Working longer hours: less productive but less costly?

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Motivations

- Very old question of working time: from Barzel (1973), Freeman & Gottshalk (1998) to recent work by Rogerson (2009, 2011, 2012)
- With novel, richer view of the problem facing the firm: focus on demand side, following Pencavel (2016) and Feldstein (1967, 1976).
- With a rich dataset

Novelty of the approach:

- Extensive (number of workers) and intensive (number of hours worked) margins.
- Number of workers and hours worked viewed as a firm's decision (exclusively), simultaneous decision.
- Rich labour cost structure: $C(N, H) = FF + N(w(H)H + F)$
  - Fixed costs: do not vary with the number of workers (FF)
  - Fixed labour costs: vary with the number of workers but not with hours worked (F)
  - Variable labour costs: vary with hours worked ($w(h)$)

Ultimate goal, using public data on total hours, number of workers and total labour cost:

- Estimate the relative size of fixed labour costs (F) in total labour costs.
- Estimate (average) marginal cost and (average) marginal productivity of hours worked in Belgium.
- Shed new light on working time policies (better understanding of firms' incentives).

Model of the firm's optimization problem

Production: $Q(K, L) = f(K, L)$ *where* $L = Ng(H), g'(H) > 0$

Labour costs: $C(N, H) = FF + N[w(H)H + F]$

Profit maximization: $\frac{L_H}{L_N} = \frac{C_H}{C_N}$

Re-write the profit maximization condition to get:

$$\frac{Ng'(H)}{g(H)} = \frac{Nw'(H)H + w(H)N}{w(H)H + F}$$

As neither F, nor $g(H)$ are observed directly, re-write the equlibirum conditions:

$$\frac{H}{N}\frac{L_H}{L_N} = \frac{H}{N}\frac{C_H}{C_N}$$

Using iso(labour)quant:

$$dL = 0 = L_H dH + L_N dN$$

$$-\frac{H}{N}\frac{L_H}{L_N} = \frac{H}{N}\frac{dN}{dH}_{|dL=0} \equiv -\sigma(H,N)$$

$$-\frac{H}{N}\frac{Ng'(H)}{g(H)} = -\sigma(H,N)$$

$$\frac{g'(H)}{\frac{g(H)}{H}} = \sigma(H,N)$$

Using iso(labour)cost:

$$
\begin{aligned}
dC = 0 &= C_H dH + C_N dN \\
-\frac{H}{N}\frac{C_H}{C_N} &= \frac{H}{N}\frac{dN}{dH}_{|dC=0} \equiv -\gamma(H,N) \\
-\frac{H}{N}\frac{Nw'(H)H + w(H)N}{w(H)H + F} &= -\gamma(H,N) \\
\frac{1+\epsilon}{1+rF} &= \gamma(H,N)
\end{aligned}
$$

With $\epsilon \equiv \frac{w'(H)}{\frac{w(H)}{H}}$ the elasticity of hourly wage to working hour, and $rF \equiv \frac{F}{w(H)H}$ the ratio of fixed over variable cost per worker.

In particular:

- estimate σ = elasticity along iso(labour)quant.
  - $\sigma < 1$: decreasing marginal productivity.
- estimate γ = elasticity along iso(labour)cost.
  - $\gamma < 1$: presence of fixed labour cost.
- use the estimation of γ to estimate de share of fixed labour cost in total labour cost. If $\epsilon = 0$ (lower bound), then $1 - \gamma = \frac{F}{F + w(H)H}$, the share of fixed costs in total costs.

Empirical strategy: use polynomial approximations of $C(N,H)$ and $F(K,N,H)$ and estimate the following (for a second order polynomial):

- $c_{it} \approx A + \theta n_{it} + \lambda h_{it} + \frac{1}{2}\chi_1 h_{it}^2 + \frac{1}{2}\chi_2 n_{it}^2 + \chi_3 h_{it} n_{it} + T_t + \nu_{it}$
- $q_{it} \approx B + \alpha k_{it} \beta n_{it} + \pi h_{it} + \frac{1}{2}\psi_1 h_{it}^2 + \frac{1}{2}\psi_2 n_{it}^2 + \psi_3 h_{it} n_{it} + T_t + \mu_{it}$

Then:

- $\gamma(H,N) \approx \frac{\lambda + \chi_1 h + \chi_3 n}{\theta + \chi_2 n + \chi_3 h}$
- $\sigma(H,N) \approx \frac{\pi + \psi_1 h + \psi_3 n}{\beta + \psi_2 n + \psi_3 h}$

Sample

- 115 337 firm-year observations
- unbalanced panel of 14 544 firms.
- 2007-2015
- large set of data (number of workers, by type (FT, PT, Temporary)
- all sectors (excluding primary and public sectors)

Figure 1: Annual average working hours per worker (full-time only). Distribution across firms. Belgium private economy 2007-2015

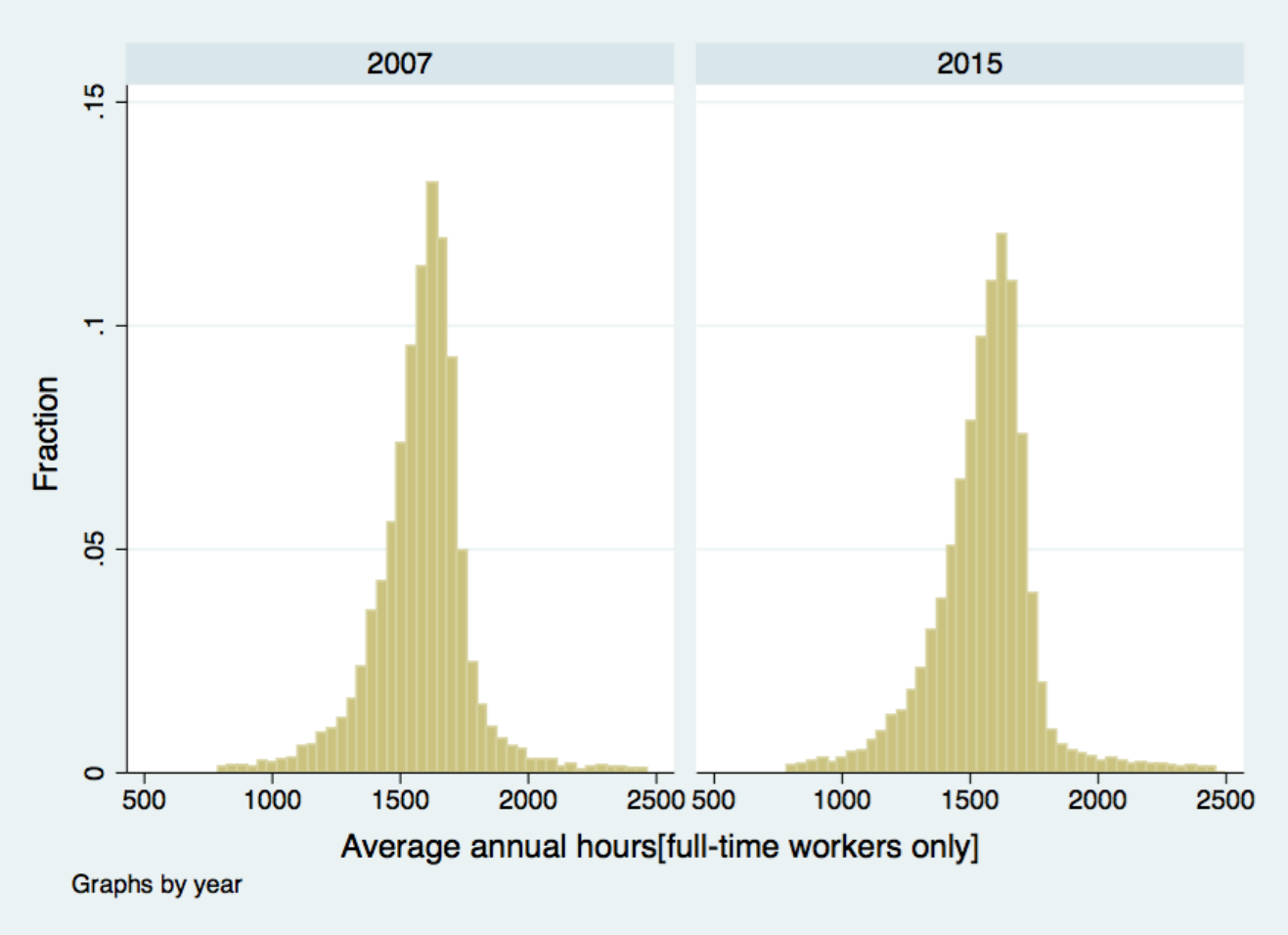


Table 1: Descriptive statistics, main variables

	Hours per empl.[annual]	Workers full time	Workers part time	Workers interim
2007	1,472.4	80.4	24.8	14.6
2008	1,472.4	80.8	24.8	13.0
2009	1,428.4	76.8	25.0	11.5
2010	1,433.2	74.7	25.6	12.6
2011	1,437.2	76.3	27.1	12.3
2012	1,427.9	75.8	28.0	12.6
2013	1,422.4	75.4	29.0	12.8
2014	1,427.7	90.8	36.4	12.4
2015	1,430.1	75.3	37.9	13.7
Total	1,438.5	78.5	28.9	12.8
N	115337			

Source: Bel-first(2016)

Results

- $c_{it} \approx A + \theta n_{it} + \lambda h_{it} + \frac{1}{2}\chi_1 h_{it}^2 + \frac{1}{2}\chi_2 n_{it}^2 + \chi_3 h_{it} n_{it} + T_t + \epsilon_i + \nu_{it}$
- $q_{it} \approx B + \alpha k_{it} \beta n_{it} + \pi h_{it} + \frac{1}{2}\psi_1 h_{it}^2 + \frac{1}{2}\psi_2 n_{it}^2 + \psi_3 h_{it} n_{it} + T_t + \mu_{it}$
  - C: total wage cost
  - N: total number of workers
  - H: average hours per worker
  - T: year
  - ϵ: firm FE
  - A, B constant
- $\gamma(H, N) \approx \frac{\lambda + \chi_1 h + \chi_3 n}{\theta + \chi_2 n + \chi_3 h}$
- $\sigma(H, N) \approx \frac{\pi + \psi_1 h + \psi_3 n}{\beta + \psi_2 n + \psi_3 h}$

Firm-level fixed effect

Table 2: Econometric Results - Fixed Effects

	1^{st} order approximation		2^{nd} order approximation		3^{rd} order approximation	
	Productivity	**Cost**	**Productivity**	**Cost**	**Productivity**	**Cost**
$k_{it} = ln(K_{it})$	0.0878***		0.0864***		0.0853***	
	(0.001)		(0.001)		(0.001)	
$n_{it} = ln(N_{it})$	0.779***	0.926***	0.788***	0.930***	0.800***	0.933***
	(0.002)	(0.001)	(0.002)	(0.001)	(0.003)	(0.002)
$h_{it} = ln(H_{it})$	0.627***	0.711***	0.672***	0.746***	0.687***	0.759***
	(0.004)	(0.003)	(0.005)	(0.003)	(0.005)	(0.003)
n_{it}^2			-0.00159	-0.00973***	-0.00421*	-0.00150
			(0.001)	(0.001)	(0.002)	(0.001)
h_{it}^2			0.0830***	0.0699***	-0.0388***	-0.0678***
			(0.003)	(0.002)	(0.005)	(0.003)
$n_{it}h_{it}$			0.0908***	0.0805***	-0.0344***	-0.0367***
			(0.003)	(0.002)	(0.006)	(0.004)
n_{it}^3					-0.00444***	0.00159***
					(0.001)	(0.000)
h_{it}^3					-0.0270***	-0.0307***
					(0.001)	(0.001)
$n_{it}^2 h_{it}$					-0.0189***	-0.00997***
					(0.002)	(0.001)
$n_{it}h_{it}^2$					-0.0422***	-0.0412***
					(0.002)	(0.001)
R^2	0.606	0.823	0.610	0.828	0.613	0.831
	Control: year and industry(NAICS 4-digit)					
	Implied elasticities along the effective labour isocost/isoquant					
$\sigma; \gamma$	0.80	0.77	0.67	0.75	0.68	0.76
$prob = 1$	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

Standard errors in parentheses

Source: Bel-first

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

By worker type

Table 3: Econometric Results by type

FE (first difference) - 2^{nd} order approx.				
	All Workers	**Full-time workers**	**Part-time workers**	**Interim workers**
n_{it}	0.815***	0.862***	0.938***	0.974***
	(0.002)	(0.003)	(0.003)	(0.002)
h_{it}	0.642***	0.657***	0.845***	0.946***
	(0.003)	(0.004)	(0.004)	(0.005)
n_{it}^2	0.0392***	0.0308***	0.00744***	0.00388*
	(0.001)	(0.002)	(0.002)	(0.002)
h_{it}^2	-0.00771***	0.00261*	-0.0147***	0.00112
	(0.001)	(0.001)	(0.001)	(0.004)
$n_{it}h_{it}$	0.0326***	0.0378***	-0.00553	-0.00274
	(0.002)	(0.002)	(0.003)	(0.005)
R^2	0.603	0.558	0.560	0.859
Control: year and firm fixed effects				
Implied elasticities along the effective labour isocost				
γ	0.64	0.66	0.85	0.95
$prob = 1$	0.0000	0.0000	0.0000	0.0000

Standard errors in parentheses

Source: Bel-first

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

By sector

Table 4: Econometric Results - By sector

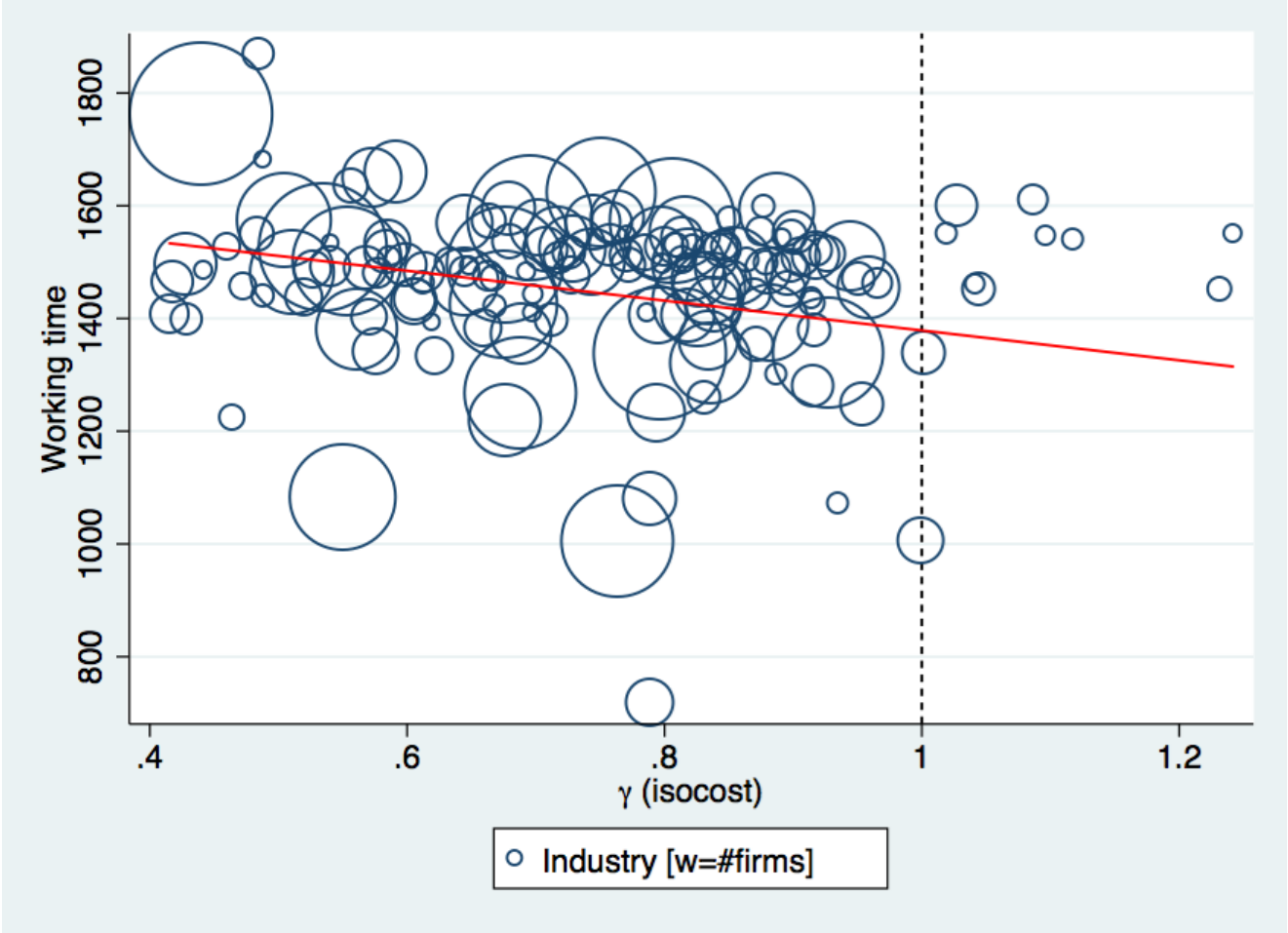
FE (first difference) - 2^{nd} order approx.				
	All sectors	**Manufacturing**	**Wholesale & Retail**	**Horeca**
n_{it}	0.815***	0.775***	0.841***	0.822***
	(0.002)	(0.005)	(0.005)	(0.007)
h_{it}	0.642***	0.594***	0.732***	0.780***
	(0.003)	(0.006)	(0.007)	(0.009)
n_{it}^2	0.0392***	0.0568***	0.0456***	0.0185***
	(0.001)	(0.002)	(0.003)	(0.003)
h_{it}^2	-0.00771***	-0.00730***	0.0169***	-0.00947
	(0.001)	(0.002)	(0.002)	(0.007)
$n_{it}h_{it}$	0.0326***	0.0548***	0.0644***	0.00862
	(0.002)	(0.003)	(0.003)	(0.007)
R^2	0.603	0.637	0.529	0.787
Control: year and firm fixed effects				
Implied elasticities along the effective labour isocost				
γ	0.64	0.60	0.74	0.78
$prob = 1$	0.0000	0.0000	0.0000	0.0000

Standard errors in parentheses

Source: Bel-first

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Figure 2: Working time and estimated isocost elasticities, by industry (slope coeff $-0,115^{***}$)



Accounting for simultaneity bias

Table 5: Econometric Results - accounting for simultaneity

Accounting for simultaneity bias)				
	$LP^{\$}$		$ACF^{\$}$	
	Productivity	**Cost**	**Productivity**	**Cost**
n_{it}	0.645***	0.684***	0.756***	0.914***
	(0.004)	(0.004)	(0.006)	(0.008)
h_{it}	0.475***	0.464***	0.564***	0.701***
	(0.008)	(0.008)	(0.063)	(0.052)
R^2	0.499	0.477		
Control: year and firm fixed effects, log of K in productivity equation				
Implied elasticities along the effective labour isocost/isoquant				
$\sigma; \gamma$	0.74	0.68	0.74	0.77
$prob = 1$	0.0000	0.0000	0.0017	0.0000

£: Levinsohn-Petrin; $ Ackerberg, Caves & Frazer

Cobb-Douglas specification of $Q(NH)$ and $C(NH)$

Standard errors in parentheses

Source: Bel-first

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Interpretation

Fixed labour costs in Belgium

- Hiring, training and firing costs.
- In-kind benefits (surveys estimate: 14% of total labour costs).
- Minimum contractual working time rules (1/3 of full time).
- Un-worked, paid days (sick leave, paid leave, parental leave, "economic"" unemployment, ...) that give right to social benefits (pension, annual premium, ...).

Cross validations

1. International comparison using indirect estimation:
   - International individual-level survey data
   - For Belgium: coeff 0.18

2. International comparison using direct estimation (decomposing firm's balance sheet):
   - Hart (1984): " ... suggests that for both the United States and the United Kingdom it is reasonable to put "fixed labour costs" at rougly 20 percent of total cost."
   - Ehrenberg, Ronald G. (2016): "The [USA] data suggest that around 19 percent of total compensation (about 60 percent of nonwage costs) is quasi-fixed".

Conclusions

- Productivity gains of reducing working time.
- At least 20% of labour cost is independant of hours worked.
- Incentive for firms to increase working time, resistance to reducing working time (even without compensating wages)