

Markups and Firm-level Export Status

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- Long tradition in IO to analyze impact of various competitive pressures on price cost margins:
 - Deregulation, Privatization, Trade liberalization and - protection.
 - Data requirements and proprietary cost data make it hard to 'measure' p/mc .
- Antitrust authorities often rely on simple and fast procedures to evaluate impact of policy change on market power.
- It is in this context that some 'simple' techniques became popular and relied on relatively easy to come by data.
- Focus on an approach developed by Hall (1986 and later modifications) used intensively in empirical work recently due to increased availability of micro data and need to test recent developed theories on export/productivity/markup.

Markups, export and productivity

- Recent shift in international trade to model firms (Melitz, 2003) and incorporate firm-level data in analysis.
- Big focus on productivity and international participation status (export, import, FDI, outsourcing, etc.).
- Empirical work on self-selection and learning by exporting. What is mechanism and we know TFP measures include market power effects.
- We provide (robust) evidence that exporters have higher markups on average, and that markups increase when firms enter export markets. Consistent with TFP studies (De Loecker, 2007).

- Provide a flexible empirical framework to estimate markups, and how they change with firm characteristics and decisions (here becoming an exporter). The most important features are:
 - ① Flexible production function, only log additive in productivity
 - ② Various price setting models
 - ③ No RTS assumption, and no need to measure user cost of capital
 - ④ General treatment of productivity shocks and state variables
 - ⑤ All this while relying on standard micro data.
- Intuition of approach: markup is wedge between revenue share and cost share of factors of production. ($\alpha_L = \frac{wL}{pQ}\mu$)
- Provide new evidence on export and markups, in particular in how markups change as firms enter foreign markets.

Main advantages of general approach

- Relatively low data and computing requirements.
- Nests various price setting models. Example: structural approach of Levinsohn (1993, JIE).
- Ability to evaluate average markup changes due to changes in operating environment (e.g. Konings et. al 2005) under the alternative hypothesis (imperfect competition).
- In theory Hall's approach provides estimates for productivity growth as well.

Deriving the regression equation

- Starting out with a production function

$$Q_{it} = \Theta_{it} f(L_{it}, M_{it}, K_{it})$$

- Take a Taylor expansion of Q_{it} around Q_{it-1} [nothing behavioral!]

$$\Delta Q_{it} = \Theta_{it} \left(\frac{\Delta f_{it}}{\Delta L_{it}} \Delta L_{it} + \frac{\Delta f_{it}}{\Delta M_{it}} \Delta M_{it} + \frac{\Delta f_{it}}{\Delta K_{it}} \Delta K_{it} \right) + f_{it} \Delta \Theta_{it} \quad (1)$$

Price setting: For example Nash in quantities.

- Assume Nash in quantities with homogeneous goods (Bertrand, + MP, etc.). Profits are

$$\pi_{it} = P_t Q_{it} - w_{it} L_{it} - m_{it} M_{it} - r_{it} K_{it}$$

- The FOC for labor (similar for other inputs)

$$\Theta_{it} \frac{\Delta f_{it}}{\Delta L_{it}} = \frac{w_{it}}{P_t} \left(1 + \frac{s_{it} \theta_{it}}{\eta_t} \right)^{-1} \quad (2)$$

where $s_{it} = \frac{Q_{it}}{Q_t}$ is the market share of firm i , η_t is the market elasticity of demand, and θ_{it} takes values 0 or 1 depending on Nash in prices (pc) or quantities, respectively.

- The optimal output choice Q_{it} will satisfy the following F.O.C.

$$\frac{P_t}{c_{it}} = \left(1 + \frac{s_{it} \theta_{it}}{\eta_t} \right)^{-1} \equiv \mu_{it} \quad (3)$$

- Follow Levinsohn (1993) and use the optimal input choices for inputs together with the pricing rule into the Taylor expansion.

$$\Delta Q_{it} = \mu_{it} \left(\frac{w_{it}}{P_t} \Delta L_{it} + \frac{m_{it}}{P_t} \Delta M_{it} + \frac{r_{it}}{P_t} \Delta K_{it} \right) + f_{it} \Delta \Theta_{it}$$

- Last step is to note that $\frac{\Delta X_{it}}{X_{it}} = \Delta \ln X_{it} = \Delta x_{it}$.

$$\Delta q_{it} = \mu_{it} (\alpha_{L_{it}} \Delta l_{it} + \alpha_{M_{it}} \Delta m_{it} + \alpha_{K_{it}} \Delta k_{it}) + \Delta \omega_{it}$$

- where $\ln \Theta_{it} = \omega_{it}$
- Note that this is exactly what Hall (1986) introduced and has been used extensively in the literature.

Estimating markups using production data: industry and firm-level data

- Increased availability of micro data (i) boosted empirical research analyzing markup and - responses relying on this framework.
- where now μ can be identified in both cross section and in time series, or μ_t is identified.
- Most common approach is even to further introduce interaction Δx_{jit} with Z_{it} to estimate change in *market power*.
- Clear implication on identification assumptions: policy shock cannot be correlated with productivity. In context of trade and competition policy!

Problems with using micro data

- Instrument approach is no longer feasible due to aggregation
- Well known heterogeneity of plant-level data, unobserved productivity shocks!
- Strict assumption is needed on *identical cost structure* for all firms to use cross section
- Returns to scale play an important role (industry vs firm-level)

We introduce an approach where we control for unobserved productivity and the dynamics of entry/exit (selection) using a dynamic model as in Ericson and Pakes (1995) and Olley and Pakes (1996).

Method provides consistent estimates of the markup

- Controlling for unobserved productivity using a control function in spirit of Olley and Pakes (1996).
- Controlling for non random exit of firms [inherent to FD approach].
- Without making any assumptions on RTS.
- Application to export status and markups: controlling for productivity is key! (evidence export-TFP).
- Again, no extra data requirements – only clearly spelled out underlying assumptions of firm behavior.

Underlying Model of industry dynamics

- OP (1996) based on underlying industry dynamics model of Ericson and Pakes (1995)
- At each period t a firm evaluates whether to stay in the market or exit $V_t(\omega_t, k_t)$
- Conditional upon survival a firm decides on investment i and (variable) inputs (l, m)
- Model delivers investment policy function $i_t = i_t(k_t, \omega_t)$ which is basis for estimation algorithm as we can invert relationship (under mild conditions) to obtain

$$\omega_{it} = h_t(i_{it}, k_{it})$$

Two approaches to control for productivity: Model 1

- From Olley and Pakes (1996) we know $\Delta\omega_{it}$ is

$$\Delta\omega_{it} = h_t(i_{it}, k_{it}) - h_{t-1}(i_{it-1}, k_{it-1})$$

- This will generate the following estimating equation

$$\Delta q_{it} = \mu_{it} [\alpha_{Lit} \Delta l_{it} + \alpha_{Mit} \Delta m_{it} + \alpha_{Kit} \Delta k_{it}] + \Delta\omega_{it} + \Delta\varepsilon_{it}$$

$$\Delta q_{it} = \mu_{it} \Delta x_{it} + \Delta\phi_t(i_{it}, k_{it}) + \Delta\varepsilon_{it}$$

where

$$\Delta x_{it} = \alpha_{Lit} \Delta l_{it} + \alpha_{Mit} \Delta m_{it}$$

$$\Delta\phi_t(i_{it}, k_{it}) = \mu_{it} \alpha_{Kit} \Delta k_{it} + h_t(i_{it}, k_{it}) - h_{t-1}(i_{it-1}, k_{it-1})$$

- law of capital has implications for terms
 $k_t = (1 - \delta)k_{t-1} + i_{t-1}$.
- This approach will deliver an estimate for the markup (μ) that directly controls for the non random exit of firms.

Model 2: Solving for productivity and selection control

- We can directly rely on Markov process for productivity and implies adding selection process
- Crucial in the OP model is the relevant information set and the dynamics of capital and productivity
- Exit decision is taken at t to exit at $t + 1$.
- Productivity follows a Markov process [non parametrically, important for FD correction] $\omega_{it} = g(\omega_{it-1}) + \xi_{it}$
- The law of motion of capital is simply given by $k_{it} = (1 - \delta)k_{it-1} + i_{it-1}$

- Use this information and we obtain expression for productivity growth

$$\Delta\omega_{it} = \omega_{it} - \omega_{it-1} = g(\omega_{it-1}, P_{it}) - \omega_{it-1} + \xi_{it}$$

$$\Delta\omega_{it} = g(i_{it-1}, k_{it-1}, P_{it}) + \xi_{it}$$

where P_{it} is survival probability at (information set) time $t - 1$ to next year t , estimated of a probit on relevant state variables (application: export status)

- where ξ_{it} is the productivity shock between t and $t - 1$, which is exactly the source of the simultaneity bias (requires extra step).

- We now have the following estimating equation for our model.

$$\Delta q_{it} = \mu_{it} (\alpha_{Lit} \Delta l_{it} + \alpha_{Mit} \Delta m_{it}) + \tilde{\phi}_t (i_{it-1}, k_{it-1}, P_{it}) + \Delta \varepsilon_{it}^*$$

$$\Delta q_{it} = \mu_{it} \Delta x_{it} + \phi_t (i_{it-1}, k_{it-1}, P_{it}) + \Delta \varepsilon_{it}^*$$

where

$$\tilde{\phi}_t (i_{it-1}, k_{it-1}, P_{it}) = \mu_{it} \alpha_{Kit} \Delta k_{it} + g(i_{it-1}, k_{it-1}, P_{it})$$

$$\Delta \varepsilon_{it}^* = \Delta \varepsilon_{it} + \xi_{it}$$

- Capital stock at t no longer appears due to law of motion on capital. But extra moment conditions are needed (also for m)

$$E(l_{it} \xi_{it}) \neq 0$$

$$E(l_{it-1} \xi_{it}) = 0$$

Alternative proxy estimators: LP

- Levinsohn and Petrin (2003) suggest intermediate inputs instead of investment

$$m_{it} = m_t(\omega_{it}, k_{it}) \quad (4)$$

- LP approach needs additional assumption to allow inversion and be consistent with imperfect competition in output market, and then yields

$$\Delta q_{it} = \mu_{it} \alpha_{Lit} \Delta l_{it} + \Delta \phi_t(m_{it}, k_{it}) + \Delta \varepsilon_{it} \quad (5)$$

where

$$\Delta \phi_t(m_{it}, k_{it}) = \mu_{it} (\alpha_{Mit} \Delta m_{it} + \alpha_{Kit} \Delta k_{it}) + \Delta \omega_{it} \quad (6)$$

Alternative proxy estimators: ACF

- Recent paper ACF discusses validity of the DGP of OP and LP
- Conclusion: modified 1st stage to allow for adjustment costs, timing of inputs wrt productivity shock. Include (potentially all) inputs in control function [example hiring/firing costs labor].

$$\Delta q_{it} = \Delta \phi_t(i_{it}, k_{it}, l_{it}, m_{it}) + \Delta \varepsilon_{it}^* \quad (7)$$

$$i_{it} = i_t(k_{it}, \omega_{it}, l_{it}) \Leftrightarrow \omega_{it} = h_t(i_{it}, k_{it}, l_{it})$$

- However, allowing intermediate inputs to adjust to productivity would allow to identify markup parameter for instance

$$\Delta q_{it} = \mu_{it} \alpha_{Mit} \Delta m_{it} + \Delta \phi_t(i_{it}, k_{it}, l_{it}) + \Delta \varepsilon_{it}^* \quad (8)$$

- Consider most general version and simply use first stage to purge out measurement error and shocks.
- Setup moment conditions for μ using results of first stage and productivity process.

$$\Delta q_{it} = \Delta \phi_t(i_{it}, k_{it}, l_{it}, m_{it}) + \Delta \varepsilon_{it}^* \quad (9)$$

- where $\Delta \phi_t(i_{it}, k_{it}, l_{it}, m_{it}) = \mu(\alpha_{Lit}\Delta l_{it} + \alpha_{Mit}\Delta m_{it} + \alpha_{Kit}\Delta k_{it}) + \Delta h_t(i_{it}, k_{it}, l_{it}, m_{it})$ and the markup parameter is not identified in a first stage.

$$E(\Delta \omega_{it} Z_{it}) = 0$$

- where $\Delta \omega_{it} = \widehat{\Delta \phi_{it}} - \mu \Delta x_{it}^{all}$.
- Natural candidates for Z_{it} are l_{t-2}, k_{t-2} from law of motion structure.

Estimating markups for different set of firms: interaction

- We consider various specifications based on

$$\Delta q_{it} = \mu^D \Delta x_{it} + \mu^E \Delta x_{it} EXP_{it} + \delta EXP_{it} + \Delta \phi_t(i_{it}, k_{it}) + \Delta \varepsilon_{it}$$

- where depending on export part of control function estimated in first or second stage.
- Main point: clearly problem of correlation between both inputs AND export status with productivity.

Data: Slovenian manufacturing 1994-2000

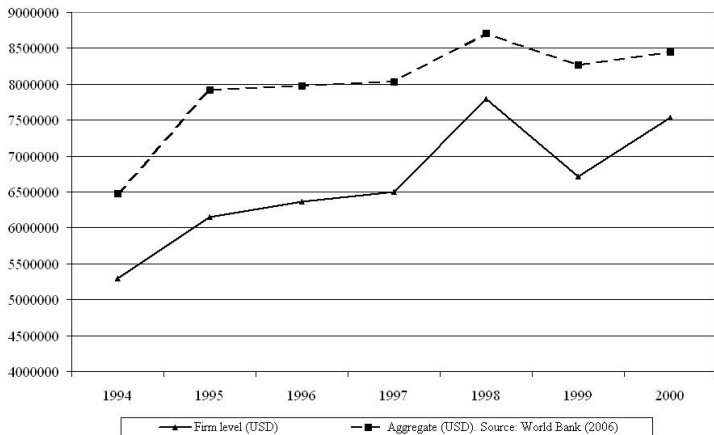
- Unbalanced panel of 7,915 plants
- Detailed information on entry/exit, export status in addition to balance sheet variables.
- Period of drastic trade reorientation with high productivity gains due to exporting, reallocation towards entrants (De Loecker and Konings, 2006 and De Loecker 2007).
- Good environment to study markups in light of export-productivity gains - and in addition importance of methodology ($E(\text{exportstatus}, \text{productivity})$).

Export dynamics and productivity gains

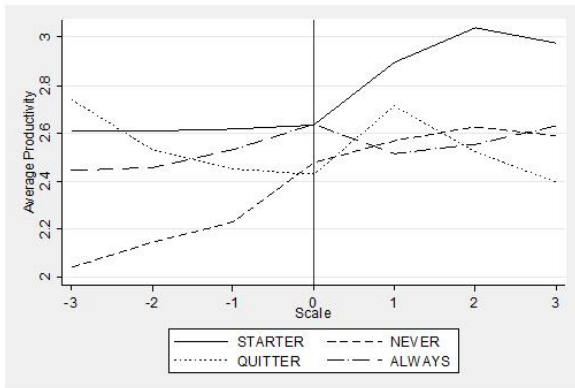
- Slovenian manufacturing experienced significant productivity growth after 1994.
- Export reorientation towards Western markets and sharp increase in export participation.
- Significant productivity gains upon export entry (controlling for self-selection process, Melitz 2003).
- 3 Pictures follow.

Export participation and firm-level data

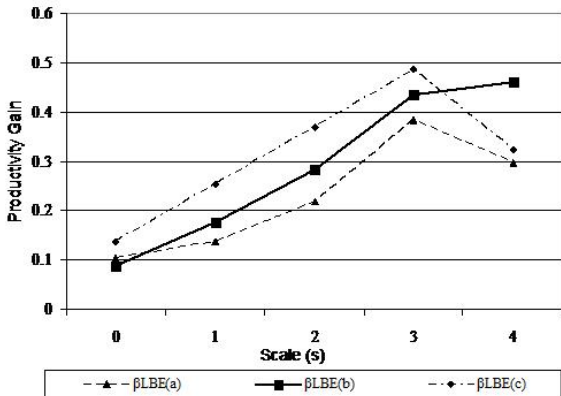
Figure 1: Export Evolution Firm Level versus Aggregate Trade (in 1000 USD)



Productivity gains upon export entry



Estimated productivity dynamics



Results: Markups in Slovenian manufacturing

Table: Markups in Slovenian Manufacturing

Specification	Estimated Markup	Standard Error
Standard Hall	1.03*	0.0044
CF I	1.11*	0.0068
CF II	1.13*	0.0056
CF II including Selection	1.11*	0.0070
CF III (labor state)	1.14*	0.0078
<i>Exporters versus Domestic Producers</i>		
Hall		
average markup	1.0279*	0.0056
exporter effect	0.0155	0.0100
CF I		
average markup	1.0543*	0.0090
exporter effect	0.1263*	0.0134

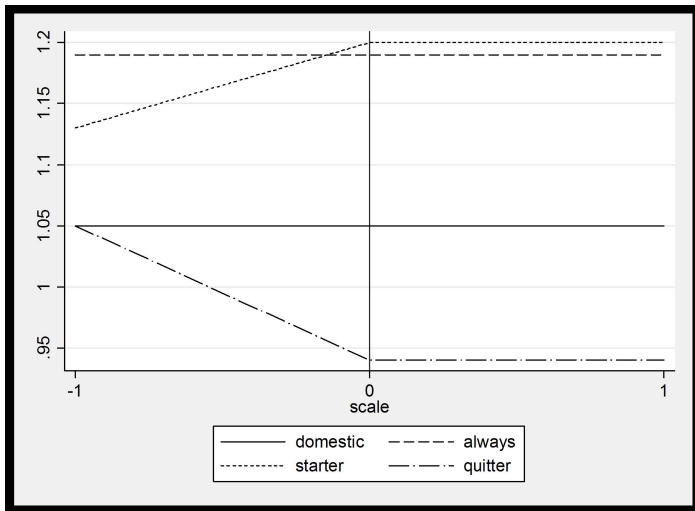
Markups and export dynamics

$$\begin{aligned}\Delta q_{it} &= \mu \Delta x_{it} + \mu_s \text{state}_{it} * \Delta x_{it} + \Delta \phi_t(i_{it}, k_{it}) + \Delta \varepsilon_{it} \\ \mu_s \text{state}_{it} &= (\mu_{s,b} B_{it}^{st} + \mu_{s,a} A_{it}^{st} + \mu_{al} AL_{it} + \mu_{q,b} B_{it}^q + \mu_{q,a} A_{it}^q)\end{aligned}$$

Table: Markups and export dynamics

		Coefficient	s.e.
Baseline		1.05*	0.012
Starter	Before	0.08**	0.033
	After	0.15*	0.021
Always		0.14*	0.020
Quitters	Before	0.03	0.02
	After	-0.11*	0.03

Export-Markup Dynamics: plotting the results



Revenue versus quantity data

- As in production function literature we know R and not Q (Klette and Griliches, 1996; De Loecker, 2008).
- However, given our first difference model and interest in coefficient μ and not in residual, we eliminate some important sources of potential biases.
- In our context the bias in the markup parameter is reduced to the extent that unobserved growth in firm-level price deviations away from the average price are correlated with input growth.
- Our estimating routine already incorporates full interaction of industry and year dummies which controls for unobserved demand shocks in the spirit of Klette and Griliches (1996).
- To see how our main estimating equation is affected by not observing firm-level prices, consider deflated revenue Δr_{it}

$$\Delta r_{it} = \mu \Delta x_{it} + \Delta \phi_t(i_{it}, k_{it}) + \Delta(p_{it} - p_t) + \Delta \varepsilon_{it} \quad (10)$$

- Concern is the correlation between Δx_{it} and $\Delta(p_{it} - p_t)$ and expected to be negative under quite general demand and cost specifications
- If anything we are underestimating markups. Higher estimated markups, while controlling for productivity shocks through the control function, are in fact consistent with this.
- As shown in De Loecker (2008) the control function $\Delta \phi_t(i_{it}, k_{it})$ fully controls for unobserved demand shocks following the same process as the productivity unobservable ω_{it} .
- Export results. We further control for exporters and non exporters, or more precisely for firms switching their particular export status.

Implications for productivity growth estimates

- Going back to Hall's insight using Solow's residual, ignoring market power will give us misleading productivity growth estimates. In addition here, productivity premia for exporters is not recovered.

$$\Delta q_{it} - \hat{\mu}(\alpha_{Lit}\Delta l_{it} + \alpha_{Mit}\Delta m_{it} + (\lambda_{it} - \alpha_{Lit} - \alpha_{Mit})_{it}) = \widehat{\Delta\omega}_{it} \quad (11)$$

	CRS		IRS		DRS	
	I	II	I	II	I	II
A) Man.	3.52	2.16	3.01	1.58	4.03	2.75
B) Industry	3.21	1.57	2.77	1.03	3.73	2.11
C) Man. (status)	3.52	2.45	3.01	1.87	4.03	3.07

- where I is standard, and II with our control function approach.

Conclusion and Discussion of results

- We show new findings on markup-export dynamics (controlling for export-productivity relationship) that are not established without correction.
- Implications export-productivity relationship and aggregate productivity growth.
- Simple b.o.t.e.c. implies almost no price difference between exporters and domestic producers (using measured TFP premia and markup differences for our data).
- Method suggests natural extensions towards international participation (export, FDI, etc.) among many others without introducing computational burden or higher data requirements due to the importance of productivity shocks.
- E.g. recent theoretical models deliver endogenous markups due to trade liberalization.
- Rich setting in transition economy allows us to test main prediction of recent trade models.