

**Discussion of Altig, Christiano, Eichenbaum, and Linde's (ACEL)
paper:
"Firm-Specific Capital, Nominal Rigidities, and the Business Cycle"**

by

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ACEL's Big Machine

Inputs

- a DSGE model with lots of plausible ingredients (habit formation, Calvo sticky prices and wages, indexation, capital-adjustment costs,...)
- an appealing estimation method (pioneered in CEE's JPE paper)
- a good computer
- excellent human capital!

Output

- broad range of possible issues they could have looked look at.
- focus of choice: inflation inertia and price stickiness
- main result: the introduction of firm-specific capital allows one to reconcile the New Keynesian model simultaneously with the evidence of (i) strong aggregate inflation inertia, and (ii) relatively flexible prices at the micro level (caveat: at least for MP shocks).

Discussion Outline

- What the paper's contribution is (and what it is not)
- The role of firm-specific capital as a source of inflation inertia
- Is the preferred model *really* consistent with the micro data on price setting behavior?
- Impulse response-based estimation of DSGE models: benefits and possible pitfalls (in the present application).

What the Paper's Contribution is (and what it is Not)

The (augmented) Calvo inflation equation

$$\pi_t = \phi_b \pi_{t-1} + \phi_f E_t\{\pi_{t+1}\} + \gamma \hat{s}_t$$

Galí-Gertler (1999): rule-of-thumb price setters

Smets-Wouters (2003): partial indexation

CEE (2005): full indexation $\rightarrow \Delta\pi_t = \beta E_t\{\Delta\pi_{t+1}\} + \gamma \hat{s}_t$

where

$$\gamma = \frac{(1 - \beta\xi_p)(1 - \xi_p)}{\xi_p} \chi$$

with $\chi \leq 1$ and where $\xi_p \in [0, 1]$ is an index of price stickiness.

Under homogeneous capital (i.e., constant marginal cost): $\chi = 1$

Under firm-specific capital (i.e., increasing short-run marginal cost): $\chi < 1$

Key issue: only γ is identified \rightarrow given γ , the estimate for ξ_p is increasing in χ .

Imposing $\chi = 1$ \rightarrow overstatement of degree of stickiness

\rightarrow conflict with micro evidence

ACEL: let's re-estimate ξ_p using a model that allows for firm-specific capital ($\chi < 1$).

Main comments

- The basic result is well known (though one would not tell from the discussion in the paper)
- It is not specifically related to firm-specific capital (but to increasing marginal cost).

Earlier empirical papers focusing on this point:

- Sbordone (JME, 2002)
- Galí, Gertler and López-Salido (EER, 2001) (see Table)

Recent theoretical work:

- Woodford (2003, chapters 3 and 5): analysis of alternative sources of $\chi < 1$ and its implications for persistence:
- Sveen and Weinke (2004): in the context of a (simpler) model with firm-specific investment.

Table 2
Hybrid model^a

	Parameters						Test	
	ω	θ	β	γ_b	γ_f	λ	D	J
<i>Euro area</i>								
$\mu = 1.1, \alpha = 0.32$								
(1)	0.030 (0.083)	0.668 (0.029)	0.804 (0.056)	0.043 (0.115)	0.773 (0.064)	0.214 (0.079)	3.0 (0.09)	8.983 (0.344)
(2)	0.287 (0.126)	0.787 (0.089)	0.925 (0.069)	0.272 (0.072)	0.689 (0.047)	0.039 (0.049)	4.7 (0.42)	7.484 (0.380)
$\xi = 1$								
(1)	0.024 (0.122)	0.907 (0.015)	0.897 (0.053)	0.025 (0.127)	0.877 (0.045)	0.018 (0.012)	10.0 (0.14)	8.428 (0.393)
(2)	0.335 (0.129)	0.922 (0.031)	0.920 (0.074)	0.272 (0.072)	0.689 (0.044)	0.006 (0.007)	12.8 (0.40)	7.485 (0.380)
<i>United States</i>								
$\mu = 1.1, \alpha = 0.40$								
(1)	0.255 (0.054)	0.498 (0.072)	0.863 (0.056)	0.347 (0.045)	0.584 (0.054)	0.291 (0.139)	2.0 (0.14)	4.993 (0.661)
(2)	0.317 (0.065)	0.569 (0.080)	0.916 (0.042)	0.364 (0.042)	0.599 (0.041)	0.162 (0.093)	2.3 (0.19)	4.216 (0.754)
$\xi = 1$								
(1)	0.400 (0.074)	0.818 (0.038)	0.878 (0.052)	0.339 (0.0046)	0.610 (0.034)	0.026 (0.013)	5.5 (0.21)	4.332 (0.741)
(2)	0.451 (0.075)	0.827 (0.042)	0.898 (0.052)	0.364 (0.042)	0.599 (0.032)	0.020 (0.011)	5.8 (0.24)	4.216 (0.755)

So, what is the paper's main contribution (and motivation)?

- Candidate: the use of the Big Machine may help identify and estimate parameters χ and ξ_p .
 - as opposed to single equation estimation
 - as opposed to models with increasing marginal costs but no endogenous capital accumulation
- Unfortunately, the paper does not even report an expression for χ nor discusses its determinants (the reader is referred to a technical appendix).
- Some parameters that are key in determining χ end up being calibrated (not estimated):
 - α : output elasticity with respect to capital
 - λ_f : steady state price markup (but it implies a price elasticity of 100!)

The Unanswered Question:

- Does endogenous capital accumulation make any difference with regard to the issues of interest, relative to a model with fixed capital?

The role of firm-specific capital as a source of inflation inertia

- Recall the logic of ACEL's argument: a low γ is needed to account for observed inflation inertia, and firm-specific capital (i.e., increasing marginal costs) can reconcile it with micro evidence. In particular, in response to a monetary policy shock:

$$\Delta\pi_t = \gamma \sum_{j=0}^{\infty} \beta^j E_{t-1}\{\widehat{s}_{t+j}\}$$

- But having a low γ is not sufficient !. In the absence of indexation or prices-set-in-advance we would have:

$$\pi_t = \gamma \sum_{j=0}^{\infty} \beta^j E_t\{\widehat{s}_{t+j}\}$$

which for $\beta \simeq 1$ implies

$$\pi_{t+1+j} = \pi_{t+j} - \gamma \widehat{s}_{t+j}$$

after the initial impact (i.e., for $j = 1, 2, 3, \dots$). Hence under the plausible assumption that $\widehat{s}_{t+j} \geq 0$ after a monetary expansion, it follows that the response of inflation will attain a peak on impact and will be monotonically decreasing afterwards (i.e., no inertia).

- *Corollary:* indexation and price setting in advance play a role *at least as important* as having a low γ .

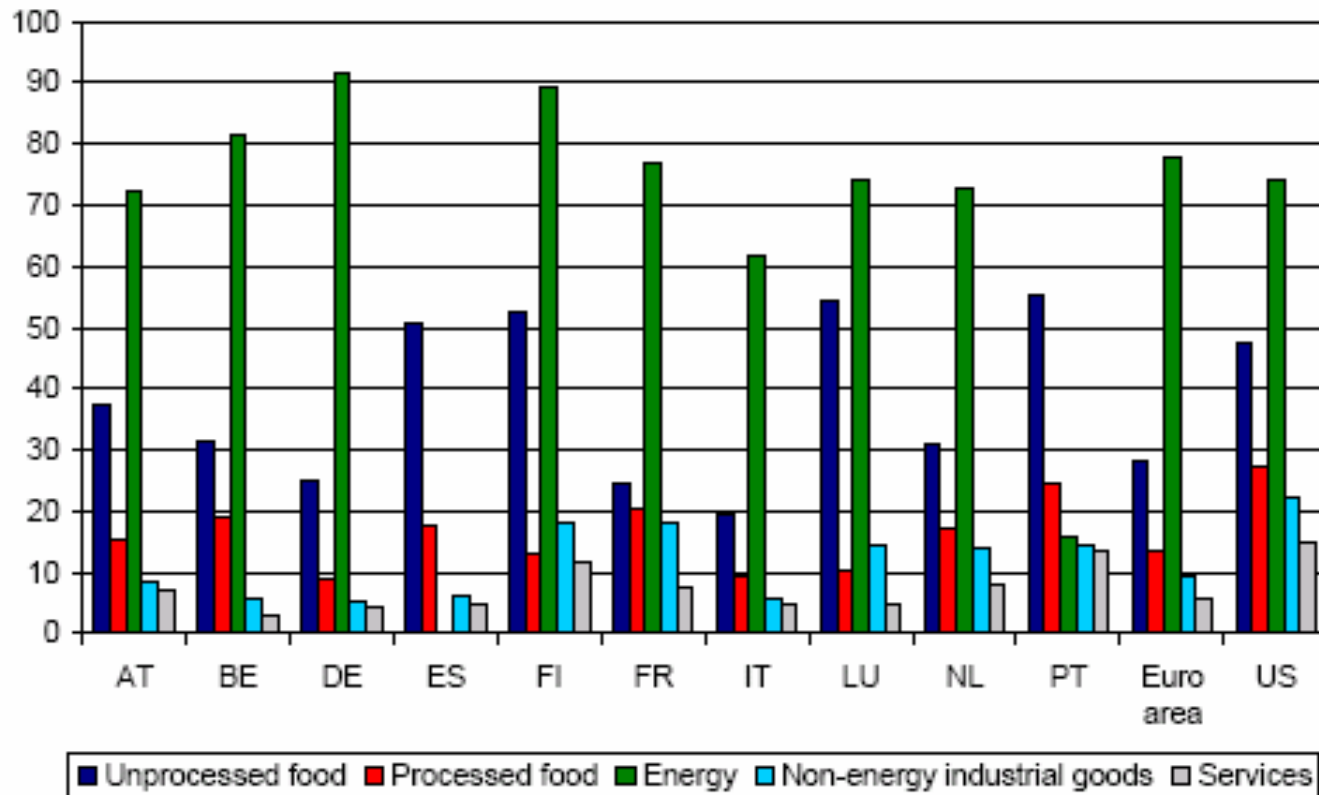
Unfortunately a discussion of the relative importance of those factors is missing (the model without indexation or price setting in advance is not even considered).

Is the preferred model really consistent with the micro data on price setting behavior?

- Bils and Klenow's benchmark for average duration of prices: 1.5 quarters (BK: median 4.3 months, including sales).
- But there are other dimensions one should not ignore:
 - huge heterogeneity across sectors → downward bias in estimates of price duration (sectors with more frequent price changes are "oversampled")
 - much longer average price durations in Europe (see ECB's Inflation Persistence Network papers).

See Tables from Dhyne et al. (2004)

**Figure 6 - Frequency of price changes -
Analysing cross-components differentials**



Source: Dhyne et al. (2004)

Table 3 - Frequency of price changes and average price duration in the euro area and the US

	euro area	US
Frequency of price changes		
50 product sample	15.1 p.c.	24.8 p.c.
Full CPI	15.3 p.c.	26.1 p.c.
Trimmed mean	16.9 p.c.	
Average duration		
Based on frequencies at the euro area product category level	13.0 months	6.7 months
Based on frequencies at the country-product category level	15.1 months	
Inverting the aggregate frequency of price changes	6.6 months	3.8 months
Median price duration	10.6 months	4.6 months

Sources: NCBs calculations on NSIs data, Bils and Klenow (2004)

Source: Dhyne et al. (2004)

- Most striking conflict between ACEL and micro data:

ACEL: indexation implies that *all* prices and wages are *adjusted* each period (though not necessarily re-optimized)

Data: often long spells without price adjustment (especially in manufacturing and services, same for nominal wages).

- Under the lens of the ACEL model, Bils and Klenow's observation of frequent price adjustments are consistent with infrequent re-optimizations (large ξ_p).

Impulse response-based estimation of DSGE models

- matching impulse responses to various structural shocks is a most appealing aspect of ACEL's framework.

- major progress relative to matching of unconditional moments, in the presence of multiple shocks.

"...it is not enough that a behavioral model should match a few observed second moments in sign. By insisting on a quantitative match to the data, in as much detail as possible, the data have a chance to be much more informative" (Chris Sims, 1989)

- one may need to rely on some controversial identifying restrictions (e.g., timing of price adjustments in ACEL's model and VAR)
 - monetary shocks: (uncomfortable?) consensus
 - technology shocks: ACEL's estimated impulse responses (based on CEV's specification) are far from gathering such consensus.

Sample of papers that find a negative short-run comovement of output and employment in response to technology shocks (as surveyed in Gali and Rabanal's macro annual paper)

Using Long Run Identifying Restrictions

- Galí (1999)
- Francis and Ramey (2004)

Using constructed technology measures

- Blanchard, Solow and Wilson (1995)
- Basu, Fernald and Kimball (2005)

Using indicators of technological innovation

- Shea (1998)

Using alternative transformations of hours (without Δ)

- Francis and Ramey (2004)
- Galí and Rabanal (2005)

- Fernald (2004)

Using industry-level data

- Kiley (1996)
- Francis (2001)

Using international data

- Galí (1999, 2004) : G7
- Francis and Ramey (2003) : UK
- Galí (2004): euro area
- Carlsson (2000): SVE manuf. industries

Suppose ACEL's estimated responses to a positive technology shock overstate the response of output and employment.

Does it matter? YES.

→ may distort estimates of parameters that affect that response (including degree of price stickiness!)

→ estimated monetary policy rule will be wrong (too accommodative)

Unfortunately, hard to judge from the money supply based estimated rule (vs. Taylor-type rule)