Einkäufe verstaut	1	1	X						17
14.25-14.30			1	1						X	17
14.30-14.35	Imbiß für Kinder vorbereitet		1	1						X	17
14.35-14.40			1	1						X	17
14.40-14.45	der Nachbarin beim Verstauen	Unterhaltung mit Nachbarin	2	2			X				17
14.45-14.50	der Einkäufe geholfen	über ihre persönl. Probleme	2	2			X				17
14.50-14.55			2	2			X				17
14.55-15.00	Küche aufgeräumt		1	1						X	18

Working Time Arrangement Categories

Source: German Time Use Study 2001/02

	examples	7 am	5 pm	n %
0	**no work**			**61.4%**
1	**mainly core, one episode**			**25.1%**
2	**mainly core, more than one episode**			**9.7%**
3	**mainly non-core, one episode**			**2.5%**
4	**mainly non-core, more than one episode**			**1.3%**

Working hour arrangement categories by timing of work and fragmentation in Germany 2001/2002

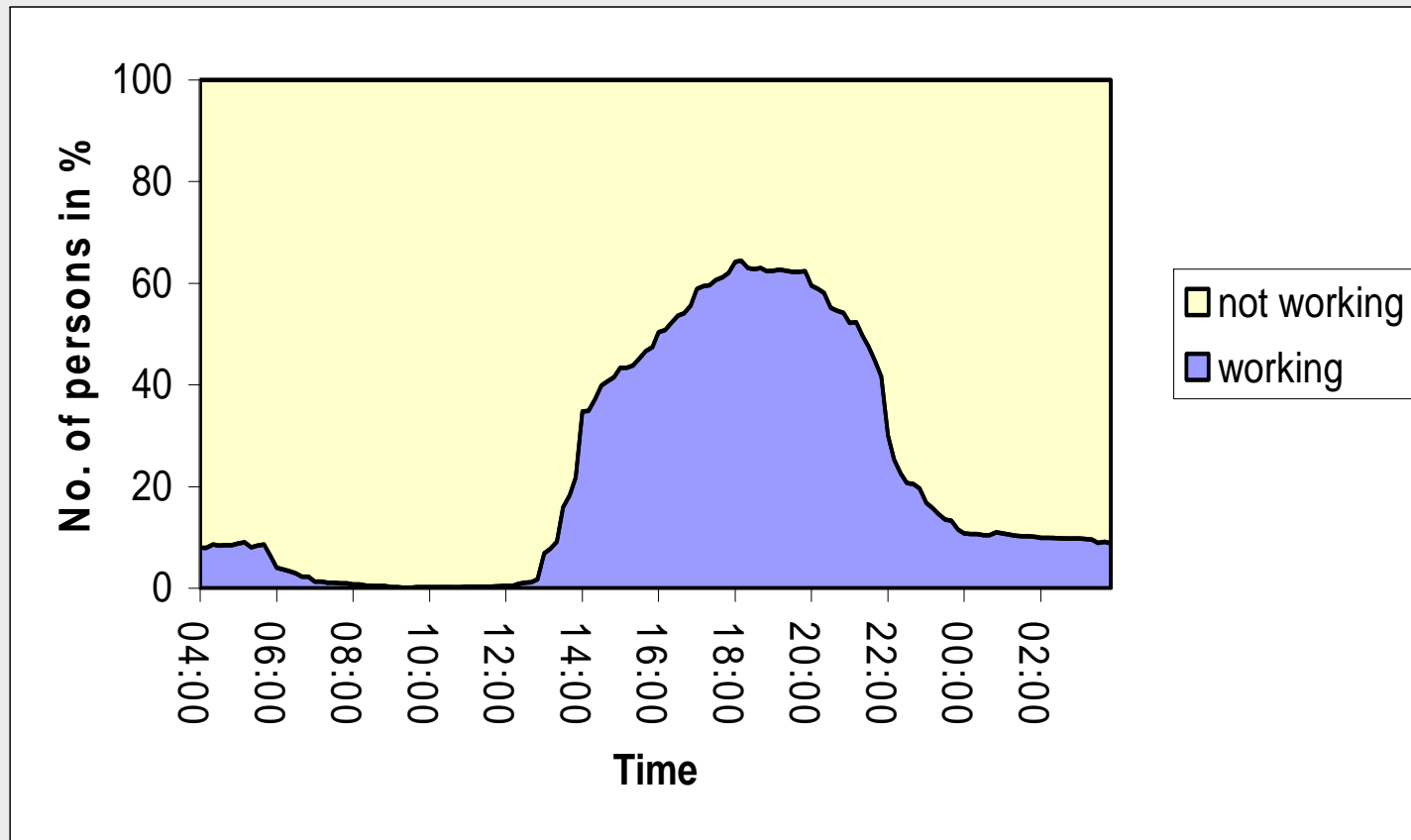|	Timing of work		Total
	mainly core	mainly non-core	
Fragmentation one episode	**I** **65.1%** n = 6,884 N = 40,503,406	**III** **6.5%** n = 716 N = 4,037,688	**71.6%**
two or more episodes	**II** **25.1%** n = 2,698 N = 15,605,547	**IV** **3.3%** n = 350 N = 2,026,132	**28.4%**
Total	**90.2%**	**9.8%**	n=10,648 **N = 62,172,772**

Daily timing of work:
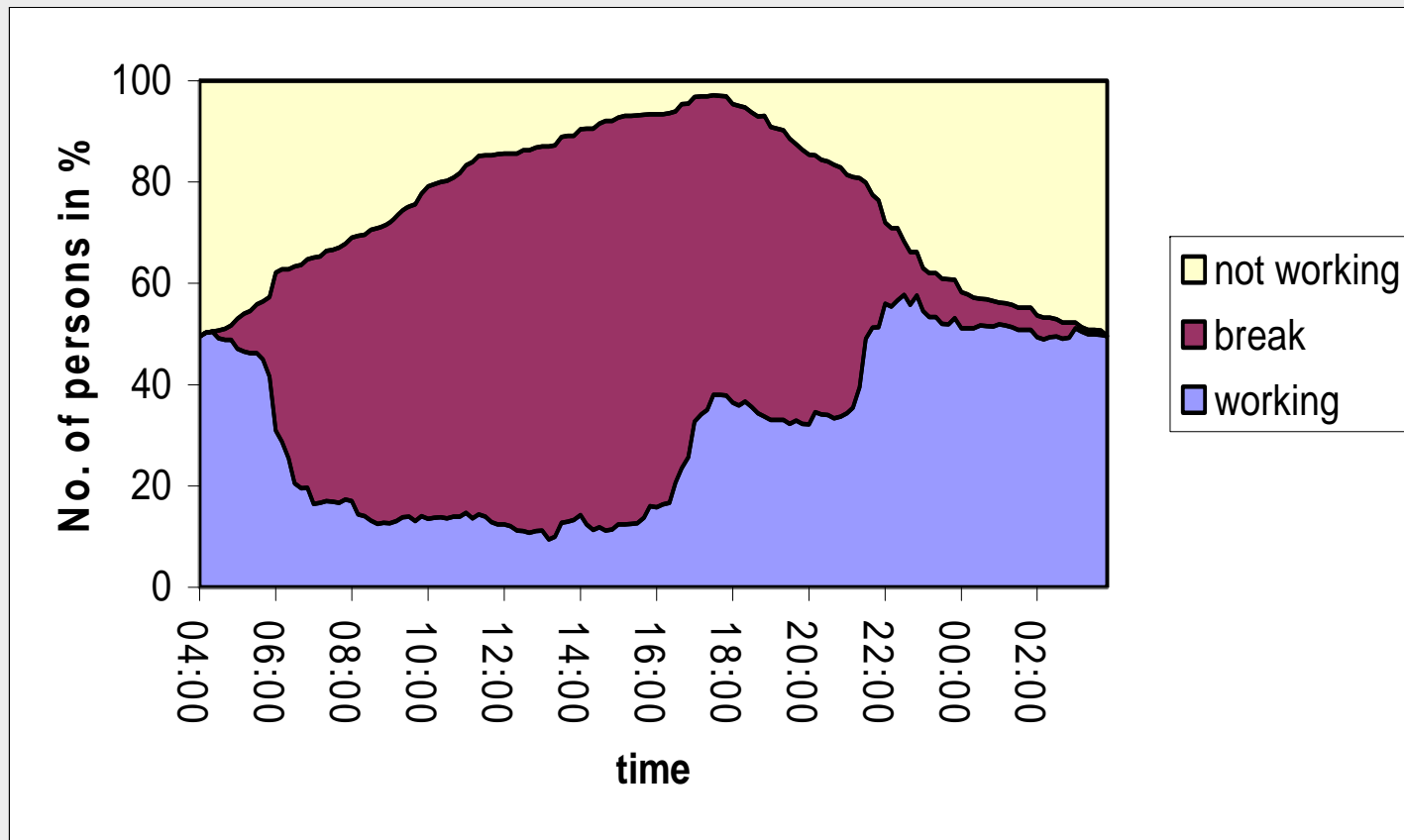# Category I (core/one episode)
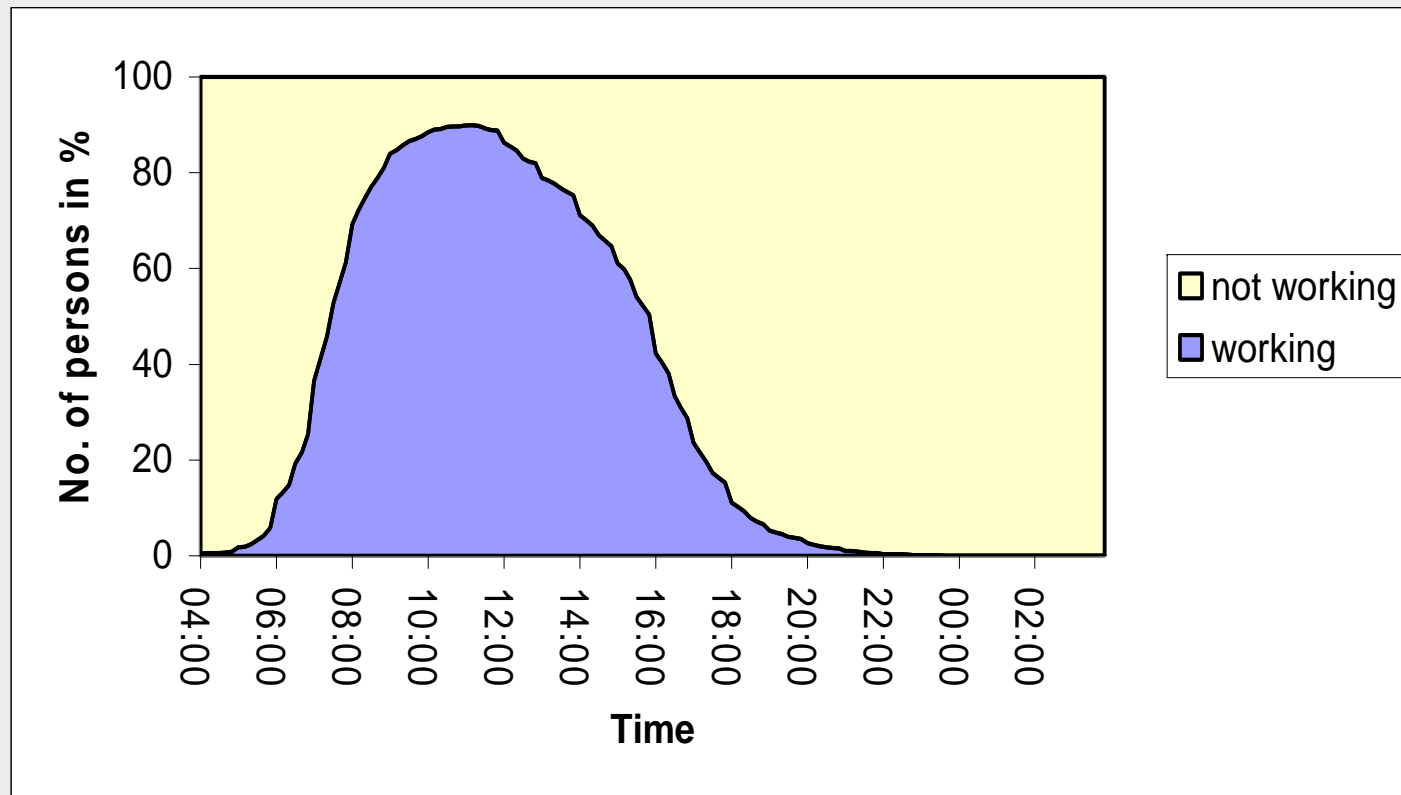
Daily timing of work and breaks:
Category II (core/multiple episodes)
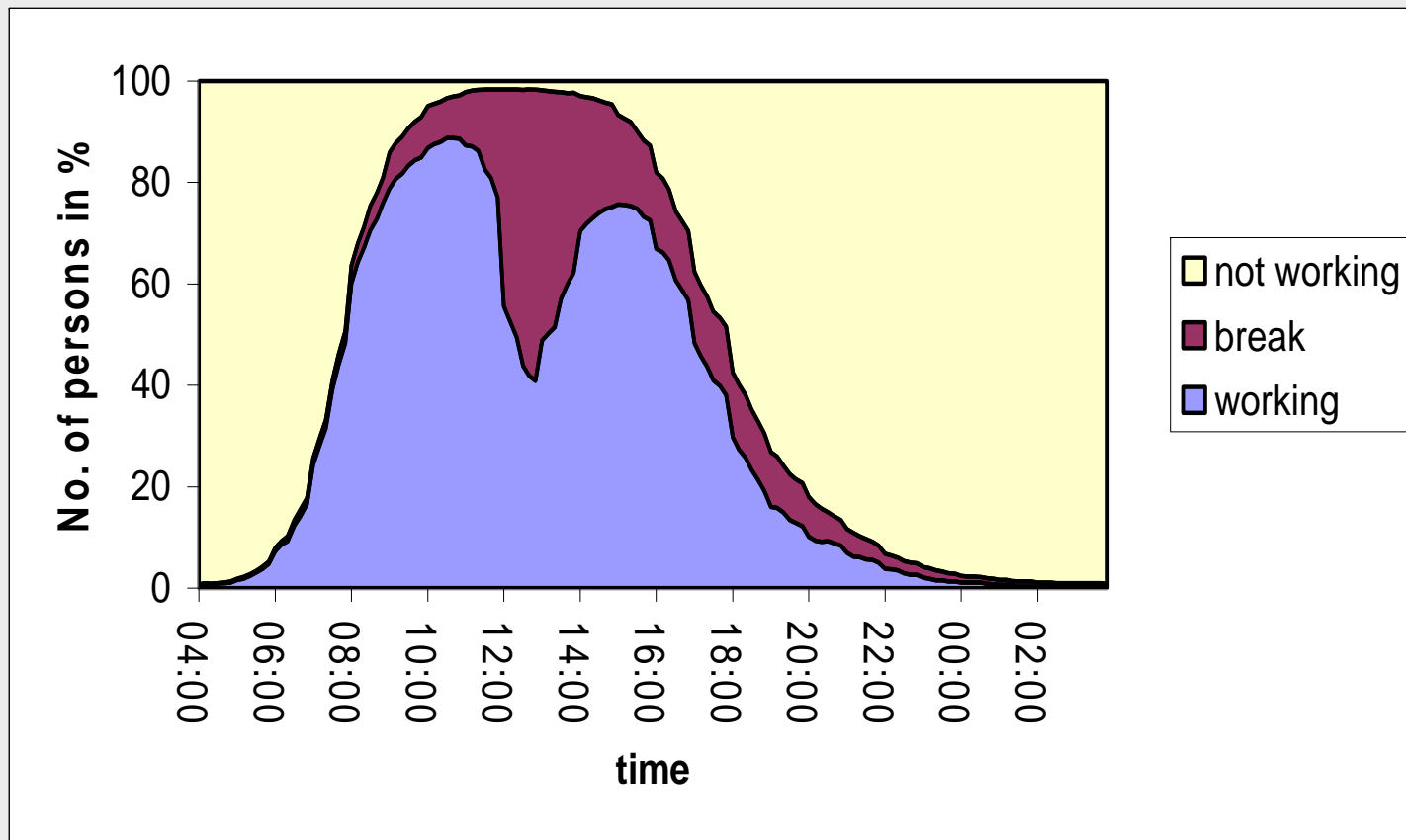
Daily timing of work:
Category III (non-core/one episode)

Daily timing of work and breaks:
Category IV (non-core/multiple episodes)

Descriptive Results

	Mean wage €	Mean hours[1]	Mean income[2] €	N %
Core not fragmented (Category I)	9,71	38,2	1.552	65,2
Core fragmented (Category II)	10,10	43,4	1.802	25,1
Non-core not fragmented (Category III)	9,17	34,0	1.319	6,5
Non-core fragmented (Category IV)	10,18	44,2	1.787	3,3
All	9,79	39,4	1.608	3,3

1 weekly, 2 monthly net income

Source: German Time Budget Survey 2001/02, own calculations.

Kernel density estimates of monthly net income: Cat I
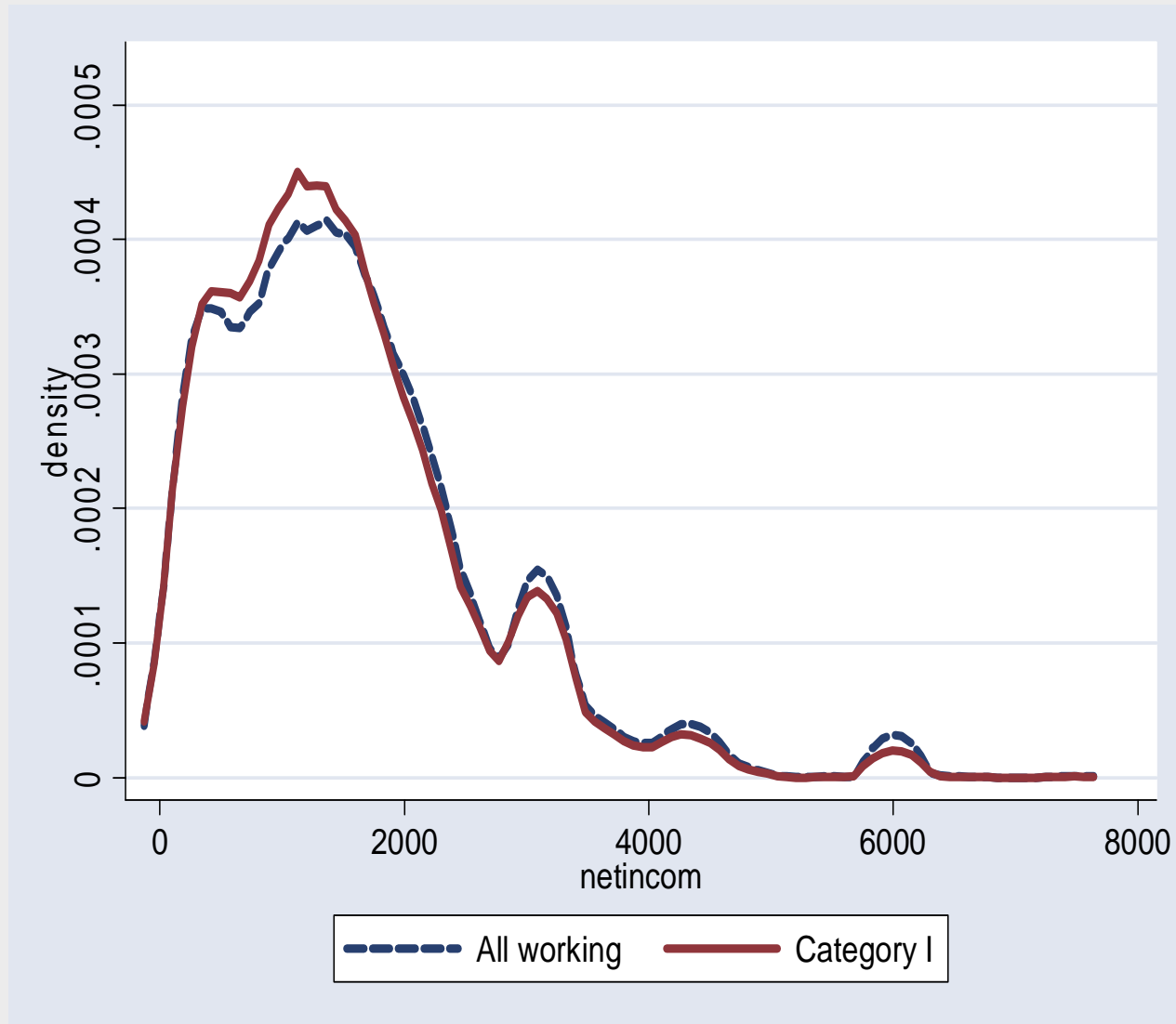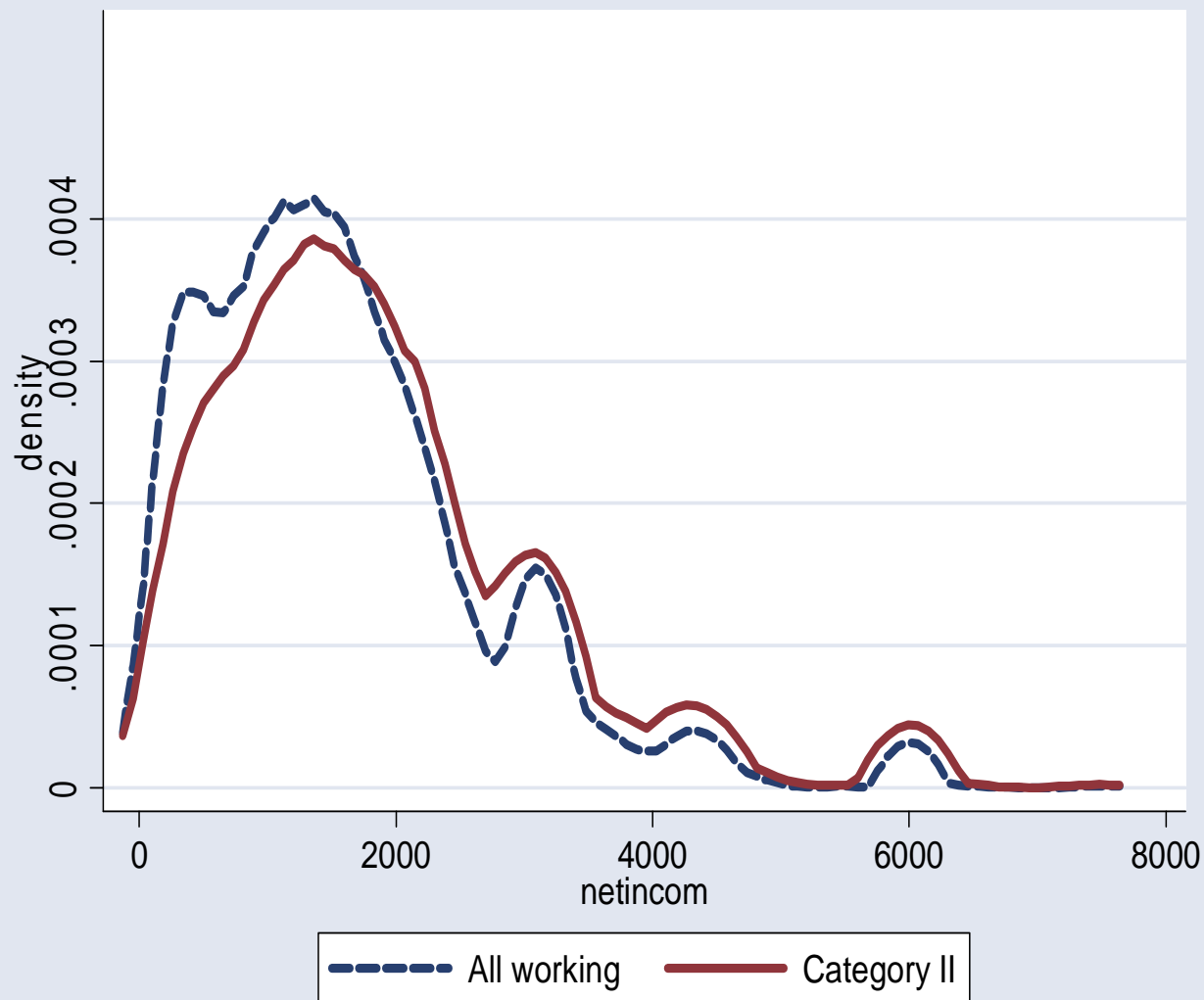
Kernel density estimates of monthly net income: Cat II

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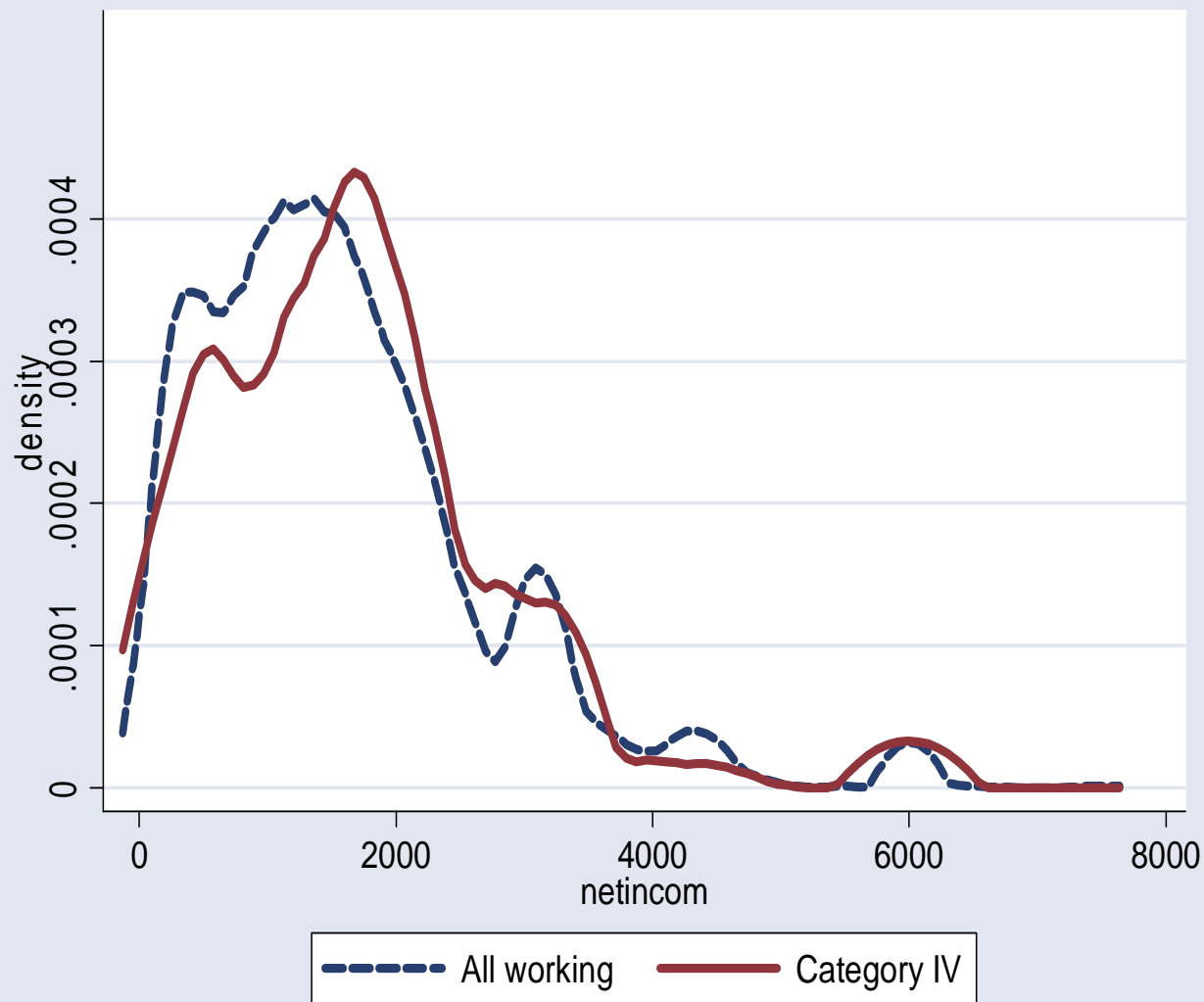# Kernel density estimates of monthly net income: Cat III
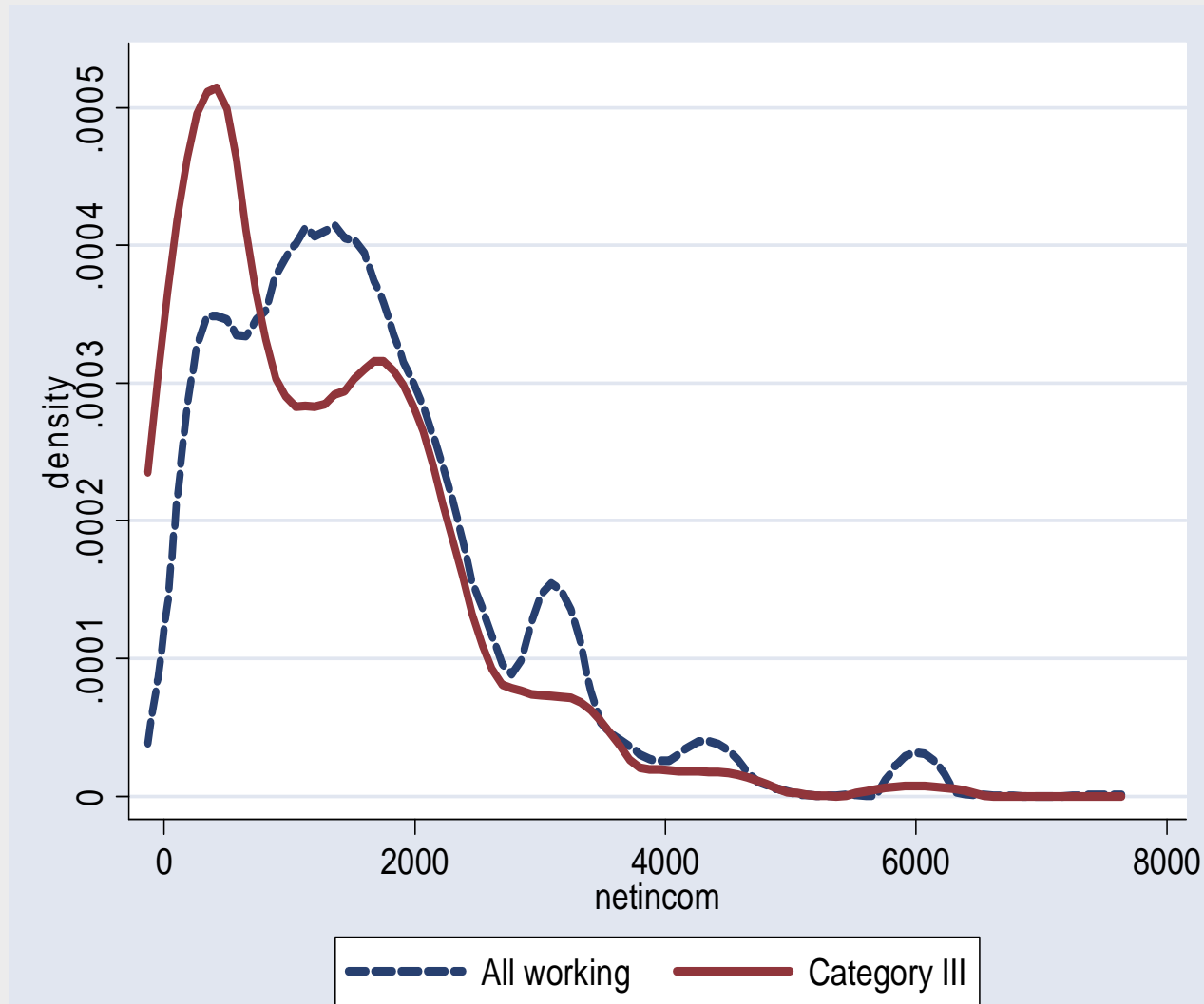
Kernel density estimates of monthly net income: Cat IV

Net Income:
Distributive Measures by Working Hour Arrangement (1)

	Working	Cat. I core one	Cat. II core #episode	Cat. III non-core one	Cat. IV non-core #episodes
Mean in €	**1,607.69**	**1,552.22**	**1,802.42**	**1,319.72**	**1,787.20**
Median in €	**1,431.62**	**1,380.49**	**1,556.62**	**1,252.67**	**1,636.13**
Scewness	1.57	1.51	1.53	1.17	1.76
Kurtosis	4.04	4.07	3.05	2.67	5.10
Variation	0.63	0.60	0.65	0.68	0.60
Decomposition					
Theil Index	0.18166	0.16983	0.18846	0.23217	0.16407
Inequality		**59.94**	**29.82**	**6.93**	**3.31**
Group share in %					
within	98.09	-	-	-	-
between	1.91	-	-	-	-
n	10,607	6,859	2,689	712	347
N	61,962,57	40,360,17	15,581,4	4,014,101	2,006,809
N in %	100.00	65.14	25.15	6.48	3.24

Net Income:
Distributive Measures by Working Hour Arrangement (2)

|	Working	Category I core one episode	Category II core #episodes>1	Category III non-core one episode	Category IV non-core #episodes>1
Distributive measures					
Gini-	**0.32563**	**0.31487**	**0.33476**	**0.36723**	**0.29871**
Atkinson-Index					
$\varepsilon = 1$	0.19580	0.18435	0.19528	0.27102	0.18412
$\varepsilon = 2$	0.45425	0.43385	0.43287	0.58784	0.45809
Decile shares in % (Decile limits in €)					
1. Decile	1.77 (511)	1.88 (511)	1.99 (625)	0.98 (230)	1.72 (625)
2. Decile	4.38 (875)	4.53 (875)	4.41 (920)	2.60 (500)	4.57 (1074)
3. Decile	6.17 (1125)	6.33 (1125)	5.93 (1125)	4.76 (750)	7.25 (1375)
4. Decile	7.26 (1253)	7.43 (1227)	6.88 (1351)	6.97 (1100)	7.75 (1500)
5. Decile	8.37 (1432)	8.49 (1381)	8.05 (1557)	8.99 (1253)	8.42 (1636)
6. Decile	9.53 (1625)	9.63 (1585)	9.07 (1770)	10.10 (1432)	9.70 (1875)
7. Decile	10.70 (1875)	10.69 (1790)	10.69(2119)	11.90 (1636)	11.08 (2000)
8. Decile	12.49 (2147)	12.50 (2125)	12.47(2434)	13.40 (1943)	11.66 (2375)
9. Decile	15.40 (3000)	15.18 (2812)	15.87(3170)	15.83 (2250)	14.71 (3125)
10. Decile	23.93	23.35	24.62	24.47	23.13
90/10	**13.52**	**12.42**	**12.37**	**24.97**	**13.45**
n	10,607	6,859	2,689	712	347
N	61,962,578	40,360,174	15,581,494	4,014,101	2,006,809
N in %	100.00	65.14	25.15	6.48	3.24

Net Income:
Person Shares by Category within Overall Net Income Deciles (%)
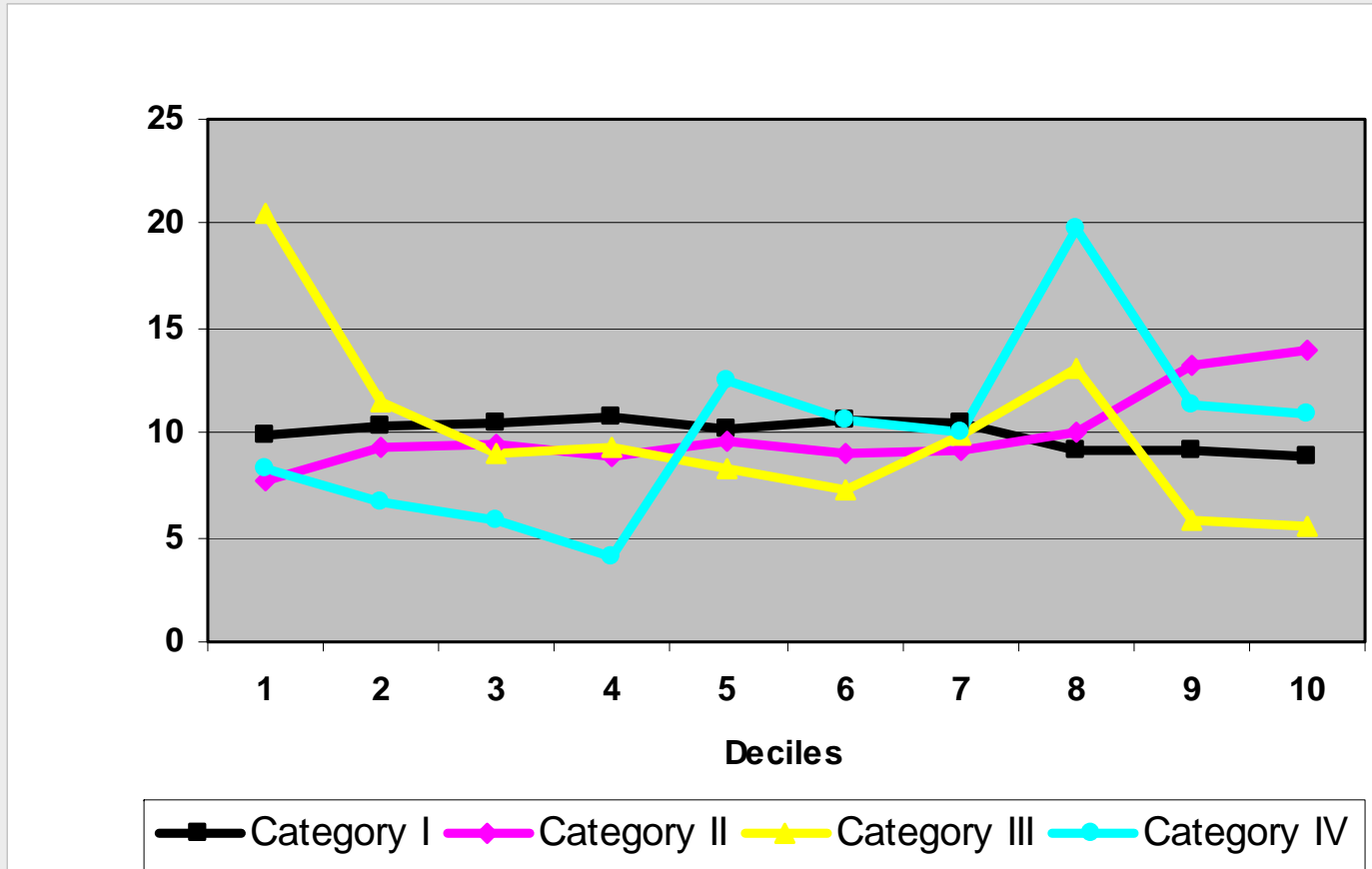
Reading: 21% of Category III people have less than 511 €(First Decile limit)

Net Income:
Lorenz Curves by Category
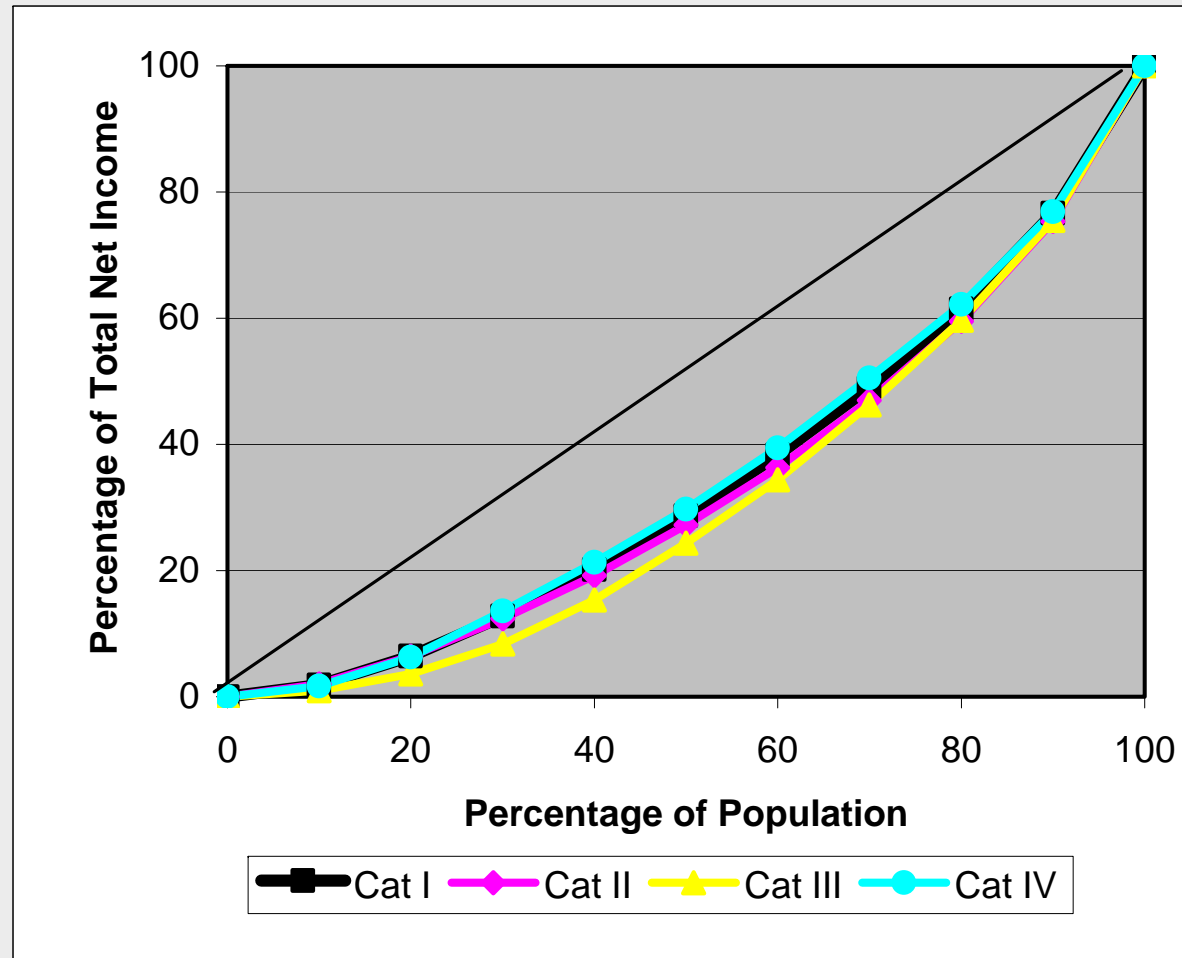
Results of the Distribution Analysis

Categories	Net Income				Wage				Working Hours			
	I	II	III	IV	I	II	III	IV	I	II	III	IV
Mean	-	+	-	+	-	+	-	+	-	+	-	+
Gini	-	+	+	-	-	+	-	+	-	-	+	+
Atkinson 1	-	-	+	-	-	+	-	+	-	-	+	+
Atkinson 2	-	-	+	+	-	+	-	+	-	-	+	+
90/10 Relation	-	-	+	-	-	+	-	+	-	-	+	+

Compared to All Working Results

Zusammenfassung – Deskriptive Ergebnisse

1. Cat II&IV (mehrere Arbeitsepisoden):
    *   Größtes Nettoeinkommen
    *   Größter Stundenlohn
    *   Längste Arbeitszeit

2. Einkommensverteilung
    *   Cat III (Nicht-Kernzeit/1 Arbeitsepisode) mit der ungleichsten Einkommensverteilung

3. Verteilung der Stundenlohns
    *   Cat II&IV (mehrere Arbeitsepisoden) mit der ungleichsten Verteilung des Stundenlohns

4. Arbeitszeitverteilung
    *   Cat III&IV (Nicht-Kernzeit) mit der ungleichsten Arbeitszeitverteilung

Economics: Human capital earnings function

Basic human capital model:

$$\ln E_t = \ln E_0 + r_s S + a r_p T + b r_p T^2$$

E_t :   capacity earnings in year t

E_0 :   ‚original' capacity earnings

S: years of schooling

T: years of job experience

r_s :   rate of return to schooling

r_p :   rate of return of job experience

Earnings function - Theoretical background:
Human capital in a market and non-market context

Human capital earnings equation (with observed earnings Y)

$$\ln Y_t = \alpha_0 + rS + \alpha_1 T + \alpha_2 T^2$$

Extension of the earnings function with additional socio-economic vector x)

$$\ln Y_t = \alpha_0 + rS + \alpha_1 T + \alpha_2 T^2 + x_i' \beta$$

Econometrics: Working category as a specific treatment

Evaluation of social programs, Causality problem, potential outcome approach Rubin 1974

Average treatment effect on the treated (ATT)

$$ATT = E(y_{1i} - y_{0i} \mid D_i = 1) = E(y_{1i} \mid D_i = 1) - E(y_{0i} \mid D_i = 1)$$

The average causal effect of a treatment on those who are treated (ATT) is the difference of the treated $E(y_{1i} \mid D_i = 1)$

and what would have happened to the same persons if not treated $E(y_{0i} \mid D_i = 1)$

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Challenge: eliminate /respect selection bias

Then the **average treatment effect** can be measured by the

average observable outcomes of the participants of a program (treated) minus

that of the non-participants (nontreated).

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Our model:
Heckman type common treatment effects approach
(selectivity bias correcting)

Endogenously chosen binary treatment (selection of working hour arrangement) on endogenous income/wages

Participation in category j (j=1,…,4)

from an unobserved latent variable D^* as:

$$D_{ij}^* = Z_{ij}\gamma_j + V_{ij},$$

$$D_{ij} = 1 \quad if \; D_{ij}^* > 0, \quad D_{ij} = 0 \quad otherwise.$$

Outcome
Category j specific earnings function with socio-economic variables and endogenous participation decision:

$$E\left[\ln Y_{ij} \mid D_{ij} = 1, S_{ij}, T_{ij}, X_{ij}, Z_{ij}\right]$$

$$= \alpha_{0j} + r_j S_{ij} + \alpha_{1j} T_{ij} + \alpha_{2j} T_{ij}^2 + X_{ij}\beta_j + \alpha_j D_{ij} + E\left[U_{ij} \mid D_{ij} = 1, S_{ij}, T_{ij}, X_{ij}, Z_{ij}\right]$$

$$= \alpha_{0j} + r_j S_{ij} + \alpha_{1j} T_{ij} + \alpha_{2j} T_{ij}^2 + X_{ij}\beta_j + \alpha_j D_{ij} + \rho_j \sigma_{\varepsilon j} \lambda_j (-Z_{ij}\gamma_j)$$

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Bivariate Probit equation for category choice with covariance matrix:

$$\mathrm{cov}(V_{ij}, U*_{ij}) = \begin{pmatrix} \sigma_j & \rho_j \\ \rho_j & 1 \end{pmatrix}$$

Difference in expected ln income between participants and non participants:

$$E\left[\ln Y_{ij} \mid D_{ij} = 1\right] - E\left[\ln Y_{ij} \mid D_{ij} = 0\right] = \alpha_j + \rho_j \sigma_{Uj}\left[\frac{\phi_{ij}}{\Phi_{ij}(1 - \Phi_{ij})}\right].$$

Results: Earnings estimates by a treatment effects model (1)

	Category I	Category II	Category III	Category IV
	Core	**Core**	**Non-core**	**Non-core**
	One episode	**# episodes**	**One episode**	**# episodes**
	–	**≥ 2**	**–**	**≥ 2**
ln EARNINGS				
Category j δ_j	-3.908531 ***	2.850709 ***	-2.217199 ***	157.194 ***
Hazard lambda	2.362135 ***	-1.636485 ***	1.035406 ***	-.6644788 ***
human capital				
School years (S)	52858	.0004131	.0429798 ***	.0545976 ***
Work experience (T)	.0578081 ***	.05921 ***	.0444624 ***	.0419555 ***
Work experience^2 (T^2)	-.0010511 ***	-.001103 ***	-.0007361 ***	-.0006443 ***
Wald chi^2 (16)	1386.03	2525.95	4938.93	6425.18
p-value for chi^2	.00000 ***	.00000 ***	.00000 ***	.00000 ***
n (working: 10607)	6852	2678	719	358

Results: Earnings estimates by a treatment effects model (2)

	Category I	Category II	Category III	Category IV
	Core	**Core**	**Non-core**	**Non-core**
	One episode	**# episodes**	**One episode**	**# episodes**
	–	**≥ 2**	**–**	**≥ 2**
ln EARNINGS				
occupational status				
reference: blue collar	-	-	-	-
self-employed 0 empl.	.5877811 ***	.5590384 ***	.7731187 ***	.8196024 ***
self-employed >0 empl..	.385388 *	.3715193 **	.6535276 ***	.7175627 ***
liberal professions	.4569893 ***	.4563182 ***	.5722316 ***	.6073045 ***
civil servants	.8885734 ***	.8803991 ***	.9466153 ***	.9849433 ***
white collar worker	.4029769 ***	.3505992 ***	.3148965 ***	.3512981 ***
apprentice	-.3574205 ***	-.3627674 ***	-.3195913 ***	-.2942108 ***
helping family member	-.1604767	-.1234818	-.2040246 ***	-.2584336 *

Results: Earnings estimates by a treatment effects model (3)

	Category I	Category II	Category III	Category IV
	Core	**Core**	**Non-core**	**Non-core**
	One episode	**# episodes**	**One episode**	**# episodes**
	–	**≥ 2**	**–**	**≥ 2**
ln EARNINGS				
multiple jobs				
Second job	-.2356443 ***	-.2275196 ***	-.2438255 ***	-.263097 ***
demand side				
ref.: agriculture				
industry	.6705779 ***	.6928089 ***	.7440246 ***	.7576406 ***
services	.4377631 ***	.430295 ***	.447006 ***	.4520374 ***
region				
East	.1744386 **	.0219009	-.2191925 ***	-.1931014 ***
constant	8.200124 ***	5.066563 ***	5.595438 ***	5.228578 ***

Results – Bivariate Probit Model:
Endogeneous participation probability estimates (1)

	Category I	Category II	Category III	Category IV
	Core	**Core**	**Non-core**	**Non-core**
	One episode	**# episodes**	**One episode**	**# episodes**
	–	**≥ 2**	**–**	**≥ 2**
PARTICIPATION PROBABILITY				
Personal demographics				
age	.0227389 *	-.0182999	-.0220969	.0306111
age ^{2}	-.0003184 **	.0003255 **	.0001241	-.0003687
woman	.1531365 ***	-.0199893	-.1680781 **	-.3783944 ***
married	.1552043 **	-.1302822 **	-.0212925	-.2004843 *
education				
elemantary	.116942	-.1358193	-.1749561	.254799
intermediate	.1200956	-.0870726	-.1716882	-.0095316
spec. upper or upper	-.0835988 **	.1385355 ***	-.2079447 ***	.1692626 **
university	-.2891626 ***	.330533 ***	-.1448368	.2736943 **
Wald chi^2 (16)	1386.03	2525.95	4938.93	6425.18
p-value for chi^2	.00000 ***	.00000 ***	.00000 ***	.00000 ***
n (working: 10607)	6852	2678	719	358

Results – Bivariate Probit Model:
Endogeneous participation probability estimates (2)

	Category I	Category II	Category III	Category IV
	Core	**Core**	**Non-core**	**Non-core**
	One episode	**# episodes**	**One episode**	**# episodes**
	–	**≥ 2**	**–**	**≥ 2**
PARTICIPATION PROBABILITY				
non-market time use				
time for household	.0000759	-.0015483 ***	.0023518 ***	.0011799 ***
time for child care	.0010501 *	-.000907	-.0001078	-.0011221
time for do-it-yourself	.000299	-.0026076 ***	.0021689 ***	.0021063 **
active help (h)	-.0017347	.0013517	-.0014825	.0048663 *
partner`s employment				
partner full time work	-.0763369	.0253924	-.0308513	.3155059 ***
partner part time work	-.0887075 *	.0536556	.0915853	.0799004

Results – Bivariate Probit Model:
Endogeneous participation probability estimates (3)

	Category I	Category II	Category III	Category IV
	Core **One episode** –	**Core** **# episodes** ≥ 2	**Non-core** **One episode** –	**Non-core** **# episodes** ≥ 2
PARTICIPATION PROBABILITY				
Household characteristics				
receiving help (h)	.0007053	-.0020338	.0010574	.0014867
number of hh members	-.0652222 ***	.0669324 ***	.0017645	.018666
young kids	-.0634876	.0857412	-.0448537	.0361543
Income/wealth situation				
own house	-.0602891	.0840075 *	-.0599845	.049606
residual income	8.92e-06	-5.52e-06	-6.23e-06	-1.45e-06
region				
east Germany	.2765265 ***	-.2670162 ***	.014006	-.2985634 ***
constant	.0018567	-.4213718	-.7616166 *	-2.777401 ***

Overview of explanatory pattern (1)

	Category I **Core** **One episode** _		Category II **Core** **# episodes** **≥ 2**		Category III **Non-core** **One episode** _		Category IV **Non-core** **# episodes** **≥ 2**	
	earnings	part.	earnings	part.	earnings	part.	earnings	part.
Category j	***	-	***	-	***	-	***	-
λ	***	-	***	-	***	-	***	-
PERSONAL CHARACTERISTICS								
Demographics	-	***	-	**	-	*	-	**
human capital	***	-	***	-	***	-	***	-
education	-	**	-	***	-	**	-	**
occupational status	***	-	***	-	***	-	***	-
multiple jobs	***	-	***	-	***	-	***	-
non-market time use	-	***	-	***	-	***	-	***
demand side: business sectors	***	-	***	-	***	-	***	-

Overview of explanatory pattern (2)

	Category I **Core** **One episode** **_**		Category II **Core** **# episodes** **≥ 2**		Category III **Non-core** **One episode** **_**		Category IV **Non-core** **# episodes** **≥ 2**	
	earnings part.		earnings part.		earnings part.		earnings part.	
PARTNER'SCHARACTERISTICS								
partner`s employment	-	*	***		-		-	***
HOUSEHOLD CHARACTERISTICS								
Household characteristics	-	**	-	**	-		-	
Income/wealth situation	-		-	*	-		-	
REGIONAL VARIABLES								
region	**	***	-	***	***		***	***

Concluding remarks (1)

Contribution to economic well-being by adding insights into particular work effort characteristics - *daily timing of work and its fragmentation* - and its resulting income distributive effects

Descriptive results

On average: Working hour arrangements with more than one working episodes categories II and IV): they work longer, have a higher wage rate and thus an above–average income

Distribution: All non-normal working hour arrangements (categories II,III,IV) compared to he normal situation (category I) show higher inequalities with regard to hours worked, wage paid, and income achieved; one exception: the most irregular working hour arrangement (category IV) shows a more equally distributed income.

Concluding remarks (2)

The most unequal net income distribution: category III (non-core/one episode) with the most unequal working hours distribution.

The descriptive distributive analysis thus has shown that timing and fragmentation of work time do have distinct consequences on the earnings distribution.

Microeconometric results

Estimates with endogenous self-selection (treatment effects approach) explaining earnings and participation (bivariate probit-approach) in different daily working hour arrangements support our interdependent two stage modelling strategy with the overall result:

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Concluding remarks (3)

- Individual earnings in Germany are dependent on and significant different with regard to the daily working hour arrangement capturing timing and fragmentation of work.

- The participation probability for the core/non-core and number of episodes working time categories follow different explanatory pattern with regard to

- *personal characteristics* (demographics, human capital, education, occupational status, multiple jobs, non-market time use), *demand side* (business sectors), *partner's employment*, *household characteristics* (composition, wealth) as well as a *regional indicator*.

Concluding remarks (4)

- Earnings:
  human capital returns are highest in non-core wh arrangements;
  work experience returns are highest in core wh arrangements.
  Occupational status with regard to the self-employed/liberal
     profession results in highest earnings in non-core wha
  Multiple jobs diminish earnings in all wha
  Industry jobs result in higher earnings (compared to services and
     agriculture) in all wha
  Traditional core jobs are preferred in East-Germany

The detailed findings support targeted modern economic and social
   policy with regard to non-traditional labour market situation and
   flexibility.

Vielen Dank für Ihre Aufmerksamkeit

Tägliche Arbeitszeitmuster und Einkommensverteilung –

Ein Treatment-Effekt Ansatz mit den Daten der
deutschen Zeitbudgeterhebung

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