Prices, markups and product portfolio

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[Preliminary and incomplete]

How do firms spread markups across products? Are there reduced markups on new products thanks to profit on core or established products? In this paper, we derive per-product markup and marginal cost following (De Loecker et al. 2016) on a large panel of French manufacturers over 2009-2016. We confront marginal costs' estimates to out-of-sample cost shocks to assess their relevancy. We then describe within-firms markups along several dimensions of firms characteristics but also product dynamics and how do they interact.
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I. Introduction

Within-firm product switching is increasingly recognized as a major source of ressource reallocation and industry dynamics. For the US, (Bernard, Redding and Schott 2010) find that newly created or about to be dropped products represent a share of output comparable to firms exit and entry. Firm entry and exit churning process has been the focus of considerable attention, in particular questionning whether selection operates on productivity or profitability. (Foster, Haltiwanger and Syverson 2008) find that profitability (partly determined by productivity) explain firms selection. As for product churning within firms, fewer studies exist. Across its set of products, a firm decision to maintain, create or drop a product may depend heavily on its profitability, hence on the markups and marginal costs across its range of products. For instance, the profit made on some products may be used to launch new products. It may play a part in the innovation process within firms.

This paper examines how markups across products interact with product switching dynamics. The goal is to shed light on the role of markups on firm choices over product dynamics. Prices heterogeneity across homogeneous products may reflect a number of factors related to either market power (markups) or production efficiency (productivity, marginal costs of production). Being able to observe both physical output and prices at a very detailed product level, we may ade-

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quately approximate production efficiency, hence marginal costs. Subsequently, the wedge between marginal cost and prices reflect markups.

We first analyse how markups are spread across products, and quantify their heterogeneity. In particular, our results suggest that markups are higher on core products, with this profitable position increasingly salient as the number of products rises. Markups are lower on products which are about to be dropped.

In order to estimate the range of markups of firms across its products, we rely on the methodology of (De Loecker et al. 2016) which we apply to a large panel of French manufacturers. This method allows to recover markups and quantity-based productivity estimates from production data, where per-product quantity are observed, under conditions which are discussed below. From there, dividing prices by markups, marginal costs are recovered. The panel dimension and the very detailed level of disagregation allow to carefully examine product portfolio and product switching from one year to the next. The analysis is here related to the work by (Bernard, Redding and Schott 2010), which describe product switching dynamics in US manufacturing. We test one of their model prediction: productivity estimates are positively correlated to the number of products.

We confront marginal cost estimates to cost shocks from trade, with data which are not used in the markups and marginal costs estimations. By checking that indeed the marginal costs of importers respond to import-weighted exchange rates, we provide evidence on their consistency. We then turn to the domestic market. While the empirical literature on international firms' product portfolio is dense, it is less the case for multiproduct domestic firms.[1] The focus of the paper is on the interaction between markups and product portfolio. We may think as productivity as a firm-specific characteristics which applies similarly to all its products, while the product-specific markup reflects market power or customer taste, hence profitability.

The remaining of the paper goes as follows: the second part describe the data, related to the period 2009-2016. The third review the main points in (De Loecker et al. 2016) which are applied here to a large set of French manufacturers. Results on production function and markups estimation are reported in section four. The fifth part confront these estimates to out-of-sample cost shocks, and then describe how markups and product dynamics interact. Future work will entail using exogenous cost shocks (from trade, but also from the labor cost, through firm-exposition to a large tax credit in 2013) estimates pass-through of cost shocks in markups, according to product position in firm portfolio.

[1] Multiproduct firms selling to customer (Hottman, Redding and Weinstein 2016)

II. Data

We gather three distinct datasets relative to the period 2009-2016 at annual frequency. The first is firm-product-level production data (*Enquête annuelle de production*) collected by the French National Statistical Institute Insee for the PRODCOM regulation at yearly frequency. It covers the manufacturing sector, except the agri-food firms, and surveys about 35 000 firms (legal units). The exhaustive strata of the sample comprises firms with more than 20 workers or with sales revenues over 5 millions euros. The other firms are sampled. A distinctive feature of these data is to record both quantities and sales at a very detailed product level (PRODFRA, 10 digits levels). Observation of physical output (instead of revenue output alone) has proven very helpful for neat production function estimation. Moreover, the very detailed features of the data allows to monitor closely products portfolio changes. Table 1 provides examples of the product notion used hereafter.

1812125000	Advertising and similar printed matter (excluding commercial catalogs)
1812199010	Administrative or commercial printed matter, flat or continuous, customized or not, and directories
2511235040	Industrial boiler products: not including tanks, boilers, nuclear equipment
3102100010	Wooden kitchen furniture: by mounted elements, including custom
310912502B	Dining and living room furniture other than tables: buffets, credenzas and livings, bookcases, cabinets by element.

Table 1—Examples of products in EAP (PRODFRA nomenclature)

The second is FARE *Fichier Approché des Résultat d'Esane* data, firm-level compulsory tax files recording firm balance sheet which cover the manufacturing sector (but not only). These data are used in production function estimation, as they contain materials, employment and capital information among other. Employment is computed in full-time equivalent and is very close to the number of worked hours. It is therefore a volume of work rather than payroll information. Materials include merchandises (that are sold as bought) and raw or source materials, that are destroyed in the production process. We also include in intermediate consumption (and materials), the other and external expenses, as they notably include energy expenses (electricity, gas), or outsourcing expenses. These material expenses are deflated with a sectoral intermediate consumption price index (2 digits, 88 sectors). Capital measure is also derived from the tax record files. Measuring capital volume is difficult because assets are recorded at their acquisition price in the books. We hence need to estimate the average age of the assets in order to deflate by the investment price index which was current at the acquisition date. We calculate the average age of fixed assets, multiplying the depreciated portion of fixed assets by the usual depreciation period. Firms report both the gross acquisition value of fixed assets and the cumulated depreciated value of the assets, because each year, companies can recognize the depreciation of their investment as operating expense according to strict accounting rules. Tangible assets on the assets side of the balance sheet are broken down into four categories: land, buildings, technical and industrial equipment (which account for most of the assets of industrial enterprises), and other tangible assets (including vehicles and IT equipment). Once the assets age is recovered, the asset book values are deflated with the sectoral price index (construction for building assets, mechinery and equipments, NACE 28 for technical and industrial equipment and electronical industries NACE 27 for other tangible assets) at the estimated date of acquisition.

Our main sample merge EAP and FARE datasets (EAP-FARE). The third dataset is firm-to-firm exporting transactions, from French customs. The three datasets can be merged based on the unique identifier of the firm legal entity (SIREN). This third dataset is for now used only to estimate cost shocks from trade.

To accomodate product classification changes, we aggregate products within the smallest products' enveloppe which is stable over our time period.[2] From the 3789 products in our sample defined with a year-specific nomenclature, we get 3131 products with our 2009-2016 stable nomenclature on product enveloppe. In the remaining of the paper, this is the concept of product which we follow.

Table 2 describes the sample. We kept observations with both non missing quantity and sales to be able to compute a unit price. We exclude as well two concentrated sectors, with few firms: pharmaceutical industry and petroleum processing and coking. Per year, in-sample firms account for about 350 billions of sales and 2900 distinct products. Multiproduct firms (with more than one product) represent slightly more than 30% of the sample. There is on average 1.8 products per firm a given year, but the median is at 1. Only 1% of firms produce more than 9 products.

In Table 3, we report product dynamics when the sample is restricted to firms which are present the eight years. In 2010, about 4% of firms both dropped a product and introduce a new product, 5% dropped a product and 5% introduced a new product. From 2013 onward, the dynamics is slightly slower: 3% of firms change their product-mix by addition and deletion, and new products are introduced by only 3% of firms in 2016. See (Bernard, Redding and Schott 2010) for a US comparison (where periodicity is 5 years, product are at 5 digits level, but where all the universe of manufacturing firms is covered).

Finally, Figure 1 shows the dynamics of product portfolio for firms starting with 1, 2, 3 or 4 product in 2009, and staying in the sample until 2016.

[2]Derived from a simple connected components algorithm

Table 2—Manufacturing firms: sales and number of products

Year	Firms	Product	Total sales (Billions)	Multiproduct	Products per firm				
					Med	p80	p90	p99	Mean
2009	22025	2898	313.719	0.36	1	2	4	10	1.95
2010	24630	2898	343.024	0.34	1	2	4	9	1.88
2011	26641	2911	367.203	0.34	1	2	4	9	1.87
2012	28409	2939	361.808	0.33	1	2	4	9	1.84
2013	31237	2956	355.469	0.32	1	2	3	9	1.80
2014	31036	2959	353.792	0.32	1	2	3	9	1.80
2015	31584	2950	361.508	0.31	1	2	3	9	1.78
2016	31262	2951	361.823	0.31	1	2	3	9	1.77

Note: EAP-FARE sample

Table 3—Product-mix changes per year, relative to previous year.

Product-mix changes	2010	2011	2012	2013	2014	2015	2016
Both	0.04	0.04	0.04	0.03	0.03	0.03	0.03
Drop	0.05	0.04	0.04	0.04	0.04	0.05	0.04
New	0.05	0.05	0.05	0.04	0.04	0.04	0.03
None	0.87	0.87	0.87	0.89	0.89	0.87	0.90

Note: The sample is restricted to 8-year-present firms. *Both* refers to firms which both drop at least one product and introduce at least one new product (as observed in the survey).

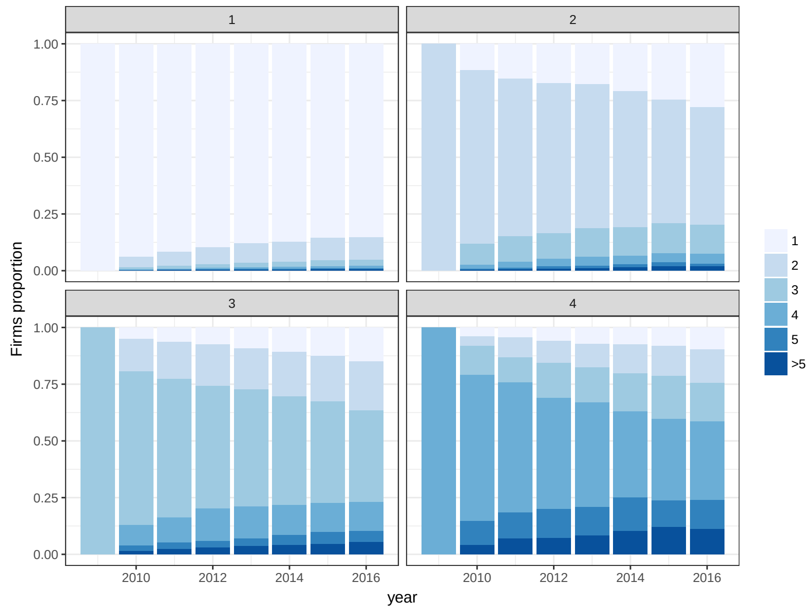

FIGURE 1. PRODUCT PORTFOLIO DYNAMICS (NUMBER OF PRODUCTS) FOR FIRMS STARTING WITH 1, 2, 3 OR 4 PRODUCTS.

Note: Among 8-year-present firms.

III. Estimation

This section largely builds on (De Loecker et al. 2016) and thereby on (Hall 1988). We reproduced here the main elements of (De Loecker et al. 2016) estimation methods for the reader not familiar with the method. We clarify some estimation details. Firms are assumed to minimize costs and thus to choose optimally their inputs under on a production level objective. It this context, markups can be expressed as the ratio of the output elasticity with respect to one input (production efficiency) to the share of the same input cost in output revenue (cost in revenue). Importantly, the analysis is conducted at the product level: the goal is to derive markups and marginal costs per product (and per firm). A firm f producing product j at time t has the following production function:

$$Q_{fjt} = \Omega_f F_j(M_{fjt}, L_{fjt}, K_{fjt}) \tag{1}$$

Q is physical output, Ω_f is firm productivity and F_j is the production technology which takes as inputs materials M, labor L and capital K. For our purpose, output elasticities are defined once F_j is estimated, and inputs must be spread out by product (this breaksdown is typically unobserved): inputs are indexed by j.

The estimation procedure proceeds as follows. First, F_j is estimated on the sample of monoproduct firms with production function estimation following (Wooldridge 2009) and (Ackerberg, Caves and Frazer 2015). By industry, the coefficients of a translog production function are derived. For monoproduct firms, no assumption on the input allocation across product are needed. These production features are assumed representative: they apply to products in multiproduct firms. Namely, the production function estimates of a multiproduct firm consists in (1) overall productivity $\hat{\Omega}_f$ and (2) translog coefficients for each of its products $\hat{F}_j$. The latter is given by the corresponding estimates in monoproduct firms. The former is then estimated: it allows multiproduct firms to be more efficient than monoproduct firms although the production technology is product-specific. In addition, per-product output elasticities are varying by firms as with a translog production function, the output elasticities are a function of the set of inputs.

However, a challenge remains: allocating inputs across products in multiproduct firms. For this last step, for each multiproduct firms producing J_f products, to determine its J_f production processes (one per product) we shall estimate (1) its productivity, invariant across product (1 unknown), (2) how its inputs are spread over products ($J_f - 1$ unknown shares, as shares sum to one). This boils down to J_f unknown in J_f production equations, which can be solved approximately.

We detail in this section the firm problem, the estimation of production functions on the sample of monoproduct firms and finally the estimation of last production features in multiproduct firms.

A. *Firm optimization problem*

Firms are assumed to minimize their cost $C(M_{fjt}, L_{fjt}, K_{fjt}) = W^m_{fjt} M_{fjt} + W^l_{fjt} L_{fjt} + W^k_{fjt} K_{fjt}$, where W_{fjt} is the vector of input prices faced by the firm for a given product. The firm pursue an output objective: $Q_{fjt} = Q_{fjt}(V_{fjt}, K_{fjt})$, which is a constraint in the optimization problem. Thus, the Lagragian associated to its choice of inputs $(M_{fjt}, L_{fjt}, K_{fjt})$ is:

$$\mathcal{L} = W^m_{fjt} M_{fjt} + W^l_{fjt} L_{fjt} + W^k_{fjt} K_{fjt} + \lambda_{fjt}[Q_{fjt} - Q_{fj}(V_{fjt}, K_{fjt})]$$

Optimal input choice verifies the first order condition, for a given input, here M:

$$\frac{\partial \mathcal{L}}{\partial M_{fjt}} = 0 = W^m_{fjt} - \lambda_{fjt} \frac{\partial Q_{fj}(.)}{\partial M_{fjt}} \tag{2}$$

The lagrange multiplier, at the optimal choice of inputs, is by the enveloppe theorem equal to

$$\lambda_{fjt} = \frac{dC(M^*_{fjt}, L^*_{fjt}, K^*_{fjt})}{dQ_{fjt}}$$

It is the marginal cost of a unit of output. In this setting, if prices are observed, markups are defined with:

$$\mu_{fjt} = \frac{P_{fjt}}{\lambda_{fjt}} \tag{3}$$

Combined with Equation 2, it is easy to show that

$$\mu_{fjt} = (\frac{M_{fjt}}{Q_{fjt}} \frac{\partial Q_{fj}(.)}{\partial M_{fjt}}) \times (\frac{P_{fjt} Q_{fjt}}{W^m_{fjt} M_{fjt}}) \tag{4}$$

which is the product of an output elasticities with respect to materials in the production of product j and of the inverse of the share of material cost (for this product) over firm revenues (on this product).

Equation 4 is the basis of the econometric approach in (De Loecker et al. 2016), which we implement here.

B. *Production function of mono-product firms*

In this section, we detail the estimation of $f_j = \log(F_j)$, restricting to single-product firms. Taking the logs of equation 1, where lower cases indicates the logs,

$$q_{ft} = \omega_{ft} + f_j(m_{ft}, l_{ft}, k_{ft}; \beta) + \epsilon_{ft} \tag{5}$$

We drop the subscript j in inputs as $J_f = 1$ for all firms considered. We assume a flexible translog form for f_j, which can be seen as a second order approximation of the production function.[3] β is the parameter we wish to estimate. In this equation, we link physical quantities. However, we observe physical quantities only for output and labor. We denote $\tilde{m} = m + \log(W^m) - \log(I^m)$ and $\tilde{k} = k + \log(W^k) - \log(I^k)$ the deflated materials and capital which are observed (because material costs are observed, and I is a sector-specific deflator). Production can be written:

$$q_{ft} = \omega_{ft} + f_j(\tilde{m}_{ft}, l_{ft}, \tilde{k}_{ft}; \beta) + \underbrace{B(.)}_{f_j(m_{ft}, l_{ft}, k_{ft}; \beta) - f_j(\tilde{m}_{ft}, l_{ft}, \tilde{k}_{ft}; \beta)} + \epsilon_{ft} \tag{6}$$

[3]Namely, $f_j(m, l, k) = \beta_l l + \beta_m m + \beta_k k + \beta_{ll} l^2 + \beta_{mm} m^2 + \beta_{kk} k^2 + \beta_{lk} lk + \beta_{mk} mk + \beta_{ml} lm + \beta_{lmk} klm$

B quantify the bias of not observing input prices (ideally, we should deflate by a firm-specific input price index). But as noted by (De Loecker et al. 2016), if we assume the errors in input prices to be proportional across inputs,[4]

$$B(.) = \underbrace{w_{ft}}_{\text{Error in input price}} \times a(w_{ft}, \tilde{m}_{ft}, l_{ft}, \tilde{k}_{ft}) \tag{7}$$

This remark is important as it provides an estimation strategy to dampen the input price bias, while identifying the parameters of f_j. In Equation 6, all the terms due to the input price biais appear in interaction with the error in input prices. For instance, eventhough $\tilde{m}$ enters both f_j and B, it does in B only in interaction with the input price control, which insure identification here of β_m. The strategy is therefore as follows: (1) assume a control proxy for $w_{ft} = \log(W_{ft}) - \log(I)$, (2) estimate Equation 6 by substituing for w_{ft}. In fact, if we approximate B at first order, we get:

$$B(.) \approx -w_{ft} \times (\beta_l + \beta_k + \beta_m) \tag{8}$$

The deviation of firms input prices with respect to the sector deflator is assumed to reflect output quality. To proxy for unobserverd quality, we assume

$$w_{ft} = \alpha p_{ft} + \beta ms_{ft} + \zeta \text{EXP}_{ft} + \xi \text{COM}_{ft} + \mu \text{Age}_{ft} + \gamma R_{ft} + \delta_j + \nu_{ft} \tag{9}$$

where p_{jt} is final product price, ms_{ft} are firm market shares, which are completed with dummies: at t, is the firm (1) exporter, (2) having retail activities, (3) which category of age it belongs, (4) its regional location. Finally, we introduce product dummies. In what follows, we denote $z_{ft} = (p_{ft}, ms_{ft}, \text{EXP}_{ft}, \text{COM}_{ft}, \text{Age}_{ft}, R_{ft}, \delta_j)$ and $B(.) = z_{ft}\alpha$.[5]

After its detour to tackle input price bias, we combine Equations 6, 8 and 9 to get

$$q_{ft} = \omega_{ft} + f_j(\tilde{m}_{ft}, l_{ft}, \tilde{k}_{ft}; \beta) + z_{ft}\alpha + \tilde{\epsilon}_{ft} \tag{10}$$

We then follow the literature on production function estimation, starting from (Olley and Pakes 1996),(Levinsohn and Petrin 2003) to deal with unobserved productivity. We use a control function inverting the demand for input, more

[4] That is $w_{ft} = \log(W^k) - \log(I^k) = \alpha_j + \log(W^m) - \log(I^k)$. For instance, the distance between the firm pricing and the sector pricing is due to both inputs' quality which is reflected in their higher prices. See (De Loecker et al. 2016) for a discussion.

[5] $\alpha_1 = -(\beta_l + \beta_k + \beta_m) \times \tilde{\alpha}$ etc..

specifically the demand for materials. The demand for materials is assumed to reflect productivity level and to be adjusted by the firm which observes its productivity and other variables:

$$\tilde{m}_{ft} = m_t(\omega_{ft}, \tilde{k}_{ft}, l_{ft}, z_{ft})$$

Inverting this equation gives the control function:

$$\omega_{ft} = h_t(\tilde{m}_{ft}, \tilde{k}_{ft}, l_{ft}, z_{ft})$$

Now, we follow (Ackerberg, Caves and Frazer 2015) and more precisely the one step GMM version in (Wooldridge 2009) and estimates the parameters in 10 by forming moments on the innovation ξ_{ft} in the productivity process:

$$\xi_{ft} = \omega_{ft} - E[\omega_{ft}|\omega_{f,t-1}]$$

Here, we use that $\omega_{ft} = \omega_{ft}(\alpha, \beta)$ where (α, β) is the vector of parameter to estimate, as

$$\omega_{ft} = q_{ft} - (f_j(\tilde{m}_{ft}, l_{ft}, \tilde{k}_{ft}; \beta) + z_{ft}\alpha + \tilde{\epsilon}_{ft}) \tag{11}$$

and that $E[\omega_{ft}|\omega_{f,t-1}] = g(\omega_{f,t-1}) = g(h_t(\tilde{m}_{f,t-1}, \tilde{k}_{f,t-1}, l_{f,t-1}, z_{f,t-1}))$ can be approximated by a flexible function in its argument. The identification strategy is complete once we have assumed that

$$E[\xi_{ft} + \tilde{\epsilon}_{ft}|\tilde{k}_{ft}, z_{ft}, \tilde{m}_{f,t-1}, \tilde{k}_{f,t-1}, l_{ft-1}, z_{ft-1}, \tilde{m}_{f,t-2}, \tilde{k}_{f,t-2}, l_{ft-2}] = 0 \tag{12}$$

Here, the contemporaneous state variables $(\tilde{k}_{ft}, z_{ft})$ acts as their own instruments, and $\tilde{m}_{f,t-1}, l_{f,t-1}$ acts as an instruments for m_{ft}, l_{ft}. In practice, to identify all the terms in the translog, we introduce the corresponding squares and interaction terms. Equation 12 is estimated with a GMM procedure which allows to recover α and β, by industry.

C. *Share of inputs attributable to each products in multi-product firms*

For multiproduct firms, there is an addditional challenge: spreading inputs across products. For firm j producing J_{ft} products, its J_{ft} production process are as follows for $j \in J_{ft}$, which mobilize a share $\exp \rho_j$ of each inputs:

$$q_{fjt} = \omega_{ft} + f_j(\tilde{m}_{ft}, l_{ft}, \tilde{k}_{ft}; \beta) + \underbrace{f_j(m_{ft}, l_{ft}, k_{ft}; \beta) - f_j(\tilde{m}_{ft}, l_{ft}, \tilde{k}_{ft}; \beta)}_{B(.)} +$$
$$\underbrace{f_j(\rho_j + m_{ft}, \rho_j + l_{ft}, \rho_j + k_{ft}; \beta) - f_j(\tilde{m}_{ft}, l_{ft}, \tilde{k}_{ft}; \beta)}_{A(.)} + \epsilon_{ft}$$

If we assume the technology to be product-specific, in this equation, β and $B(.)$ are recovered from the previous section method. The remaining unknowns of these J_{ft} equations are ρ_j and ω_{ft} which is assumed to be constant over time and therefore becomes an additional unknown. In total, we have $J_{ft} + 1$ unknowns for the same number of equations (if we add that $\sum_{j=1}^{J_{ft}} \exp \rho_j = 1$). We approximately[6] solve this problem for each firm-year pairs.

IV. Estimation results

In this section, we detail the results we obtain by applying the methodology of (De Loecker et al. 2016) to our large sample of French manufacturers. Table 4 reports the output elasticities for both multiproducts and monoproducts firms. They are a function of estimated β, ρ_j, w_{ft} and observed inputs. For instance, the output elasticities for materials is equal to

$$\hat{\beta}_m + 2\hat{\beta}_{mm} m_{fjt} + \hat{\beta}_{mk} k_{fjt} + \hat{\beta}_{ml} l_{fjt} + \hat{\beta}_{mlk} l_{fjt} k_{fjt}$$

where physical inputs are unobserved at the product levels, but can be recovered by taking into account (1) the estimated input price correction and (2) the estimated input shares. It clearly appears that output elasticities vary by firms (and across product within firms) eventhough technology does not, so we report the mean output elasticities and their standard errors over firms. Returns to scale are the sum of the three elasticities: with respect to labor, materials and capital. Across all firms, the average output elasticities with respect to labor, materials and capital are respectively 0.23, 0.64, and 0.07. Among the highest labor elasticities, we find textile, cloth and shoes industries. Among the highest capital elasticities, we find metal and paper industries. The highest elasticity with respect to materials is found in the manufacture of other transport equipment industry.

Table 5 provides the results for markups. In column (1), we show markups over all product-firm pairs by industry. The mean markup across all product-firm is 1.5, with a standard deviation of 2.7. But the median markup is 0.86, which mean that for half of the product in the sample, prices are set below marginal

[6] Note that the problem is not linear (it contains a polynomial of order three in rho_j).

Table 4—Average output elasticities by sector

Sector (NACE code)	Labor	Materials	Capital	Returns to scale
13	0.30	0.63	0.02	0.96
	[0.11]	[0.12]	[0.02]	[0.06]
14	0.32	0.7	0.04	1.05
	[0.22]	[0.19]	[0.03]	[0.18]
15	0.56	0.52	-0.07	1.01
	[0.11]	[0.16]	[0.07]	[0.12]
16	0.21	0.64	0.04	0.89
	[0.09]	[0.08]	[0.09]	[0.14]
17	0.24	0.68	0.08	1.00
	[0.12]	[0.07]	[0.07]	[0.06]
18	0.23	0.61	0.08	0.93
	[0.13]	[0.09]	[0.06]	[0.08]
20	0.06	0.62	0.15	0.83
	[0.21]	[0.07]	[0.08]	[0.25]
22	0.28	0.64	0.05	0.97
	[0.11]	[0.1]	[0.03]	[0.03]
23	0.22	0.65	0.07	0.93
	[0.2]	[0.25]	[0.09]	[0.11]
24	0.16	0.69	0.10	0.95
	[0.13]	[0.1]	[0.07]	[0.14]
25	0.23	0.57	0.11	0.91
	[0.11]	[0.11]	[0.04]	[0.09]
26	0.14	0.73	0.06	0.93
	[0.08]	[0.1]	[0.05]	[0.11]
27	0.26	0.63	0.06	0.95
	[0.12]	[0.14]	[0.05]	[0.07]
28	0.25	0.63	0.07	0.95
	[0.15]	[0.13]	[0.03]	[0.07]
29	0.31	0.66	-0.04	0.93
	[0.1]	[0.11]	[0.07]	[0.16]
30	0.21	0.79	-0.11	0.89
	[0.15]	[0.17]	[0.15]	[0.10]
31	0.15	0.73	0.05	0.92
	[0.15]	[0.1]	[0.05]	[0.10]
32	0.31	0.44	0.09	0.84
	[0.21]	[0.13]	[0.09]	[0.19]

Note: This table reports output elasticities from the production function estimates, for both monoproducts and multiproducts firms. Average are across firms within sectors, as well as standard deviations in brackets.

costs. However, if we restrict the sample to a specific product per firm, the product where the maximal markup is realized (column (3) of Table 5, which comprises single-product firms where the maximal markup is achieved on its only product), the median is above one and the mean markup considerably higher. Column (2) shows the mean and median markups for core product (with maximal revenue) within multiproduct firms. Here as well, markups are higher and clearly above 1. We interpret these findings as supporting the idea that revenue is borne by some products (core product, or product with maximal markups), and firms accept markups under 1 for some of their products, whose production is *de facto* sustained by the other products in firm portfolio.

Table 5—Markups by sector

	All product-firms (1)		Core products within multiproduct firms (2)		Product with maximal markup (3)	
Sector	Mean	Median	Mean	Median	Mean	Median
13	1.39	0.86	2.36	1.29	1.74	0.99
14	1.56	0.81	2.98	1.72	2.97	1.52
15	1.31	0.77	2.46	1.33	1.73	0.96
16	1.41	0.87	1.79	1.07	1.89	1.07
17	1.43	0.95	2.51	1.59	1.80	1.08
18	1.37	0.98	2.47	1.69	1.80	1.13
20	1.67	0.61	2.71	1.18	3.15	1.15
22	1.55	0.97	2.13	1.16	1.83	1.04
23	1.63	0.89	1.96	1.05	2.14	1.08
24	1.46	0.94	2.26	1.56	2.04	1.20
25	1.15	0.81	1.69	0.98	1.31	0.89
26	1.92	0.95	2.57	0.96	2.23	1.09
27	1.63	0.86	2.45	1.00	2.00	1.00
28	1.46	0.78	2.15	0.95	1.74	0.89
29	1.46	0.88	2.48	1.29	1.66	0.96
30	1.52	0.89	2.11	1.23	1.74	1.00
31	1.61	0.96	2.29	1.57	2.39	1.41
32	1.14	0.70	1.61	0.61	1.24	0.77

Note: This table reports markups recovered from production function estimates, input price correction and shares attribution. These statistics are computed first for all firm-products-years estimates in columns (1), only for the year-specific core product within multi-product firms in columns (2) and only for the year-specific product where maximal markup is realized in each firm, be it because it is the only product (single-product firms) or because its markups is higher than on other products (3). They are computed excluding both extreme percentiles.

Finally, we check a final stylized fact in Figure 2. Our estimates of firm productivity is increasing with the number of products produced by the firm.In the next section, we study more in detail the breakdown of prices between markups and marginal cost.

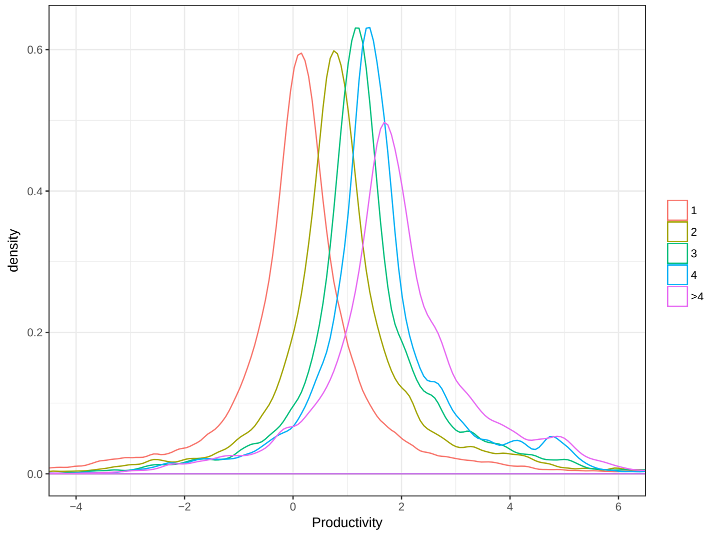

Figure 2. Productivity of firms with 1, 2, 3, 4 or more than 4 products

V. Empirical analysis of markups

A. *Pass-through of cost shocks*

We confront the breakdown of price between markup and marginal cost estimates to various type of cost shocks (work in progress). First, we restrict the sample to firms with at least one import from the 30 first France non-euro trade partners, to capture evolution of imported good marginal costs due to exchange rate variations. We weight these 30 log exchange rates (foreign currency per euro) with firm-specific weights, which are proportional to the lagged imported value by the firm from the foreign country with the given currency.

Table 6 shows the pass-through of the foreign exchange rates (at the firm-level) to its product prices, and the estimates markups and marginal costs. We introduce product-year fixed effects to capture product-specific trends and shocks. We observe a significant pass-through, namely marginal costs decreases when foreign currencies depreciate against the euro, with half of the pass-through being in lower prices and half in higher markups. Note that a currency shock is most likely affecting a minor part of the firm costs (those related to import with non-euro partners).

The second panel of Table 6 shows the results when confronting marginal cost estimates to exposures to the *CICE*, a tax credit representing a cut in labor cost under 2.5× the national minimum wage. We here follow (Carbonnier et al. 2018) work in progress. We use the tax credit exposure as measured from *past* wage bill (share of eligible bill times the rate of the tax credit, 4% in 2013 and 6% in 2014-2016, which measures the mean percentage cut in wage bill)[7] and compare firms within cells where the share of the wage bill under 2.2× NMW and above 2.8× NMW are the same. They differ only with respect to the repartition of the wage bill across the eligibility threshold of 2.5× NMW. Here as well, we see that the exposure to the tax-credit correlates with lower marginal costs (and lower prices).

We see Table 6 as prodiving preliminary evidence of the consistency of marginal costs estimates.

Table 6—Pass-through of foreign exchange rate in marginal cost, mark-ups and prices

	Dependent variable:		
	log price	log markup	log marginal cost
Importers from non-euro partners			
	(1)	(2)	(3)
log import-weighted foreign exchange rate	-0.030^{***}	0.030^{***}	-0.060^{***}
(foreign currencies per euro)	(0.004)	(0.006)	(0.006)
Product x year FE	Yes	Yes	Yes
Observations	139,294	139,209	139,209
R^2	0.898	0.250	0.792
Full sample			
	(1)	(2)	(3)
Tax credit exposure	-0.014^{***}	0.0003	-0.015^{***}
	(0.003)	(0.005)	(0.005)
Product x year FE	Yes	Yes	Yes
Cells of Wage distribution	Yes	Yes	Yes
Observations	343,702	343,339	343,339
R^2	0.920	0.233	0.826

Note: From the estimation sample (product-firm-year), we keep for all firm-year with at least one importation from the 30 first France non-euro trade partners (first panel). *p<0.1; **p<0.05; ***p<0.01

B. Within-firm markups distributions

Figure 4 shows how markups are spread across product within multiproduct firms. Here log markups are demeaned by product. The larger is the size of the

[7]DADS data is used here.

product portfolio increases, the larger is the difference between the markup on the main product (the product with maximal sales value) and the markup on the other products. In diversified firms, markups on secondary products are much more spread than in firms with a few products.

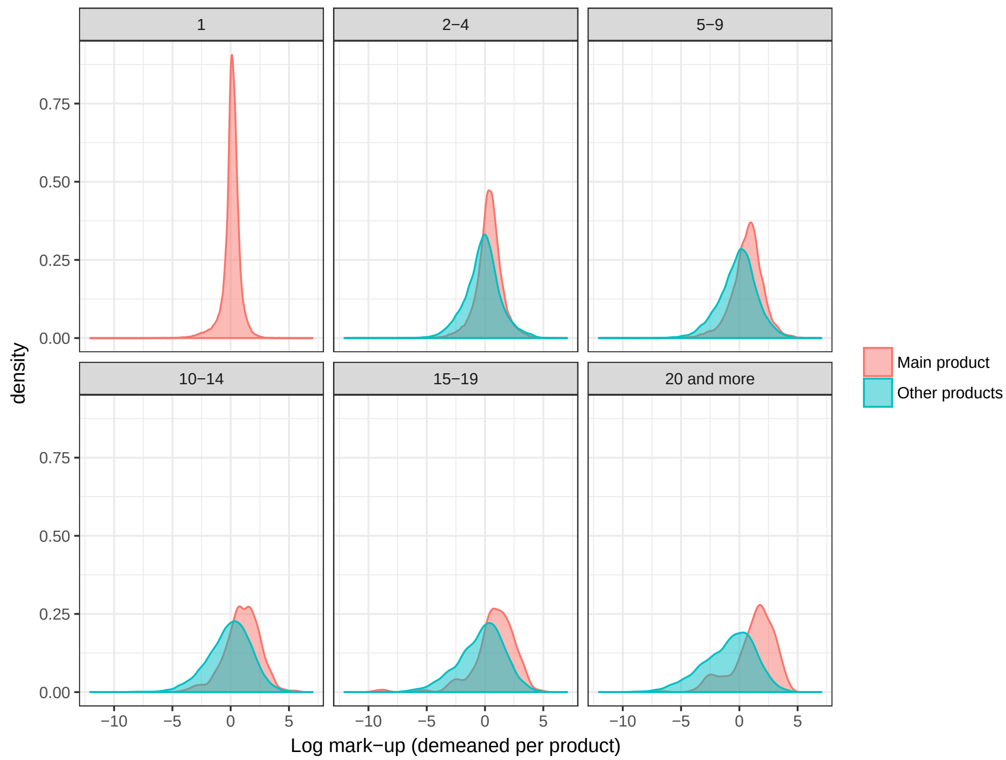

FIGURE 3. MARK-UP WITHIN MULTIPRODUCT FIRMS, BY PRODUCT PORTFOLIO SIZE

Note: The product with maximal sales value is the main product. Log mark-up are demeaned by product. The markup (relative to the product market) are generally higher on the main product.

C. Within-firm markups and product dynamics

Finally, Figure 4 shows the distribution of markups depending on whether the product is about to be dropped (it is dropped the following year) or not (it remains in firm's portfolio the following year). We represent both markups distribution for respectively new and stable (which were in firm's portfolio the year before) products. Among new products, products which are dropped are characterised by lower markups. It is also the case, eventhough slightly less pronounced, for stable product (which were here the year before).

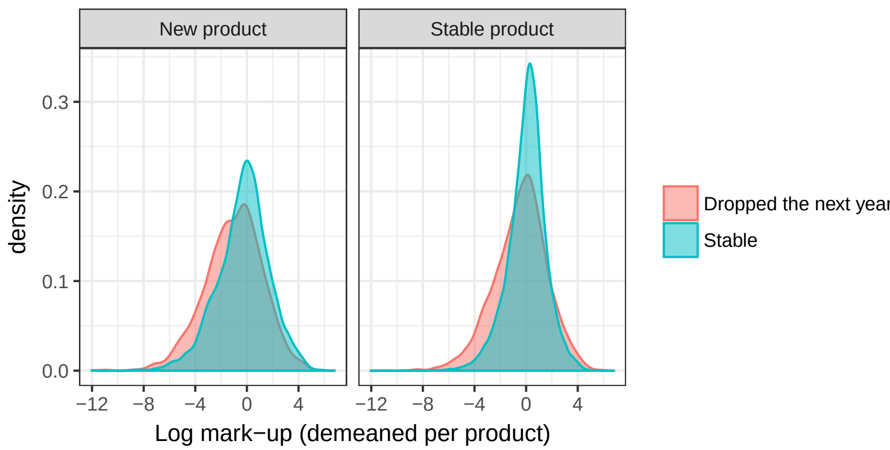

Figure 4. Mark-up within multiproduct firms, across new and stable (incumbent) product which will be dropped or not next year

Note: Multiproduct firms only. Log mark-up are demeaned by product.

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Appendix

Table A1—Monoproduct and multiproduct firms: descriptive statistics (after partialling out industry fixed effects)

variable	1 product	2-4 products	5 products
Firm size : <20 workers	4,92	-6,11	-13,57
>=20 and <100	0,05	0,43	-1,90
>=100 and <250	-2,80	4,05	5,72
>=250	-2,17	1,63	9,74
Labor productivity (in k)	-0,09	-0,34	1,87
Economics profitability	0,42	-0,47	-1,27
Financial profitability	0,48	-0,51	-1,65
Export rate	-0,40	-0,02	2,89
Investment rate	-0,21	0,19	0,85
Margin rate	0,25	-0,56	0,18
Corporate group	-2,15	2,50	6,55
Workers <30 yo	0,35	-0,34	-1,26
Workers >=30 yo and <50 yo	0,12	-0,15	-0,33
Workers >=50 yo	-0,46	0,49	1,60
Managers and professionals	-0,04	-0,13	0,76
Intermediate professions	-0,10	-0,16	1,31
Prop. CS 15	-0,02	-0,02	0,22
Prop. CS 16	0,05	0,48	-2,05
Women	-0,21	0,19	0,81
Techies	0,01	-0,10	0,30

Table A2—Markups, marginal costs, quantity and product share

	Dependent variable:			
	Log markups	Log marginal costs	Log markups	Log marginal costs
	(1)	(2)	(3)	(4)
Quantity	0.567^{***}	-0.778^{***}		
	(0.002)	(0.001)		
Product share			2.253^{***}	-3.009^{***}
			(0.016)	(0.013)
Product-year FE	Yes	Yes	Yes	Yes
Firm-year FE	Yes	Yes	Yes	Yes
Observations	356,694	356,694	356,694	356,694
R^2	0.685	0.979	0.610	0.949

Note: This table replicates the results found in (De Loecker et al. 2016) for Indian manufacturing firms.
*p<0.1; **p<0.05; ***p<0.01