The Dynamics of Firms' Product Portfolios in Response to International Competition: Evidence from French Firms*

Claire Lelarge† Benjamin Nefussi‡

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Abstract

We propose a simple extension of the Olley - Pakes / Levinsohn - Petrin structural approach for the estimation of production functions in order to address the main endogeneity concerns arising in the analysis of firms' product portfolio strategies. Using a comprehensive sample of French manufacturing firms, we show that firms that are most exposed to low-cost country competition tend to diversify their product portfolios, while those that are most exposed to the competition of developed countries tend to re-focus on their core activities. The subsequent differential evolution of their revenue and physical productivities is consistent with the hypothesis that the first tend to resort more often to differentiation strategies, while the latter engage more often in cost reduction and productive rationalization strategies.

JEL classification: F14, L11, L25, L60
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†Corresponding author. INSEE, CREST. E-mail : claire.lelarge@ensae.fr. Mailing address: INSEE, Timbre G230 / 15, Boulevard Gabriel Péri / 92245 MALAKOFF CEDEX / FRANCE. Tel. + 33 1 41 17 60 73, Fax. + 33 1 41 17 60 45.

‡MINEFE, French Treasury. E-mail: benjamin.nefussi@dgtresor.fr

1 Introduction

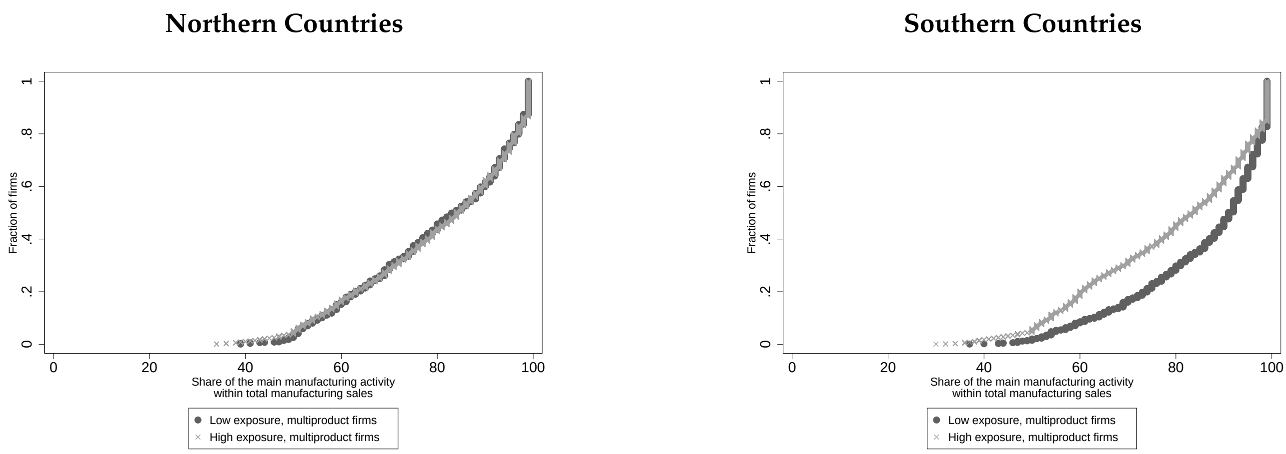
The recent literature in empirical international trade has demonstrated that multi-product firms are prevalent in developed (Bernard, Redding and Schott [2010]) as well as developing (Goldberg et al. [2010], Navarro [2008]) economies. The mechanisms driving the productive reallocations within such complex organizations have been investigated in several important contributions of the theoretical literature. These analyses are based on two main assumptions: first, multi-product firms are characterized by a “core product” they are able to produce at the lowest cost, while the production of other goods becomes increasingly costly for them as they become more "distant" in the technology space (De Loecker [2011], Mayer *et. al.* [2011]). Second, multi - product firms are able to internalize potential demand linkages such as cannibalization effects across varieties (Eckel and Neary [2010], Feenstra and Ma [2008]).

In this setting, increased trade integration has two contrasting effects on within-firm productive reallocations. On one side, the implied increase in competition favors a re-centering of multi - product firms on their core products (see e.g. Eckel and Neary [2010], Bernard, Redding and Schott [2010]). On the other side, access to new or larger markets, or more broadly, demand aspects will favor diversification (Feenstra and Ma [2008]). Most of the empirical literature, and especially Bernard, Redding and Schott [2010] describes the recent tendency of multi-product firms to re-focus on their core competence, which suggests that the first force might dominate. However, a striking feature of the French data is that firms which are most exposed to low-cost country competition appear to be on average *more* diversified than firms operating in more sheltered areas, whereas the symmetric pattern prevails, although not significantly on gross data, with respect to the competition arising from other countries (figure 1).

The main contribution of our paper is to propose a precise framework for the empirical analysis of these productive strategies. We show that these two contrasting patterns of correlations actually reflect differentiated mechanisms, with low-cost country competition inducing product diversification while competing with technologically advanced economies requires to refocus on core competencies. A first explanation might be that the market size effect might dominate when trade integration increases with (southern) countries[1] which are as large and growing as China, as compared with trade integration with more “mature” countries and markets. The literature also proposes alternative mechanisms which are consistent with the empirical pattern we obtain. As suggested by Bernard and Koerte [2007], the specificity of low-wage country competition is that it is almost impossible for a firm to engage a race in factor cost reduction and remain competitive on the same market. The appropriate response might rather be to relocate production on productive segments that are more sheltered and more differentiated (Vernon [1966]). Second, the transposition of the analysis in Foster *et. al.* [2008] in a multi-product setting suggests that the demand side might also play an important role in explaining within-firm product

[1] In what follows, for simplicity, we refer to low-cost countries as “southern countries”, and to other countries as “northern countries”.

Figure 1: Northern and Southern Penetration Indices and Firms' Main Activity Share



Kolmogorov-Smirnov Test

$\mathbf{H_0}$: $\mathbf{F}_{\text{Low Exp.}}(\bullet) < \mathbf{F}_{\text{High Exp.}}(\bullet)$, $\mathbf{D}^+ = \max_{\mathbf{x}} \{\mathbf{F_W}(\mathbf{x}) - \mathbf{F_H}(\mathbf{x})\}$

Northern Countries	Southern Countries
$D^+ = 0.018$, p-val = 0.629	$D^+ = 0.000$, p-val = 1.000

$\mathbf{H_0}$: $\mathbf{F}_{\text{Low Exp.}}(\bullet) > \mathbf{F}_{\text{High Exp.}}(\bullet)$, $\mathbf{D}^- = \min_{\mathbf{x}} \{\mathbf{F_W}(\mathbf{x}) - \mathbf{F_H}(\mathbf{x})\}$

Northern Countries	Southern Countries
$D^- = -0.018$, p-val = 0.617	$D^- = -0.170$, p-val = 0.000

$\mathbf{H_0}$: $\mathbf{F}_{\text{Low Exp.}}(\bullet) = \mathbf{F}_{\text{High Exp.}}(\bullet)$, $\mathbf{D} = \max\{|\mathbf{D}^+|, |\mathbf{D}^-|\}$

Northern Countries	Southern Countries
$D = 0.018$, p-val = 0.966	$D = 0.170$, p-val = 0.000

Notes: Multi-product firms only, manufacturing activities only. "High exposure" is defined as belonging to an industry with a high (above the 66^{th} sample percentile) southern penetration index. Conversely, "low exposure" relates to firms experiencing low penetration indices (below the 33^{th} sample percentile). These descriptive statistics relate to the year 2004.
This figure reports the cumulative density function of the share of the main activity of a multi-product firm in its total sales (indicator of *concentration*). Highly exposed firms are on average less specialized (and therefore more diversified) than weakly exposed firms, and the difference is statistically significant as evidenced by the Kolmogorov-Smirnov test. The difference is not significant when performing the symmetrical experiment with the northern import penetration index. Note that firms that are most exposed to international competition are on average more likely to be multi-product, but the contrast is higher with respect to the southern import penetration index (16.3% as compared to 6.6%) than with respect to the northern import penetration index (17.9% as compared to 9.8%).

selection and firm productivity[2]. As a consequence, the selection rule for products does not necessarily become uniformly more stringent as a firm moves away from its core technological competence, because the idiosyncratic demand conditions on the different market segments can counterbalance the technological constraints of the firm. We actually show that the subsequent evolution of firm level technological and revenue productivities is consistent with the hypothesis that selection is on profitability rather than efficiency.

On the econometrical side, the empirical question we raise is typically difficult, since it amounts to track the (causality) relations between the productive strategies of manufacturing firms, their idiosyncratic characteristics and the characteristics of their markets. Endogeneity concerns typically arise because of simultaneity problems, as in the case of production functions: unobserved firm level produc-

[2]These demand aspects could explain why the increase in low-cost country competition is not well described by the homogeneous, downward shift in the distribution of markups across *all* products sold domestically which is often considered in the literature (e.g. Mayer, Mélitz and Ottaviano [2011]).

tivity and (partially observed) aggregate market conditions are both determinants of product portfolio strategies, but are also generically correlated. Therefore, the OLS estimator of the coefficient associated with (any) indicator of international competition will be biased. To solve this problem, we use an extension of the structural framework initially introduced by Olley and Pakes [1996] for the estimation of production functions, along the lines suggested by De Loecker [2011]. The only conceptual difference with De Loecker [2011] is that we allow the number of products produced by a firm to evolve endogenously over time, since the "policy function" governing this "dynamic control" is at the core of our research question. Following Ackerberg, Caves and Fraser [2004], we show that our relation of interest is identified in this setting, and that the relevant "structural" parameters can be estimated up to a simple extension of their estimation procedure. Last, we implement instrumental variable techniques to address the potential endogeneity concerns arising because of the introduction of import penetration indices into the regression framework.

Our paper contributes first to the literature analyzing the consequences of the increase in trade integration which occurred over the past decades. Bernard, Jensen and Schott [2006] show that exposure to low-wage countries had a significant impact on selection at the firm level, i.e. on "between-firm" productive reallocations[3]. Martin and Méjean [2011] also show that the increase in low-wage country competition had a significant impact on the quality of French exports, driven by a reallocation of demand towards higher quality producers. A second set of recent papers has investigated the impact of trade openness on various aspects of corporate strategies, in particular corporate innovation: Costantini and Mélitz [2008] on the theory side, and Aw, Roberts and Xu [2011], Bustos [2011] or Bloom, Draca and Van Reenen [2010] on the empirical side. Last, Goldberg *et al.* [2010], Iacovone, Rauch and Winters [2011] and Navarro [2008] look at within - firm productive reallocations in the context of increased trade openness in developing economies like India, Mexico or Chile (respectively) and document selection processes at the product level. However, to our knowledge, no previous contribution has documented the potentially differentiated impact of northern and southern international competition on domestic producers in a developed economy.

The remainder of our paper is organized as follows. Our empirical strategy is explained in section 2. In section 3, we describe our dataset and our main empirical indicators. Results are commented in section 4 while section 5 concludes.

[3] The authors also look at main activity switching, but the evidence is more mixed because their empirical indicator of switching is rather crude.

2 An Empirical Setting for the Analysis of Firms' Product Portfolio Strategies

2.1 The Relation between the Analysis of Product Scope and TFP Estimation

Our estimation procedure relies on a direct extension of the framework initially introduced by Olley and Pakes [1996] for the estimation of production functions. We show in this section that their model of input choices can be augmented with a relation modeling the choice of product scope, that this latter relation is identified and can be estimated up to a straightforward generalization of their set-up.

Our starting point is the standard production function for single product firms:

$$q_{it} = \alpha_0 + \alpha_l.l_{it} + \alpha_k.k_{it} + \omega_{it} + u_{it} \tag{2.1}$$

where q_{it} stands for (ln) output (value added), l_{it} and k_{it} stand for productive inputs (labor and capital) and ω_{it} is firm TFP. As explained in detail in Ackerberg *et. al.* [2007], the unobserved productivity term ω_{it} is at the source of severe endogeneity problems because firms, in contrast to econometricians, observe ω_{it} before maximizing profit and setting their input demands, which generates a correlation (simultaneity bias) between inputs and unobserved productivity.

The principle of the estimation procedure in Olley and Pakes [1996] or Levinsohn and Petrin [2003] is to propose an explicit model of firms' decisions based on a set of reasonable assumptions about:

- the timing of input choices: labour (or materials) can be adjusted instantaneously to changes in productivity, while capital is decided upon in the previous time period (it is a state variable) via investment decisions.
- input prices and adjustment costs: they are assumed to be homogeneous across firms
- the process by which productivity evolves over time: it follows a first-order Markov process

The authors show that in this framework, all structural parameters are identified and can be consistently estimated. More precisely, they propose to consider two distinct "policy functions", governing either[4]:

- investment (Olley and Pakes [1996]): $i_{it} = f_1(k_{it}, \omega_{it}, \Phi_t)$
- the demand for materials (Levinsohn and Petrin [2003]): $m_{it} = f_2(k_{it}, \omega_{it}, \Phi_t)$

In these expressions, Φ_t captures features of the firm's environment: in our framework, it will typically correspond to indicators of market competition: import penetration indices computed for Northern and Southern countries respectively (PEN^S, PEN^N), and the herfindahl index of domestic market concentration (HHI). In cases where f_1 or f_2 are strictly increasing in ω_{it}, these functions can be inverted and

[4]These two functions depend on capital, which is considered as a state variable in the firm's problem of production optimization, while they do not depend on labour as they consider that this input can be adjusted instantaneously.

plugged (as control functions) into equation 2.1 to provide consistent estimates of α_l, α_k and ultimately ω_{it}:

$$\begin{aligned}\omega_{it} &= f_1^{-1}(i_{it}|k_{it}, \Phi_t) \\ &= f_2^{-1}(m_{it}|k_{it}, \Phi_t)\end{aligned}$$

The first step of our empirical strategy consists in extending this baseline model to multi-product firms. In absence of information about the precise allocation of inputs[5] to each activity, we adopt the approach suggested by Melitz [2001] and De Loecker [2011] and estimate the productivity index converting X_i/DIV_i inputs into Q_i/DIV_i output, where $X_i = (K_i, L_i)$ denotes production inputs and DIV_i denotes the number of different products produced by firm i ("diversification"). Taking logs, we get:

$$\begin{aligned}q_{it} - div_{it} &= \alpha_0 + \alpha_l.l_{it} + \alpha_k.k_{it} - \underbrace{(\alpha_l + \alpha_k)}_{=\gamma}.div_{it} + \omega_{it} + u_{it} \\ \iff q_{it} &= \alpha_0 + \alpha_l.l_{it} + \alpha_k.k_{it} + \underbrace{(1-\gamma)}_{=\alpha_{div}}.div_{it} + \omega_{it} + u_{it}\end{aligned} \tag{2.2}$$

The second step of our empirical strategy is to notice that an additional policy function (besides those governing investment or the use of intermediate inputs) arises naturally from this extension, namely the policy function governing product scope. Assuming that this aspect is decided upon in advance and is thus a state variable for the firm (like capital), the corresponding policy function can be written as:

$$\Delta div_{it+1} = f_3(k_{it}, div_{it}, \omega_{it}, \Phi_t) \tag{2.3}$$

The estimation of this equation is actually at the core of our research question. The main difficulty at this stage is that the unobserved productivity term $\omega_{it} = g(\omega_{it-1}) + \nu_{it-1}$ is generically correlated with k_{it}, div_{it} and Φ_t, which generates endogeneity problems. However, the structural framework provides a straightforward answer: we simply choose to estimate TFP from equation 2.2 using the Levinsohn and Petrin [2003] approach, and to plug this index into equation 2.3 to control for unobserved productivity. Estimation is performed using OLS and bootstrapped standard errors (100 replications)[6].
We estimate three different specifications for f_3, which can be written as[7]:

[5]Like De Loecker [2011], we only have the decomposition of sales across all activities of a firm, but we have no information about the precise allocation of inputs to each of these activities.

[6]A GMM procedure would also be feasible, and would provide a more direct way to compute standard errors (Wooldridge [2009]), but at the cost of re-estimating the productivity index for each different specification of equation 2.3 (lower stability).

[7]Note that we do not hace to make any assumption (e.g. in terms of monotonicity) about f_3 since we do not make use of this relation to retrieve ω_{it}.

$$
\begin{aligned}
(\Delta)div_{it} &= \theta_0 + \theta_1.\widehat{\omega}_{it-1} + \theta_2.div_{it-1} + \theta_3.k_{it-1} + \theta_4 \ln PEN^S_{t-1} + \theta_5 \ln PEN^N_{t-1} + \theta_6 \ln HHI_{t-1} + \delta_t + \epsilon_{it} \\
&\approx \theta_0 + \theta_1.\widehat{\omega}_{it-1} + \theta_2.div_{it-1} + \theta_{3a}.(k_{it-1} - \ln(\text{size}_{it-1})) + \theta_{3b}.\ln(\text{size}_{it-1}) \\
&\qquad + \theta_4 \ln PEN^S_{t-1} + \theta_5 \ln PEN^N_{t-1} + \theta_6 \ln HHI_{t-1} + \delta_t + \epsilon_{it} \qquad (2.4) \\
&\approx \theta_0 + \theta_1.\widehat{\omega}_{it-1} + \theta_2.div_{it-1} + \theta_{3a}.(k_{it-1} - \ln(\text{size}_{it-1})) + \theta_{3b}.\ln(\text{size}_{it-1}) \\
&\qquad + \theta_{4a} \ln PEN^S_{t-1} + \theta_{5a} \ln PEN^N_{t-1} + \theta_{4b} \ln PEN^S_{t-1} \times \widehat{\omega}_{it-1} + \theta_{5b} \ln PEN^N_{t-1} \times \widehat{\omega}_{it-1} \\
&\qquad + \theta_6 \ln HHI_{t-1} + \delta_t + \epsilon_{it} \qquad (2.5) \\
&\approx \theta_0 + \theta_1.\widehat{\omega}_{it-1} + \theta_2.div_{it-1} + \theta_{3a}.(k_{it-1} - \ln(\text{size}_{it-1})) + \theta_{3b}.\ln(\text{size}_{it-1}) \\
&\qquad + \sum_Q \theta_{4Q} \mathbb{I}\_PEN^{S,Q}_{t-1} + \sum_Q \theta_{5Q} \mathbb{I}\_PEN^{N,Q}_{t-1} + \theta_6 \ln HHI_{t-1} + \delta_t + \epsilon_{it} \qquad (2.6)
\end{aligned}
$$

Specification 2.4 is a direct first order linear expansion of the policy function 2.3, where we simply allow for a potential additional size effect (in case firm size is also to be considered as a state variable on top of diversification and capital intensity). Specification 2.5 is an alternative, more flexible specification where we introduce the interactions between productivity and international competition. Last, specification 2.6 is a simple variation of specification 2.4 where we allow the impact of international competition to be non-linear by introducing dummy variables for each of the quartiles of our indicators of international competition.

Last, as a small extension of our analysis, we use the same specifications as in equations 2.4 to 2.6 to check whether productive reallocations are coupled with R&D effort. These complementary analyses provide insight about whether product switching strategies or entry on new markets also incur significant fixed costs in terms of R&D.

2.2 Further Endogeneity Issues: IV Strategies for Penetration Indices

We also recognize that the import penetration indices may be endogenous in equations 2.4 to 2.6. First, endogeneity concerns arise in the cross-sectional dimension due to reverse causality or omitted variables biases (Bertrand [2007]). For example, erroneous strategy choices made in the past might affect the competitive position of a firm, or of an entire industry, and might therefore have an impact on the penetration indices they face. Alternatively, "lazy" managers are more likely to generate insufficient portfolio reallocations and might be specifically "attacked" by their (southern) competitors[8].

Two features of our empirical setting help mitigate these concerns. First, we use lagged values of the penetration indices to mitigate pure simultaneity biases. Second, we also report estimates obtained using average distances as proxies for freight costs as instrumental variables for the penetration indices (see section 3.2.2 below). The rationale behind this strategy is that transport costs (faced by foreign firms) have a direct impact on the openness of the French economy and are therefore correlated with penetration indices, as suggested by standard gravity equations, but that they do not affect directly the portfolio strategies of French firms, at least the vast majority of those which produce domestically and do not participate in international trade.

[8] These two examples would generate downward biases on our estimates but alternative stories might generate upward biases, e.g. in the case of inefficient but "hyper-active" managers.

A second source of endogeneity might arise in the time dimension. Indeed, unobserved technological shocks experienced by French firms[9] may have an impact simultaneously on French firms' product portfolio strategies *and* on their competitiveness, and therefore on penetration indices (see Thoenig and Verdier [2003]), which would generate a spurious correlation between the two. We follow Thoenig and Verdier [2003] and Bertrand [2007] and use exchange rates (corrected for differential domestic inflation) as IVs to address this concern[10]. We argue that exchange rates are primarily determined by macro-economic variables which, at least conditional on year dummies, can reasonably be regarded as exogenous to the behavior of firms in a certain industry and in a certain period.

2.3 Revenue and Physical Productivities

As in Melitz [2001] and De Loecker [2011] (and following also Klette and Griliches [1996]), for the actual estimation of TFP, we acknowledge that we observe firm revenue $r_{it} = q_{it} + (p_{it} - p_t)$ (i.e. firm sales deflated using industry level price indices) rather than actual output q_{it} and that TFP estimation is therefore potentially contaminated by unobserved demand shocks.

Assuming that consumers have Dixit-Stiglitz preferences and incorporating the implied demand function into the revenue equation of a single product firm, we get (see Melitz [2001]):

$$\begin{aligned} r_{it} &= q_{it} + (p_{it} - p_t) \\ &= \frac{\sigma - 1}{\sigma}.\left(\alpha_0 + \alpha_l.l_{it} + \alpha_k.k_{it}\right) + \frac{1}{\sigma}.q_t + \frac{\sigma - 1}{\sigma}.\omega_{it} + \underbrace{\frac{1}{\sigma}.(\xi_{it} - u_{it}) + u_{it}}_{\eta_{it}} \end{aligned} \tag{2.7}$$

where σ is the price elasticity of demand, q_t is aggregate demand (at the industry level), and ξ_{it} and u_{it} are demand and technology shocks respectively, which are uncorrelated to the other explanatory variables.

In the case of multi-product firms, we get[11]:

$$\begin{aligned} r_{it} = \frac{\sigma - 1}{\sigma}.\left(\alpha_0 + \alpha_l.l_{it} + \alpha_k.k_{it}\right) + \frac{1}{\sigma}.q_t \quad &+ \quad \frac{\sigma - 1}{\sigma}.\omega_{it} \\ &+ \quad \frac{\sigma - 1}{\sigma}.\left(\frac{1}{\sigma - 1} - (\gamma - 1)\right).div_{it} + \eta_{it} \end{aligned} \tag{2.8}$$

Equations 2.7 and 2.8 show that introducing aggregate output (at the industry level) q_t as an additional control in the TFP estimation procedure enables to estimate σ and hence all of the structural

[9] Note that on the contrary, southern technological shocks are not a source of endogeneity, but of identification in our setting.

[10] Bernard, Jensen and Schott [2006] or Bloom, Draca and Van Reenen [2010] take advantage of changes in tariffs or quotas to provide causal estimates in the same type of setting. However, a drawback of these instrumental variables is that they are only valid "locally" in time or for a limited subset of industries. Second, over our estimation period, changes in tariffs do not appear to be reasonably exogenous (they were most probably anticipated and prepared by French firms), as the first stage estimates show counter-intuitive correlations (see table 14 in the appendix).

[11] In the case of multi-product firms, we expect that $\frac{1}{\sigma-1} - (\gamma - 1) > 0$, otherwise a firm could produce the same output using fewer inputs by only producing one single variety. This quantity is reported in tables 11 and 12. Interestingly, we obtain positive and significant values in relatively low-tech industries (textile, clothing, shoe and leather, editing, metal work, furniture) except chemicals, which is a more "mixed" industry. We obtain negative and significant estimates in only two industries, which are relatively high-tech (computers and related; medical and optical instruments). These patterns are consistent with our findings that diversification is more attractive is relatively low-tech industries.

parameters of interest, in particular α_l, α_k and the physical productivity ω_{it}.
For the actual estimation, we classify each firm of the sample into its main 4-digit industry (defined in terms of sales) and we estimate the structural parameters required to compute TFPs at the 4 digit industry level[12].

This procedure only affects the way we estimate the plugged-in index ω_{it} in equation 2.3, but not the subsequent estimation procedure for this equation. It also enables to define two different indices of "efficiency", and to analyze their respective evolution for firms adopting different product portfolio strategies:

- "Physical TFP" corresponds to the previous index of technological efficiency ω_{it} in equations 2.4 to 2.6.
- "Revenue TFP" is an index of profitability which is defined as in Foster *et. al.* [2008] as physical productivity multiplied by prices:

$$\widehat{\omega}_{it}^R = \widehat{\omega}_{it} + \widehat{p}_{it} - p_t = r_{it} - \widehat{\alpha}_0 - \widehat{\alpha}_l.l_{it} - \widehat{\alpha}_k.k_{it}$$

In section 4.5, we simply regress the evolution of each of these indices on dummy variables indicating either (lagged) increases, or decreases, in diversification.

3 Data and Measurement

3.1 Data Sources

The empirical analysis is based on a very rich statistical information which was gathered from a variety of sources:

- First, we use a direct and comprehensive extraction from the information system of the French Custom Administration[13] in order to compute indicators of international competitive pressure.
- Second, standard accounting information such as value added, employment, capital, labor costs, and the main firm industry affiliation are sourced from exhaustive fiscal files (FICUS) covering virtually the entire population of French firms. These files are collected by the French fiscal administration and reformatted by the Statistical Institute.
- We use the Annual Survey of Manufacturing, in which the entire population of French manufacturing firms having more than 20 workers is sampled. With this data source, we recover the precise decomposition of each firm's sales at the 4 digit level[14].

[12] Appendix tables 11 and 12 describe the results obtained at the 2 digit level only (for a better readability).
[13] See Eaton *et al.* [2011] or Mélitz *et al.* [2011] for examples of analyses conducted using the same data.
[14] This is the same dataset as in Martin *et al.* [2011], but these authors use the plant level information, while we only use the firm-level breakdown of sales across activities. This explains the difference in the number of observations.

- Last, we incorporate complementary information about firms' R&D and patenting behavior using the annual R&D survey, several waves of the Innovation survey[15], and the exhaustive list of patent applications to the French National Patent Office. These files allow us to construct a representative sample of innovative *and* non-innovative firms over the 2000 to 2004 time periode, containing ca. 25% of the manufacturing firms having more than 20 employees.

The first three data sets are used in their exhaustive format in order to compute the penetration indices; these indicators are therefore very accurate. These two files are then matched to the other data sources using unique firm identifiers (SIREN codes) and the resulting dataset is our estimation sample. After basic cleanings (missing information in terms of the indicators of main interest, coding errors, exits and re-entries in files), we end up with a file covering the 2000 to 2004 period (with lagged information about 1999) and roughly 16% (instead of 25%) of the French manufacturing firms having more than 20 employees (for at least 2 years).

3.2 Measuring International Competition

3.2.1 Construction of the Penetration Indices

Our indicators of international competition are directly derived from Bernard, Jensen and Schott [2006]. First, countries are classified as low-cost, or "southern" if their GDP per capita is lower than 5% of the French GDP per capita[16]. Second, we compute the southern penetration indices at the industry level using the *exhaustive* custom files. Third, we then average these indices at the firm level using weights corresponding to the different (four digit) markets where the firm operates. The obtained indicator takes the following form:

$$PEN_{it}^{S} = \sum_{j} \omega_{ijt} \cdot \frac{M_{Fjt}^{S}}{M_{Fjt}^{S} + M_{Fjt}^{N} + Q_{Fjt} - X_{Fjt}} \tag{3.1}$$

where ω_{ijt} denotes the share of sales of firm i in sector j at year t. We refer to M_{Fjt}^{S} and M_{Fjt}^{N} as imports from developing and developed countries respectively (in terms of products j at time t), and to Q_{Fjt} and X_{Fjt} as domestic production and French exports[17], also measured in product segment j.
The northern penetration index is defined symmetrically as:

$$PEN_{it}^{N} = \sum_{j} \omega_{ijt} \cdot \frac{M_{Fjt}^{N}}{M_{Fjt}^{S} + M_{Fjt}^{N} + Q_{Fjt} - X_{Fjt}} \tag{3.2}$$

The two indices add up to the total penetration index of imports on the markets that are relevant for the considered firm.

[15]"Community Innovation Surveys" are conducted in each country of the European Union and are harmonized by Eurostat.
[16]Results are robust to the choice of alternative thresholds (e.g. 5% or 10%). The list of countries obtained in 2004 is reported in appendix A; on average over the 1999-2004 period, 73 countries (out of 161) are classified as low-wage countries.
[17]The denominator $M_{Fjt}^{S} + M_{Fjt}^{N} + Q_{Fjt} - X_{Fjt}$ corresponds to absorption in sector j.

These two variables have a firm level variation because of the weights used to aggregate the industry level penetration indices. However, it is useful to check that the obtained indicators are close to common wisdom when they are aggregated according to the firms' main activity[18]. Graph 2 depicts the average penetration indices experienced in 1999 by firms in the different manufacturing industries considered at an aggregate, 2-digit level[19]. Unsurprisingly, the southern import penetration index suggests that French firms operating in the rubber / tyres, clothing and furniture industries were most exposed to low-wage country competition; these industries are typically classified as "low-tech" by the OECD[20]. It is also worth noticing that the index of southern competition is overall much lower than the northern index, but also more differentiated across industries, which provides an interesting opportunity to empirically isolate the contribution of each of them in explaining firm level productive strategies across industries. Graph 3 shows that the increase in the southern penetration indices between 1999 and 2004 has been substantial in many industries, especially in medium to high-tech segments: "office machinery", "car and parts" or "electric and electronic components". In contrast, the variations in northern penetration indices were more limited over the same period. Graph 3 shows furthermore that there is no clear correlation pattern, at the industry level, between changes in northern and southern penetration indices, which also provides an interesting opportunity for identification in the time dimension.

3.2.2 Instrumental Variables for Penetration Indices

As previously explained is section 7, we propose to use distances as instrumental variables for the penetration indices presented above. These variables are computed as the average distance between France and its trading partners:

$$DIST\_IMP_{it}^{X} = \sum_{j} \omega_{ijt_0}.\left(\sum_{c} \frac{M_{Fj99}^{c}}{M_{Fj99}^{X}}.d_{cF}\right), \quad X = S, N \tag{3.3}$$

where c denotes countries, d_{cF} denotes the distance[21] in kilometers between France and country c, and $\frac{M_{Fj99}^{c}}{M_{Fj99}^{X}}$ denotes the share of imports accounted for by country c (for good j) in the total of French "southern" or "northern" imports. These weights are measured at the beginning of our estimation period (1999) and add up to one. The firm specific weights ω_{ijt_0} are measured in the first period where the considered firm enters our sample in order to avoid any endogeneity bias generated by their variation over time.

The second set of instrumental variables is constructed from exchange rates. Real exchange rates are nominal exchange rates (expressed in foreign currency per euro) that are adjusted for purchasing power

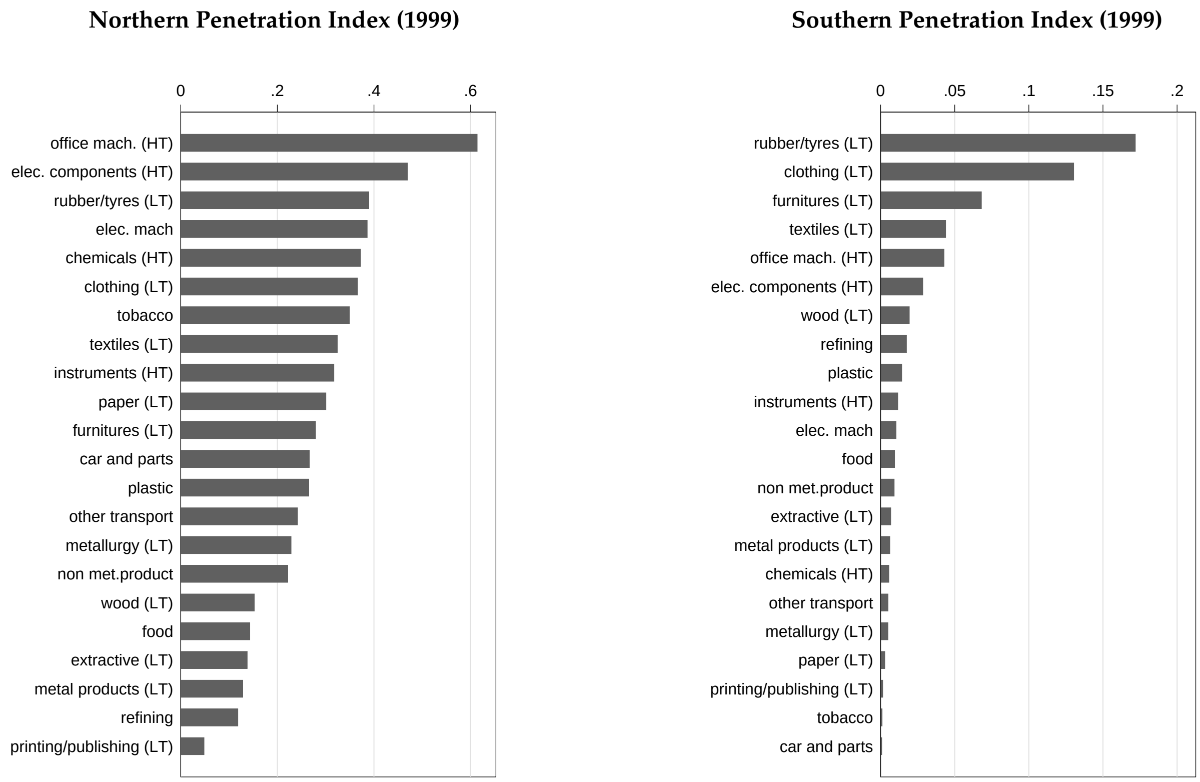
[18] Figures 2 and 3 present descriptive statistics aggregated at the 2-digit level, but our regression analyses are performed at the 4 digit level.

[19] Table 13 in Appendix C provides detailed sample statistics for these penetration indices, in particular standard deviations used below to comment the economic significance of our results.

[20] In graphics 2 and 3, we also report the information about the technological content of each 2 digit activity using the OECD classification [1997]. The remaining industries are typically "medium-high" or "medium-low" tech.

[21] The geographical information is taken from Mayer and Zignago [2006].

Figure 2: "Southern" and "Northern" Penetration Indices Across Firms' Main Industries



Note: These descriptive statistics relate to the year 1999 and are based on the average penetration indices experienced by the sample firms whose main activity belongs to the specified category.

parities, i.e. multiplied by the French consumer price index (CPI) and divided by the foreign country CPI. The information about exchange rates is sourced from the European Central Bank, while CPIs are gathered from the IMF website. Our final indicators of exchange rate take the following form:

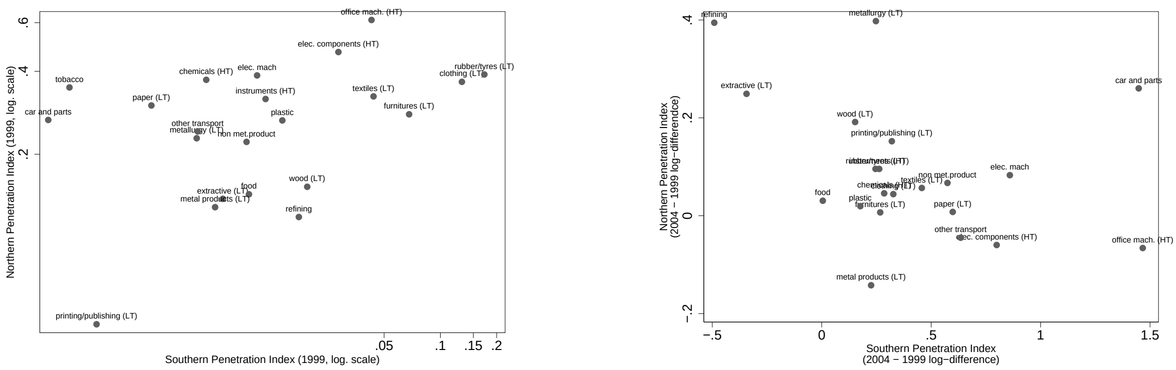
$$\Delta_t EXCH\_IMP_{it}^X = \Delta_t \sum_j \omega_{ijt_0} \cdot \left(\sum_c \frac{M_{Fj99}^c}{M_{Fj99}^X} . e_{cF} \cdot \frac{CPI_{Ft}}{CPI_{ct}} \right), \quad X = S, N \tag{3.4}$$

3.3 Describing Firms' Product Portfolios

We rely on the information about the decomposition of each firm's sales at the four digit level in order to track their product portfolio strategies. Our indicators are based on the (French / European) classification of activities (NACE) and not on the product classification constructed by the customs administration. This is an important aspect, since the main purpose of the classification constructed by the customs administration is to detect which traded product has to be taxed. The evolution of this classification reflects changes in tariffs and trade policy, which generates artificial product churning. In contrast, the classification of activities is much more stable over time because it was constructed by sta-

Figure 3: Comparison of the "Southern" and "Northern" Penetration Indices

Correlation of levels (1999) **Correlation of changes (99/04)**



Note: These descriptive statistics relate either to 1999 or to the 2004 - 1999 time difference and are based on the average penetration indices experienced by the sample firms whose main activity belongs to the specified category.

tistical institutes for purposes related to the measurement of production and growth in the short and long run. The classification at the 4-digit level provides a description of production in manufacturing industries in about 300 different classes.

Our main empirical indicator describes the diversification of a firm's production. Let $\omega_{ipt} = \frac{S_{ipt}}{\sum_j S_{ijt}}$ denote the share of sales in terms of product p in the total turnover of firm i in year t. The indicator of diversification is defined as the inverse of the Herfindahl concentration index of firms' sales:

$$DIV_{it} = \left(\sum_p \omega_{ipt}^2 \right)^{-1} \in [1; +\infty[\tag{3.5}$$

We take the inverse of the Herfindahl index in order to obtain a variable which is easier to interpret since it has the same dimension as a simple count of activities at the 4 digit level: in the case where all shares are equal, DIV_{it} coincides with the number of 4-digit activities of the firm.

We follow Bernard, Redding and Schott [2010] and complement this first synthetic indicator with indicators of *gross* product entries and exits, which are simply dummy variables indicating whether the considered firm has introduced at least one new product in its portfolio between years $t-2$ and t, or symmetrically whether it has removed at least one:

$$ADD_{it} = \mathbf{1}\{ \sum_{p/\omega_{ipt-2}=0} \omega_{ipt} > 0 \} \tag{3.6}$$

$$DROP_{it} = \mathbf{1}\{ \sum_{p/\omega_{ipt}=0} \omega_{ipt-2} > 0 \} \tag{3.7}$$

The “intensive” versions describing the share of sales represented by either new, or discarded products are also considered in a robustness check:

$$ADD\_I_{it} = \sum_{p/\omega_{ipt-2}=0} \omega_{ipt} > 0 \quad (3.8)$$

$$DROP\_I_{it} = \sum_{p/\omega_{ipt}=0} \omega_{ipt-2} > 0 \quad (3.9)$$

Descriptive statistics are reported in table 1. They show that firms which are most exposed to the international competitive pressure have a higher rate of product churning, both in terms of product adding and dropping. The contrast between highly and weakly exposed firms is more pronounced for northern than for southern competition. However, in “net” terms, firms exposed to southern competitive pressure choose more often to increase diversification than firms exposed to northern competition.

3.4 Measures of Firms' Innovative Effort and Further Control Variables

All of the previous indicators rely heavily on the existing classifications of activities (which we equate to products). They are therefore inadequate to measure "genuine" (new to market) product innovation, when it occurs. We use three additional indicators in order to capture this additional dimension. The innovative effort of the firms in our sample can first be approximated by their effort of research and development (R&D) [22]. We also use the count of patent applications to the French National Patent Office (INPI) in order to assess whether firms have launched *and protected* new products on to the market over the estimation period. The main limit of patent - based indicators of innovation is that they only capture a small proportion of all innovations introduced by firms, in particular in low-tech industries where patenting propensity is low, but southern competition high and evolving rapidly. Note however that we use information about national (French) patents, which are typically more accessible and less costly for French firms than EPO[23] patents.

Lastly, we also use a variety of standard firm level controls such as employment, capital intensity and the Herfindahl index measuring the average concentration on the firm's domestic markets (at the four-digit level).

[22]This indicator is preferred to the “qualitative” indicators available from the Innovation (CIS) surveys because of his yearly availability over the 1999-2004 period, and for his (often argued) higher “objectivity”: accounting information is often more reliable than subjective and self-assessed innovative performances.

[23]EPO: European Patent Office.

Table 1: Sample descriptive statistics

Sample:	Full	High South	Low South	High North	Low North
		Exposure		Exposure	
Description of the product portfolio (t, 4 dig.)					
Diversification (# activities)	1.155	1.207	1.104	1.175	1.136
Dynamics of product portfolio ($t/t-2$, 4 dig.)					
Product adding (dummy)	0.076	0.081	0.072	0.101	0.052
Share of added products	0.034	0.036	0.032	0.051	0.016
Product dropping (dummy)	0.100	0.114	0.086	0.132	0.069
Share of dropped products	0.033	0.036	0.030	0.052	0.014
Increase in diversification (dummy)	0.140	0.159	0.120	0.156	0.123
Indicators of innovation					
R&D expenditures	4 333	4 044	4 612	5 111	3 547
National (INPI) patents	0.961	1.013	0.906	1.186	0.733
Measures of international competition					
Northern penetration	0.284	0.372	0.197	0.424	0.144
Southern penetration	0.029	0.056	0.002	0.045	0.013
Average distance of North. imports (km)	1884	2097	1671	2218	1553
Average distance of South. imports (km)	7769	8012	7526	7992	7548
Annual growth of exchange rate, North	0.008	0.009	0.007	0.012	0.004
Annual growth of exchange rate, South	0.048	0.051	0.044	0.045	0.050
Additional Control variables					
Employment	346	369	323	414	279
Capital intensity	128	186	71	73	183
Physical TFP (estimated)	0.549	0.560	0.538	0.633	0.465
Revnue TFP (estimated)	1.269	1.197	1.340	1.394	1.144
Herfindahl index of domestic market conc.	0.107	0.103	0.111	0.083	0.131
Observations	15592	7766	7826	7796	7796

Note: French manufacturing firms over the 1999 to 2004 period, except for the indicators describing the dynamics of product portfolios, which are available for the 2000/2002 and 2002/2004 periods. All remaining indicators are available on a yearly basis, and all amounts are expressed in thousand euros. In the "High-tech" sub-sample, we excluded firms belonging to the low-tech industries (as defined in Hatzichronoglou [1997]). In the "Low-tech" sub-sample, we excluded firms belonging to the high-tech industries.

4 Results

4.1 International Competition and Product Portfolio Strategies

Table 2 contains our main estimation results: columns (1) to (3) correspond to estimates obtained from specifications 2.4 to 2.6 on our entire sample of manufacturing firms, while columns (4) to (7) contain the results obtained with specifications 2.4 and 2.6 on the sub-samples of firms in medium to "high-tech" or medium to "low-tech"[24] industries respectively.

The baseline specification in column (1) provides our main empirical result: on average, firms adopt contrasting strategies in response to southern vs. northern competitive pressure. More precisely, firms tend to re-focus their product portfolio when market penetration by their "northern" competitors is high, and when there are many players on the domestic market (i.e. when the HHI index of domestic competition is low). In contrast, a high southern competitive pressure is associated with an increase in diversification.

Lagged size and diversification are the two additional state variables that are significant: unsurprisingly, our results show that a larger size is associated with more diversification on average, whereas firms tend to re-focus their product portfolio when they were previously excessively diversified. Column (2) shows that on average this pattern is not amplified by firm productivity, whereas column (3) investigate the potential non-linearities in the relation between international competition and diversification using a set of dummy variables indicating the various quantiles for the penetration indices. The pattern appears to be slightly non-linear in the case of the southern index, while the northern index is no longer significant in this pooled sample.

We further investigate this aspect in columns (4) to (7) and show that a more detailed analysis at the industry level actually solves the problem of instability. Using more homogenous samples in terms of (productive) technologies, we obtain more clear-cut patterns. More productive firms tend to be significantly more diversified in high-tech as well as in low-tech industries. In terms of response to the international competition[25], the obtained response patterns are differentiated across industries. Firms in high-tech industries tend to refocus significantly their product portfolio when they face an intense competition from their northern competitors: the associated difference is a shortening of the product line by 11.4 percentage point. The same firms react in the opposite way and more linearly to the southern competitive pressure. In contrast, firms in low-tech industries tend to respond to tougher international competition (both southern and northern) more consistently by increases in diversification, but interestingly the associated marginal effects are significantly smaller than for high-tech industries.

[24] We use the sectoral definition proposed by the OECD in Hatzichronoglou [1997].

[25] Quantiles of the penetration index were computed on the pooled sample, which implies that few firms in high-tech industries actually face an intense southern competition (4th quantile of the penetration index). Conversely, few firms in low-tech industries actually face an intense northern competition.

Table 2: International Competition and Diversification Strategies ($t/t-1$)

Dependent variable:	Full sample			"High-tech"		"Low-tech"	
Δ ln Div.$_{t/t-1}$	(1)	(2)	(3)	(4)	(5)	(6)	(7)
ln Employment$_{t-1}$	0.0151***	0.0150***	0.0154***	0.0177***	0.0173***	0.0145***	0.0150***
	(0.001)	(0.001)	(0.001)	(0.002)	(0.002)	(0.002)	(0.002)
ln (Capital/Emp)$_{t-1}$	0.0016	0.0016	0.0013	0.0022	0.0021	0.0007	0.0003
	(0.001)	(0.001)	(0.001)	(0.002)	(0.002)	(0.002)	(0.001)
ln Herfindahl$_{t-1}$	-0.0267***	-0.0274***	-0.0264***	-0.0252***	-0.0238***	-0.0241***	-0.0244***
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
ln Diversification$_{t-1}$	-0.4474***	-0.4470***	-0.4451***	-0.4948***	-0.5029***	-0.4214***	-0.4157***
	(0.009)	(0.009)	(0.009)	(0.011)	(0.011)	(0.010)	(0.010)
ln TFP$_{t-1}$	0.0016	0.0027*	0.0019*	0.0052***	0.0050***	0.0025**	0.0030***
	(0.001)	(0.001)	(0.001)	(0.002)	(0.002)	(0.001)	(0.001)
ln North pen.$_{t-1}$	-0.0315***	-0.0307***		-0.0572***		-0.0296***	
	(0.007)	(0.007)		(0.011)		(0.007)	
ln South pen.$_{t-1}$	0.0465***	0.0464***		0.0579***		0.0440***	
	(0.005)	(0.005)		(0.006)		(0.005)	
ln North pen.$_{t-1}$ $\times$ ln TFP$_{t-1}$		0.0020					
		(0.001)					
ln South pen.$_{t-1}$ $\times$ ln TFP$_{t-1}$		-0.0012					
		(0.001)					
North pen.$_{t-1}$, 2nd quartile			0.0410**		-0.0125		0.0464***
			(0.018)		(0.015)		(0.017)
North pen.$_{t-1}$, 3rd quartile			0.0342*		-0.0080		0.0383*
			(0.020)		(0.018)		(0.022)
North pen.$_{t-1}$, 4th quartile			0.0223		-0.1140***		0.0481**
			(0.021)		(0.021)		(0.023)
South pen.$_{t-1}$, 2nd quartile			0.0927***		0.1465***		0.0690***
			(0.009)		(0.014)		(0.009)
South pen.$_{t-1}$, 3rd quartile			0.1288***		0.1785***		0.0919***
			(0.013)		(0.017)		(0.014)
South pen.$_{t-1}$, 4th quartile			0.1216***		0.2155***		0.0855***
			(0.018)		(0.022)		(0.020)
Observations	15,593	15,593	15,593	10,700	10,700	13,612	13,612

Note: Robust standard errors in parentheses with *** , ** and * respectively denoting significance at the 1%, 5% and 10% levels. The estimation period is 2000 to 2004. All equations include year and industry 3 dig. fixed effects. In the “High-tech” sub-sample, we excluded firms belonging to the low-tech industries (as defined in Hatzichronoglou [1997]). In the “Low-tech” sub-sample, we excluded firms belonging to the high-tech industries.

In table 3, we further investigate the dynamics of product portfolios using a variety of additional indicators, over a somewhat longer (2 year) period of time.

In columns (1) and (2), we separately investigate the probabilities that firms respectively diversify, or refocus their productive profiles. An interesting pattern emerges: we show that the overall positive correlation between diversification and southern competition is mainly driven by firms facing moderate southern competitive pressure since only the first quantiles of the southern penetration index significatively correlate with increases in diversification. Column (2) shows furthermore that the sub-population of firms facing the most intense southern competition actually choose to re-focus instead of diversify. This non-linearity is consistent with the hypothesis that increases in diversification are likely to be "active" responses to globalization ("à la" Thoenig and Verdier [2003]), whereas in contrast, decreases in the length of the product portfolios might rather be "passive" consequences of an excessively intense southern competition, with French firms being outperformed and ultimately crowded out of their markets by their southern competitors.

In columns (3) to (6), we look at the gross entries and exits of products. We obtain that more productive firms tend to adjust significatively more often their product portfolio on the extensive margin, with simultaneously more frequent product adding *and* dropping. Furthermore, the non-linearity with respect to the southern competitive pressure is still present in terms of our indicators of gross product introduction and gross product removal. While firms facing a moderate southern competitive pressure do launch *and* remove products more often (with a net impact on diversification which is positive), those facing a very intense southern competitive pressure stop experimenting with new products (they have a significantly lower probability to add product to their portfolios, with a net negative impact on diversification).

We replicate these analyses by high-tech *vs.* low-tech industries in table 4. Interestingly, we show that the previous non-linear pattern is driven by high-tech industries, where mild southern competitive pressure is associated with more frequent product adding, while intense northern competitive pressure is associated with tougher product selection within firms. Note that this last finding (with respect to the northern penetration index) is in particular consistent with the previous findings of Bernard, Redding and Schott [2011].

Table 3: International Competition and Product Portfolio Strategies ($t/t-2$)

Dependent variable:	Increase in Div. (1)	Decrease in Div. (2)	Product Adding (3)	Product Dropping (4)	Share Prod. Adding (5)	Share Prod. Dropping (6)
ln Employment$_{t-2}$	0.026***	0.022***	0.007*	0.014***	-0.005***	-0.006***
	(0.005)	(0.005)	(0.004)	(0.004)	(0.002)	(0.002)
ln (Capital/VA)$_{t-2}$	0.002	-0.002	-0.002	0.001	0.001	0.001
	(0.005)	(0.006)	(0.004)	(0.004)	(0.002)	(0.002)
ln Herfindahl$_{t-2}$	-0.007	-0.012	0.008	-0.005	0.005	0.000
	(0.009)	(0.010)	(0.006)	(0.006)	(0.004)	(0.003)
ln Diversification$_{t-2}$	0.243***	0.489***	0.052***	0.168***	-0.004	0.026***
	(0.024)	(0.025)	(0.017)	(0.020)	(0.009)	(0.009)
ln TFP$_{t-2}$	0.000	0.005	0.006***	0.009***	0.003***	0.003***
	(0.004)	(0.004)	(0.002)	(0.002)	(0.001)	(0.001)
North pen.$_{t-2}$, 2nd quartile	0.083	0.063	0.022	-0.010	0.026**	0.016
	(0.087)	(0.077)	(0.022)	(0.025)	(0.013)	(0.012)
North pen.$_{t-2}$, 3rd quartile	0.025	0.094	0.029	0.002	0.032**	0.025*
	(0.095)	(0.082)	(0.023)	(0.026)	(0.015)	(0.014)
North pen.$_{t-2}$, 4th quartile	0.059	0.008	0.054**	0.027	0.057***	0.051***
	(0.104)	(0.092)	(0.028)	(0.030)	(0.018)	(0.017)
South pen.$_{t-2}$, 2nd quartile	0.114***	0.082**	0.036***	0.042***	0.025***	0.028***
	(0.038)	(0.041)	(0.014)	(0.016)	(0.008)	(0.007)
South pen.$_{t-2}$, 3rd quartile	0.105**	0.145**	-0.027	0.012	-0.019*	-0.007
	(0.053)	(0.057)	(0.018)	(0.021)	(0.010)	(0.009)
South pen.$_{t-2}$, 4th quartile	0.084	0.249***	-0.049**	-0.006	-0.048***	-0.042***
	(0.070)	(0.076)	(0.024)	(0.027)	(0.015)	(0.014)
Observations	4443	4443	4443	4443	4443	4443

Note: Robust standard errors in parentheses with *** , ** and * respectively denoting significance at the 1%, 5% and 10% levels. The estimation period is 2000/2002 and 2002/2004. All equations include year and industry 3 dig. fixed effects.

Table 4: International Competition and Product Portfolio Strategies, Analysis by Industry

Sub-sample:	"High-tech"				"Low-tech"			
Dependent variable:	Inc. Div.	Dec. Div.	New Prod.	Drop Prod.	Inc. Div.	Dec. Div.	New Prod.	Drop Prod.
Mean (dummies):	0.15	0.20	0.09	0.12	0.14	0.20	0.07	0.10
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
ln Employment$_{t-2}$	0.024***	0.020***	0.008*	0.014***	0.026***	0.019***	0.008**	0.015***
	(0.006)	(0.006)	(0.004)	(0.005)	(0.006)	(0.006)	(0.004)	(0.004)
ln (Capital/VA)$_{t-2}$	0.008	-0.004	-0.002	0.001	-0.001	-0.001	-0.007	-0.001
	(0.006)	(0.007)	(0.006)	(0.006)	(0.006)	(0.006)	(0.005)	(0.005)
ln Herfindahl$_{t-2}$	-0.003	0.002	0.006	-0.005	-0.004	-0.012	0.007	-0.005
	(0.012)	(0.012)	(0.008)	(0.009)	(0.010)	(0.010)	(0.006)	(0.007)
ln Diversification$_{t-2}$	0.210***	0.436***	0.059***	0.186***	0.243***	0.513***	0.065***	0.157***
	(0.028)	(0.029)	(0.020)	(0.024)	(0.026)	(0.027)	(0.018)	(0.021)
ln TFP$_{t-2}$	-0.001	0.004	0.008***	0.012***	-0.001	0.005	0.004**	0.008***
	(0.005)	(0.006)	(0.003)	(0.002)	(0.004)	(0.004)	(0.002)	(0.002)
North pen.$_{t-2}$, 2nd quartile	0.022	-0.004	-0.006	0.004	0.024	0.072	0.018	-0.002
	(0.065)	(0.055)	(0.020)	(0.021)	(0.077)	(0.081)	(0.022)	(0.026)
North pen.$_{t-2}$, 3rd quartile	0.000	0.043	0.016	0.052**	-0.048	0.198**	0.018	-0.008
	(0.076)	(0.066)	(0.021)	(0.023)	(0.102)	(0.098)	(0.026)	(0.029)
North pen.$_{t-2}$, 4th quartile	-0.061	0.158**	0.025	0.056**	0.004	0.128	0.039	0.009
	(0.085)	(0.077)	(0.025)	(0.027)	(0.109)	(0.104)	(0.031)	(0.034)
South pen.$_{t-2}$, 2nd quartile	0.212***	0.060	0.044**	0.022	0.177***	0.029	0.087***	0.083***
	(0.052)	(0.047)	(0.018)	(0.020)	(0.045)	(0.048)	(0.019)	(0.022)
South pen.$_{t-2}$, 3rd quartile	0.220***	0.109*	-0.012	-0.006	0.186***	0.117*	-0.011	0.027
	(0.064)	(0.061)	(0.019)	(0.020)	(0.064)	(0.067)	(0.020)	(0.023)
South pen.$_{t-2}$, 4th quartile	0.281***	0.234***	-0.061***	-0.036	0.201**	0.112	-0.007	0.020
	(0.078)	(0.075)	(0.023)	(0.026)	(0.082)	(0.084)	(0.026)	(0.030)
Observations	3217	3217	3217	3217	3811	3811	3811	3811

Note: Standard errors in parentheses with *** , ** and * respectively denoting significance at the 1%, 5% and 10% levels. In the "High-tech" sub-sample, we excluded firms belonging to the low-tech industries (as defined in Hatzichronoglou [1997]). In the "Low-tech" sub-sample, we excluded firms belonging to the high-tech industries. "Inc. Div." stands for "Increase in Diversification" while "Dec. Div." stands for "Decrease in Diversification" (both are dummy variables). All equations include year and industry 3 dig. fixed effects.

4.2 Economic Magnitudes

It is useful to assess the economic significance of these patterns. On average, in our baseline specification (column 1 in table 2), a one standard deviation[26] increase in the southern penetration index from the sample average is associated with an increase in diversification by 4.9 percentage point. Since the average is 1.155 (4-digit) products per firm, this corresponds to an additional 0.06 product. In high-tech industries, a similar experiment leads to an additional 0.07 product, because the estimated marginal effect is larger, but the standard deviation of the southern penetration index is smaller. In low-tech industries, this leads to an additional 0.05 product. Conversely, "refocusing" in high-tech industries induces firms facing a one-standard deviation higher northern penetration index to reduce the scope of their productive profile by 0.03 product.

A further back of the enveloppe calculation enables to compare the magnitude of these within-firm productive reallocations to the between-firm reallocations which have been previously investigated in the literature.

In terms of between-firm reallocations, Bernard, Jensen and Schott [2006] report that a one standard deviation increase in the southern penetration index is associated with a 2.2 percentage point increase in the probability of death within a 5 year period[27]. Assume for the sake of the comparison that all firms produce slightly differentiated varieties of goods as in De Loecker [2011]. Then we can convert this quantity into a number of "destructed " varieties over a five year period:

$$2.2 \text{ percentage point } \times 1.155 \text{ product per firm } \times N \approx 0.025 \times N$$

where N denotes the total number of firms.

In terms of within-firm reallocations, our results show that a one standard deviation increase in the Southern penetration index is associated with a 4.9 percentage point increase in diversification *from one year to the other*. Assuming that this productive reallocation process is stable over time and has the characteristics of a poisson process, we can convert this result into a 4.9×5 percentage point increase in diversification *over a five year period*. Lastly, we can compute the number of new varieties created over a five year period as:

$$4.9 \text{ percentage point } \times 5 \times 1.155 \text{ product per firm } \times N \approx 0.28 \times N$$

This comparison is obviously subject to very strong hypotheses; its main purpose is however simply to show that the reallocations of production driven by the southern competitive pressure *within* firms seems to be (at least) equally relevant to the reallocations that are induced *between* firms, in terms of their economic significance and potential contribution to aggregate reallocations of production.

[26]Standard deviations are reported in appendix C. The reported magnitude in percentage points corresponds to the following computation: $0.049 \approx 0.047 \times (\ln(0.029 + 0.053) - \ln(0.029))$.

[27]The authors actually look at plant death rather than firm death, but our comparison is therefore very conservative.

4.3 More Evidence about Induced Product Innovation?

An important limit of the previous analysis is that it heavily relies on the existing classification of activities and products. However, new products, when introduced by a firm, seldom appear instantaneously as a new item in the classification system defined by the National Institute of Statistics. We therefore propose an extension of our analysis based on alternative indicators, in orer to investigate whether the previously described within-firm productive reallocations were also associated with product innovations and innovative activities at the firm level. There is a large literature on the effect of competition on innovation; theoretical predictions are however mixed. For example, Bloom et al [2005] underline two effects going in opposite directions: the replacement effect and the escape competition effect. Empirically, Bloom *et al.* [2010] provide evidence that the Chinese competitive pressure fostered IT investment on the part of European firms while Bustos [2011] also provides evidence of a positive correlation between globalization and "spendings in technology" or "improvements in products and production processes" at the (Argentinean) firm level. However, not much is known about the impact of globalization on product (as opposed to process) innovations. We provide a few new insights by investigating the relationships between international competitive pressure and two measures of innovative efforts at the firm level: patents (see also Bloom *et al.* [2010]) and R&D expenditures. The literature has shown that patents are an indicator of innovation which is biased towards product innovation (e.g. Cohen *et. al.* [2000]) while R&D effort might be directed more evenly towards product and process innovation; we will interpret our results in this light.

Table 5 provides the results for the estimation of the correlation between international competition and firm level R&D effort, both on the extensive (R&D participation, col. (1) to (3)) and intensive (R&D intensity, col. (4) and (5)) margins.
We obtain that the probability to be involved in R&D activities increases with southern competition in our main specification (col. 1). Furthermore, we obtain in col. 2 that more productive firms facing intense southern competition are more often involved in R&D activities than their less productive domestic competitors. The underlying magnitudes are large: in column 1, a one standard deviation increase in the southern penetration index is associated to an increase of 2.3 percentage point in the probability of being involved in R&D activities. For firms having a one-standard deviation higher productivity than the industry average (col. 3), we obtain a 2.9 percentage point increase.

In terms of the northern penetration index, the lack of significance in the linear specification reported in column 1 hides a non-linear pattern which emerges in column 4, with intermediate levels of competitive pressure associated to more frequent R&D activities. The interaction term between firm level productivity and the northern penetration index is positive and highly significant, with an associated marginal effect at the sample mean which is twice as large as in the southern case.

Overall, the same patterns emerge in columns 4 and 5 for R&D intensity (rather than R&D participation), but the interaction term between penetration indices and productivity are no longer significant. Last, looking at patent applications in columns 6 and 7, we obtain a positive coefficient for the southern penetration index, and for the interaction between northern penetration and productivity, but these marginal effects are only weakly significant, and very low in magnitude[28].

The analysis by industry performed in table 6 confirms the previous results. In high-tech industries, R&D activities are prevalent and the indicator of northern competition turns out to be insignificant. However, the importance of productivity as a determinant of innovative effort is amplified, and the entry of new southern competitors seems to have fostered R&D effort in these industries. In the subsample of firms belonging to low-tech industries (column 4), both the southern and northern penetration indices turn out to be significant, but the marginal effect associated to the former is larger.

Overall, these patterns only loosely replicate the findings obtained with our indicators of introduction of new products in firms' productive portfolios. This indicates that the underlying R&D efforts are most likely directed towards both product but also process innovations. It is difficult to assert that most of the observed productive reallocations described in section 4.1 were actually, or most often associated with technological innovation or genuine, "new to market" product innovation.

[28]The associated orders of magnitude are the following: starting from the sample average, an additional standard deviation in the penetration index is associated to less than 0.002 more patent application(s). The interaction between northern penetration and productivity is associated to a 3.10E-4 increase...

Table 5: International Competition and Innovative Effort

Dependent variable:	R&D dummy			ln R&D exp.		Patents	
Mean:	0.38			2.73		0.51	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
ln Employment$_{t-1}$	0.119***	0.118***	0.119***	1.092***	1.073***	0.813***	0.498***
	(0.002)	(0.002)	(0.002)	(0.020)	(0.019)	(0.062)	(0.037)
ln (Capital/VA)$_{t-1}$	0.035***	0.036***	0.035***	0.229***	0.224***	0.398***	0.242***
	(0.003)	(0.003)	(0.003)	(0.017)	(0.017)	(0.060)	(0.036)
ln Herfindahl$_{t-1}$	0.023***	0.017***	0.022***	0.145***	0.133***	-0.067	-0.046
	(0.005)	(0.005)	(0.005)	(0.023)	(0.023)	(0.054)	(0.034)
ln Diversification$_{t-1}$	0.013	0.016	0.014	-0.288***	-0.285***	0.006	0.002
	(0.011)	(0.011)	(0.011)	(0.050)	(0.049)	(0.010)	(0.064)
ln TFP$_{t-1}$	0.018***	0.030***	0.017***	0.164***	0.186***	0.176***	0.107***
	(0.002)	(0.002)	(0.002)	(0.015)	(0.017)	(0.053)	(0.031)
ln North pen.$_{t-1}$	-0.017*	-0.006	-	-0.043	-0.019	-0.082	-0.004
	(0.010)	(0.010)		(0.046)	(0.047)	(0.111)	(0.074)
ln South pen.$_{t-1}$	0.022***	0.023***	-	0.087***	0.088***	0.154*	0.096*
	(0.007)	(0.007)		(0.033)	(0.033)	(0.079)	(0.050)
ln North pen.$_{t-1}$ × ln TFP$_{t-1}$	-	0.013***	-	-	0.033**	-	0.045*
		(0.002)			(0.015)		(0.027)
ln South pen.$_{t-1}$ × ln TFP$_{t-1}$	-	0.006***	-	-	-0.011	-	-0.016
		(0.001)			(0.013)		(0.023)
North pen.$_{t-1}$, 2nd quartile	-	-	0.077***	-	-	-	-
			(0.019)				
North pen.$_{t-1}$, 3rd quartile	-	-	0.081***	-	-	-	-
			(0.024)				
North pen.$_{t-1}$, 4th quartile	-	-	0.058**	-	-	-	-
			(0.027)				
South pen.$_{t-1}$, 2nd quartile	-	-	0.058***	-	-	-	-
			(0.012)				
South pen.$_{t-1}$, 3rd quartile	-	-	0.033*	-	-	-	-
			(0.018)				
South pen.$_{t-1}$, 4th quartile	-	-	0.058**	-	-	-	-
			(0.025)				
Observations	16172	16172	16172	16172	16172	16123	16123
Estimation method	Probit (ME)	Probit (ME)	Probit (ME)	Tobit		Neg. bin. MLE (ME)	

Note: Robust standard errors in parentheses with *** , ** and * respectively denoting significance at the 1%, 5% and 10% levels. The estimation period is 2000 to 2004. All equations include year and industry 3 dig. fixed effects. In columns (1), (3) and (4), marginal effects computed from Probit MLE have been reported. In columns (6) and (7), marginal effects multiplied by 100 are reported.

Table 6: International Competition and R&D Participation, Analysis by Industry

Sub-sample:	"High-tech"		"Low-tech"	
Mean:	0.49		0.33	
	(1)	(2)	(3)	(4)
ln Employment$_{t-1}$	0.118***	0.118***	0.127***	0.127***
	(0.003)	(0.003)	(0.003)	(0.003)
ln (Capital/VA)$_{t-1}$	0.039***	0.039***	0.034***	0.034***
	(0.004)	(0.004)	(0.003)	(0.003)
ln Herfindahl$_{t-1}$	0.016***	0.018***	0.024***	0.023***
	(0.006)	(0.006)	(0.005)	(0.005)
ln Diversification$_{t-1}$	0.019	0.020	0.021*	0.021*
	(0.013)	(0.013)	(0.012)	(0.012)
ln TFP$_{t-1}$	0.043***	0.042***	0.015***	0.014***
	(0.003)	(0.003)	(0.002)	(0.002)
ln North pen.$_{t-1}$	0.001*	-0.003	-0.025	
	(0.013)	(0.015)	(0.019)	
ln South pen.$_{t-1}$	0.020***	0.021***	0.022***	
	(0.007)	(0.007)	(0.007)	
North pen.$_{t-1}$, 2nd quartile		0.042*		0.053**
		(0.022)		(0.027)
North pen.$_{t-1}$, 3rd quartile		0.039		0.109***
		(0.027)		(0.030)
North pen.$_{t-1}$, 4th quartile		0.001		0.072**
		(0.031)		(0.033)
South pen.$_{t-1}$, 2nd quartile		0.074***		0.041***
		(0.015)		(0.011)
South pen.$_{t-1}$, 3rd quartile		0.044**		0.019
		(0.021)		(0.020)
South pen.$_{t-1}$, 4th quartile		0.018		0.048*
		(0.026)		(0.027)
Observations	11213	11213	14158	14158

Note: Robust standard errors in parentheses with *** , ** and * respectively denoting significance at the 1%, 5% and 10% levels. In the "High-tech" sub-sample, we excluded firms belonging to the low-tech industries (as defined in Hatzichronoglou [1997]). In the "Low-tech" sub-sample, we excluded firms belonging to the high-tech industries. All equations include year and industry 3 dig. fixed effects.

4.4 Robustness Check: IV Evidence

In table 7, we address the potential endogeneity of penetration indices and report results obtained using instrumental variable strategies for our baseline specification reported in table 2.

In columns 1 and 2, we report the first stages for each of the penetration indices[29]. The best case corresponds to the southern penetration index: we obtain that market penetration by low-cost country competitors is negatively (but non-significantly) correlated with average distance between French producers and their southern competitors, but positively and significantly correlated with the average distance of their northern competitors, which is as expected if northern and southern competitors compete on the French market. The southern penetration index is also positively correlated with the exchange rate between the euro and the average southern currency. This is as expected since this corresponds to the case where the Euro can be converted into a higher amount of foreign currency, and therefore to a higher competitiveness of southern countries as compared to France. In terms of the northern penetration index, we obtain a positive correlation with the average distance of southern competitors, as expected, but also with the average distance of northern competitors, which is more difficult to interpret. The obtained coefficient is however lower than for the southern penetration index. The northern penetration index is also significantly and negatively correlated with the growth of the average southern exchange rate. This correlation is as expected since it corresponds to the case where southern competitors become less competitive than northern (or domestic) competitors on the French market.

Columns 3 to 5 contain the 2SLS estimates in the pooled, "high-tech" and "low-tech" samples respectively. The northern penetration index is insignificant and incorrectly signed, but the results of table 2 are preserved with respect to the southern penetration index: a high southern competitive pressure remains significantly associated with an increase in diversification, with the same magnitudes as previously.

In table 8, we replicate the analysis of tables 3 and 4, which relied on a richer set of indicators, but we use the same IV strategy as in table 7. Unfortunately, we do not have enough instrumental variables to investigate the potentially non-linear relations between penetration indices and product portfolio strategies, so that we have to keep the same linear specification as in table 7. In columns 1 to 3, we show that the contrasted pattern of correlations with respect to southern and northern penetrations indices is preserved in the specification where the dependent variable is simply a dummy indicating increases in diversification. In terms of the indicator of product introduction, the non-linear pattern with respect to the southern penetration index in table 3 ends up in a negative, but only weakly significant correlation in the IV specification (columns 4 to 6 in table 8). Northern competitive pressure remains significantly correlated to both product adding and product dropping in the sample of high-tech industries. As in table 4, the obtained coefficient for product dropping is higher than for product adding, which conforts

[29] We report in appendix D the results obtained for a wider range of candidates as IVs. Changes in tariffs are often considered in the literature but turn out to be too weak in the case of the northern penetration index, and incorrectly signed, and therefore highly suspected of endogeneity in the case of the southern index. This might be explained by the fact that over the considered time period, the French/European administration decided upon tariffs specifically in order to protect the domestic activities against low-cost country competition.

Table 7: Instrumenting Penetration Indices

	First stages		Δ ln Div.$_{t/t-1}$		
	ln North Pen. (2)	ln South Pen. (1)	Pooled sample (3)	High-Tech (4)	Low-Tech (5)
ln Employment$_{t-1}$	-0.0016	0.0092**	0.0145***	0.0177***	0.0132***
	(0.002)	(0.004)	(0.002)	(0.002)	(0.002)
ln (Capital/Emp)$_{t-1}$	0.0016	-0.0011	0.0009	0.0028	-0.0003
	(0.002)	(0.004)	(0.001)	(0.002)	(0.002)
ln Herfindahl$_{t-1}$	0.0433***	0.0542***	-0.0322***	-0.0337***	-0.0312***
	(0.005)	(0.009)	(0.004)	(0.004)	(0.004)
ln Diversification$_{t-1}$	0.0292***	0.2270***	-0.4528***	-0.4967***	-0.4265***
	(0.009)	(0.019)	(0.010)	(0.012)	(0.011)
ln TFP$_{t-1}$	0.0080**	0.0158***	0.0014	0.0040**	0.0027
	(0.003)	(0.006)	(0.002)	(0.002)	(0.002)
ln North pen.$_{t-1}$			0.0497	0.0907	0.0787
			(0.062)	(0.082)	(0.077)
ln South pen.$_{t-1}$			0.0623***	0.0642***	0.0581**
			(0.020)	(0.021)	(0.026)
Av. Dist. North	0.4175***	1.3618***			
	(0.049)	(0.103)			
Av. Dist. South	0.2822***	-0.0155			
	(0.068)	(0.185)			
Weighted av. growth of exchange rate,	-0.0064	-0.1247			
North	(0.134)	(0.219)			
Weighted av. growth of exchange rate,	-0.2863**	0.0072			
South	(0.138)	(0.324)			
Weighted av. exchange rate,	0.0852	0.2015			
North	(0.127)	(0.202)			
Weighted av. exchange rate,	-0.0105	5.0708***			
South	(0.177)	(0.454)			
Observations	14,275	14,275	14,275	10,300	12,434

Note: Robust standard errors in parentheses with *** , ** and * respectively denoting significance at the 1%, 5% and 10% levels. All equations include year and industry 3 dig. fixed effects. In the "High-tech" sub-sample, we excluded firms belonging to the low-tech industries (as defined in Hatzichronoglou [1997]). In the "Low-tech" sub-sample, we excluded firms belonging to the high-tech industries.

our previous result about refocusing in this case.

Table 8: Instrumenting Penetration Indices, Continued

	Increase in Diversification			New Product			Drop Product		
	Pooled	High-Tech	Low-tech	Pooled	High-Tech	Low-tech	Pooled	High-Tech	Low-tech
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
ln Employment$_{t-1}$	0.0235***	0.0253***	0.0210***	0.0132***	0.0151***	0.0151***	0.0155***	0.0169***	0.0144***
	(0.005)	(0.006)	(0.006)	(0.004)	(0.005)	(0.005)	(0.004)	(0.005)	(0.005)
ln (Capital/Emp)$_{t-1}$	0.0039	0.0098*	0.0020	-0.0049	-0.0058	-0.0083*	-0.0022	-0.0024	-0.0023
	(0.005)	(0.006)	(0.006)	(0.005)	(0.006)	(0.005)	(0.005)	(0.006)	(0.005)
ln Herfindahl$_{t-1}$	-0.0103	-0.0206	-0.0027	-0.0144	-0.0222	-0.0086	-0.0006	-0.0032	-0.0067
	(0.011)	(0.013)	(0.012)	(0.016)	(0.020)	(0.017)	(0.009)	(0.013)	(0.010)
ln Diversification$_{t-1}$	0.1965***	0.1936***	0.1750***	0.0859***	0.0972***	0.0807***	0.1772***	0.2169***	0.1415***
	(0.031)	(0.034)	(0.040)	(0.027)	(0.032)	(0.031)	(0.026)	(0.034)	(0.029)
ln TFP$_{t-1}$	-0.0010	-0.0022	-0.0038	-0.0030	-0.0049	-0.0023	0.0085**	0.0041	0.0081**
	(0.005)	(0.006)	(0.006)	(0.009)	(0.013)	(0.008)	(0.004)	(0.005)	(0.004)
ln North pen.$_{t-1}$	-0.3803*	0.1424	-0.6485*	0.4126**	0.5017**	0.2900	0.2257	0.7187**	0.0025
	(0.220)	(0.306)	(0.332)	(0.173)	(0.199)	(0.192)	(0.186)	(0.298)	(0.198)
ln South pen.$_{t-1}$	0.2359***	0.1556*	0.3712***	-0.1891*	-0.1730*	-0.1115	-0.1032	-0.1452*	0.0104
	(0.090)	(0.082)	(0.137)	(0.092)	(0.089)	(0.097)	(0.081)	(0.086)	(0.096)
Observations	4,113	3,100	3,521	4,113	3,100	3,521	4,113	3,100	3,521

Note: Robust standard errors in parentheses with *** , ** and * respectively denoting significance at the 1%, 5% and 10% levels. All equations include year and industry 3 dig. fixed effects. In the "High-tech" sub-sample, we excluded firms belonging to the low-tech industries (as defined in Hatzichronoglou [1997]). In the "Low-tech" sub-sample, we excluded firms belonging to the high-tech industries.

4.5 Product Portfolio Strategies and the Evolution of Firms' Productivity

In a last step of our analysis, we investigate the impact of the within-firm product portfolio strategies on the evolution of their productivity. As discussed earlier, we interpret decreases in diversification as a strategy of technological rationalization of productive portfolios, based on a criterion of cost minimization. In contrast, increases in diversification are likely to be associated with strategies of entry on market segments where the demand conditions are particularly favorable. We therefore expect decreases in diversification to be associated with increases in physical TFP, but not necessarily revenue TFP (although technological rationalization should help to minimize the potential losses on the firm's main market). In contrast, diversification might be associated with decreases in physical TFP, but increases (or at least smaller decreases) in revenue TFP.

We test these predictions in table 9 and show that the obtained patterns of correlation are as expected. In the full sample, decreases in diversification are correlated with increases in physical productivity, but not with increases in revenue TFP. The coefficients obtained in the sub-samples of high-tech and low-tech industries are correctly signed, in the same range of magnitude, but not significant. In contrast, increases in diversification are significatively correlated with increases in revenue TFP, but not with physical TFP. On average, diversification strategies are associated with a 5.6 percentage point increase in the probability of a revenue TFP increase. Since there is no correlation between diversification strategies and physical TFP, this suggests that the entire gain in termes of revenue is generated by the ability of those firms to set higher prices without loosing market shares on the new segments they enter. The obtained correlation is higher in high-tech industries than in low-tech industries, although the difference is not significant. This however suggests the intuitive interpretation that gains are larger in high-tech industries when firms manage to capture demand in those markets.

Table 9: Portfolio Strategies and the Evolution of Productivity ($t/t-2$)

	Full Sample		High-tech Industries		Low-tech Industries	
	Increase in		Increase in		Increase in	
	Physical TFP	Revenue TFP	Physical TFP	Revenue TFP	Physical TFP	Revenue TFP
	(1)	(2)	(3)	(4)	(5)	(6)
Inc. in div.$_{t/t-2}$	0.0128	0.0633***	0.0205	0.0791***	-0.0023	0.0530**
	(0.020)	(0.021)	(0.023)	(0.024)	(0.022)	(0.023)
Dec. in div.$_{t/t-2}$	0.0398**	0.0280	0.0328	0.0349	0.0294	0.0193
	(0.019)	(0.020)	(0.022)	(0.023)	(0.021)	(0.022)
Observations	4,711	4,711	3,438	3,438	4,057	4,057

Note: Robust standard errors in parentheses with *** , ** and * respectively denoting significance at the 1%, 5% and 10% levels. The estimation period is 2000/2002 and 2002/2004. All equations include year and industry 3 dig. fixed effects.

5 Conclusion

In this paper, we proposed a new and precise econometrical framework addressing the main endogeneity problems arising in the analysis of firms' choice of product scope ("product portfolios"). This framework builds on the structural approach for the estimation of production function proposed by Olley and Pakes [1996], extended to multi-product firms in De Loecker [2011].

We apply this methodology to the analysis of the within-firm productive reallocations of French manufacturing firms using a novel and high-quality dataset constructed from exhaustive fiscal files and large scale surveys.

We show that firms that are most exposed to low-cost country competition tend to diversify their product portfolios, while those that are most exposed to the competition of developed countries tend to re-focus on their core activities. The subsequent differential evolution of their revenue and physical productivities is consistent with the hypothesis that demand aspects might counterbalance technological rationalization in the first case. We also show that the within-firms reallocations might be as important as the reallocation between firms, in terms of their economic significance and contribution to aggregate reallocations of production.

Overall, these results suggest that within-firm product selection, like firm-level selection (Foster *et. al.* [2008], is (also) on profitability rather than (simply) efficiency, and that these two concepts diverge when the type of competition differs. Several important aspects remain however to be investigated. First, more insights are required about the way within-firm and between-firm reallocations articulate and jointly contribute to the evolution of aggregate productivity. Similarly, we let the analysis of the articulation between horizontal diversification strategies and vertical differentiation strategies for future research.

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Appendix

A List of Northern and Southern Countries

Table 10 reports the list of countries classified as “southern” (resp. “northern”); the criterion is that the GDP per capita of these countries is lower than 5% of the French GDP per capita. However, the results of the paper are robust to alternative choices of the threshold. 28 more countries get classified as “Southern” when choosing a threshold of 10% of GDP per capita rather than 5%, and 21 more when choosing 15% rather than 10%.

Table 10: Northern and Southern Countries

Northern countries	Southern countries	Northern countries	Southern countries
Albania	Angola	Kazakstan	Nicaragua
Algeria	Armenia	Korea	Niger
Antigua and Barbuda	Azerbaijan	Latvia	Nigeria
Argentina	Bangladesh	Lebanon	Pakistan
Australia	Benin	Lithuania	Papua New Guinea
Austria	Bhutan	Luxembourg	Paraguay
Bahamas	Bolivia	Macedonia (the former Yugoslav Rep. of)	Philippines
Barbados	Burkina Faso	Malaysia	Rwanda
Belarus	Burundi	Maldives	Sao Tome and Principe
Belgium and Luxembourg	Cambodia	Marshall Islands	Senegal
Bosnia and Herzegovina	Cameroon	Mauritius	Sierra Leone
Botswana	Central African Republic	Mexico	Solomon Islands
Brazil	Chad	Morocco	Sri Lanka
Bulgaria	China	Namibia	Sudan
Canada	Comoros	Netherlands	Syrian Arab Republic
Cape Verde	Congo	New Zealand	Tajikistan
Chile	Côte d’Ivoire	Norway	Tanzania
Colombia	Djibouti	Panama	Togo
Costa Rica	Egypt	Peru	Turkmenistan
Croatia	Eritrea	Poland	Uganda
Cyprus	Ethiopia	Portugal	Ukraine
Czech Republic	Gambia	Romania	Uzbekistan
Denmark	Georgia	Russian Federation	Vanuatu
Dominica	Ghana	Saint Kitts and Nevis	Viet Nam
Dominican Republic	Guinea	Saint Lucia	Yemen
Ecuador	Guinea-Bissau	Saint Vincent and the Grenadines	Zambia
El Salvador	Guyana	Samoa	
Equatorial Guinea	Haiti	Seychelles	
Estonia	Honduras	Singapore	
Fiji	India	Slovakia	
Finland	Indonesia	Slovenia	
Gabon	Kenya	South Africa	
Germany	Kiribati	Spain	
Greece	Kyrgyzstan	Swaziland	
Grenada	Lao People’s Democratic Republic	Sweden	
Guatemala	Lesotho	Switzerland	
Hong Kong	Liberia	Thailand	
Hungary	Madagascar	Tonga	
Iceland	Malawi	Trinidad and Tobago	
Iran	Mali	Tunisia	
Ireland	Mauritania	Turkey	
Italy	Moldova	United Kingdom	
Jamaica	Mongolia	United States of America	
Japan	Mozambique	Uruguay	
Jordan	Nepal	Venezuela	

B Estimation Results for Firm Level Productivity

Table 11: Baseline estimates of production functions at the industry 2-dig. level (1999-2004)

	Reduced form estimates					Structural parameters			
Industries (2 dig.)	$\beta_{\mathbf{k}}$	$\beta_{\mathbf{l}}$	$\beta_{\mathbf{div}}$	β_η	**Mark-up**	$\alpha_{\mathbf{k}}$	$\alpha_{\mathbf{l}}$	γ	$\frac{\mathbf{1}}{\sigma-\mathbf{1}} - (\gamma - \mathbf{1})$
Full sample	0.277***	0.622***	-0.008	0.026***	1.026***	0.284***	0.639***	0.923***	0.103***
	(0.034)	(0.013)	(0.034)	(0.007)	(0.007)	(0.035)	(0.014)	(0.035)	(0.035)
Food industries	0.320***	0.609***	-0.009**	-0.036*	0.965***	0.309***	0.587***	0.896***	0.069
	(0.071)	(0.030)	(0.068)	(0.018)	(0.017)	(0.068)	(0.029)	(0.071)	(0.071)
Textile	0.298***	0.534***	-0.015	-0.045	0.957***	0.285***	0.511***	0.796***	0.160***
	(0.075)	(0.057)	(0.1580	(0.030)	(0.028)	(0.073)	(0.057)	(0.075)	(0.071)
Clothing	0.367***	0.487***	0.050	-0.051*	0.951***	0.350***	0.464***	0.813***	0.138***
	(0.070)	(0.039)	(0.125)	(0.027)	(0.024)	(0.067)	(0.037)	(0.066)	(0.065)
Shoes and leather	0.240**	0.627***	0.001	-0.002	0.998***	0.239**	0.625***	0.864***	0.133**
	(0.104)	(0.098)	(0.455)	(0.061)	(0.060)	(0.109)	(0.084)	(0.091)	(0.079)
Wood and wood products	0.336***	0.528***	-0.313*	0.055	1.058***	0.355***	0.558***	0.913***	0.145
	(0.109)	(0.064)	(0.187)	(0.044)	(0.049)	(0.117)	(0.076)	(0.124)	(0.111)
Paper and related	0.206***	0.805***	-0.364**	0.086	1.094***	0.226***	0.881***	1.106***	-0.012
	(0.071)	(0.061)	(0.163)	(0.095)	(0.107)	(0.080)	(0.108)	(0.133)	(0.072)
Editing and printing	0.110	0.704***	0.222	0.031	1.032***	0.113	0.727***	0.840***	0.192***
	(0.081)	(0.073)	(0.186)	(0.054)	(0.061)	(0.084)	(0.092)	(0.093)	(0.082)
Coke, petroleum	0.553**	0.356	-0.813	0.004	1.004***	0.555**	0.358	0.913**	0.091
	(0.247)	(0.318)	(1.156)	(0.219)	(0.216)	(0.273)	(0.427)	(0.472)	(0.350)
Chemicals	0.096	0.569***	0.054	0.085***	1.092***	0.105	0.622***	0.727***	0.365***
	(0.117)	(0.049)	(0.109)	(0.031)	(0.037)	(0.126)	(0.058)	(0.141)	(0.144)
Rubber and plastic	0.323***	0.612***	0.196	-0.026	0.974***	0.315***	0.596***	0.911***	0.063
	(0.063)	(0.042)	(0.135)	(0.047)	(0.044)	(0.062)	(0.055)	(0.077)	(0.064)
Mineral products	0.377***	0.588***	-0.050	-0.064*	0.940***	0.354***	0.553***	0.907***	0.033
	(0.072)	(0.050)	(0.104)	(0.034)	(0.030)	(0.068)	(0.053)	(0.075)	(0.067)

Note: Standard errors in parentheses with *** , ** and * respectively denoting significance at the 1%, 5% and 10% levels. Standard deviations are computed by bootstrap (200 replications). Firms have been classified according their main industry (in terms of sales).

Table 12: Baseline estimates of production functions, continued

Industries (2 dig.)	Reduced form estimates $\beta_{\mathbf{k}}$	$\beta_{\mathbf{l}}$	$\beta_{\mathbf{div}}$	β_η	Mark-up	Structural parameters $\alpha_{\mathbf{k}}$	$\alpha_{\mathbf{l}}$	γ	$\frac{1}{\sigma-1}-(\gamma-1)$
Full sample	0.277***	0.622***	-0.008	0.026***	1.026***	0.284***	0.639***	0.923***	0.103***
	(0.034)	(0.013)	(0.034)	(0.007)	(0.007)	(0.035)	(0.014)	(0.035)	(0.035)
Metallurgy	0.220***	0.813***	-0.247	0.086*	1.095***	0.241***	0.890***	1.131***	-0.036
	(0.068)	(0.073)	(0.202)	(0.050)	(0.061)	(0.074)	(0.104)	(0.095)	(0.066)
Metal work	0.186***	0.621***	0.240	0.036	1.038***	0.193***	0.644***	0.838***	0.200***
	(0.044)	(0.026)	(0.147)	(0.022)	(0.024)	(0.045)	(0.033)	(0.046)	(0.040)
Machines and equipment	0.295***	0.648***	-0.101	0.049	1.051***	0.310***	0.681***	0.991***	0.060
	(0.056)	(0.041)	(0.100)	(0.029)	(0.032)	(0.060)	(0.049)	(0.065)	(0.055)
Computers and related	0.661***	0.647***	0.095	0.144	1.169***	0.772***	0.756***	1.528***	-0.360***
	(0.110)	(0.102)	(0.142)	(0.119)	(0.261)	(0.209)	(0.201)	(0.318)	(0.156)
Electrical equipment	0.301***	0.651***	0.107	-0.013	0.987***	0.297***	0.643***	0.94***	0.048
	(0.053)	(0.055)	(0.109)	(0.032)	(0.030)	(0.051)	(0.061)	(0.057)	(0.047)
Radio, TV, telecom.	0.547***	0.590***	0.055	-0.155	0.866***	0.474***	0.511***	0.985***	-0.119
	(0.105)	(0.073)	(0.171)	(0.109)	(0.103)	(0.101)	(0.092)	(0.133)	(0.107)
Medical, optical instruments	0.465***	0.759***	-0.322***	0.060**	1.064***	0.495***	0.807***	1.302***	-0.238***
	(0.110)	(0.069)	(0.091)	(0.026)	(0.029)	(0.117)	(0.079)	(0.122)	(0.115)
Car industry	0.320***	0.654***	0.009	0.004	1.004***	0.322***	0.657***	0.978***	0.026
	(0.077)	(0.091)	(0.175)	(0.037)	(0.037)	(0.079)	(0.087)	(0.077)	(0.083)
Other transport. equip.	0.192	0.703***	0.041	0.128***	1.146***	0.22	0.806***	1.025***	0.121
	(0.132)	(0.066)	(0.356)	(0.031)	(0.041)	(0.149)	(0.086)	(0.152)	(0.153)
Furniture	0.288***	0.512***	-0.017	-0.018	0.982***	0.283***	0.503***	0.786***	0.196***
	(0.074)	(0.069)	(0.145)	(0.037)	(0.035)	(0.074)	(0.065)	(0.083)	(0.082)
Recycling	0.402***	0.533***	0.561	-0.125	0.889***	0.357***	0.474***	0.831***	0.058
	(0.150)	(0.081)	(0.474)	(0.130)	(0.101)	(0.135)	(0.095)	(0.172)	(0.140)

Note: Standard errors in parentheses with *** , ** and * respectively denoting significance at the 1%, 5% and 10% levels. Standard deviations are computed by bootstrap (200 replications). Firms have been classified according their main industry (in terms of sales).

C Detailed Descriptive Statistics for Penetration Indices and TFP

The complementary descriptive statistics reported in table 13 are useful to assess the economic significance of the firm level strategies we document in the main part of the text.

Table 13: Penetration Indices and TFP by Sub-sample

		Penetration Indices		TFP
		North	South	estimates
Full sample	mean	0.284	0.029	0.549
(15592 obs.)	sd	0.171	0.053	0.633
"High-tech"	mean	0.313	0.017	0.550
(10700 obs.)	sd	0.160	0.033	0.604
"Low-tech"	mean	0.272	0.030	0.536
(13612 obs.)	sd	0.171	0.054	0.600

Note: French manufacturing firms over the 1999 to 2004 period. In the "High-tech" sub-sample, we excluded firms belonging to the low-tech industries (as defined in Hatzichronoglou [1997]). In the "Low-tech" sub-sample, we excluded firms belonging to the high-tech industries.

D IV Analyses: Alternative Experiments

Table 14 contains the first stage regressions associated with various sets of IVs, as a complement to our results reported in section 4.4.

It contains in particular the first stage estimates obtained using changes in tariffs as IVs since these variables are a candidate for the instrumentation of penetration indices that is frequently proposed in the literature. Our empirical indicators were constructed using the dataset made available by Mayer *et al* [2008], and containing bilateral information (in terms of countries) about tariffs and non-tariff barriers at the industry level. However, these IVs turn out to be too weak in the case of the northern penetration index, and incorrectly signed, and therefore highly suspected of endogeneity in the case of the southern index. This might be explained by the fact that over the considered time period, the French/European administration decided upon tariffs specifically in order to protect the domestic activities against low-cost country competition.

Table 14: First-Stage Regressions (IV Analysis)

Dependent variable (ln):	Pen. N	Pen. S	Pen. N	Pen. S	Pen. N	Pen. S	Pen. N	Pen. S
[ln-] mean:	[-1.43] 0.30	[-4.87] 0.03	[-1.43] 0.30	[-4.87] 0.03	[-1.43] 0.30	[-4.87] 0.03	[-1.43] 0.30	[-4.87] 0.03
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
ln Employment$_{t-1}$	-0.067***	-0.021***	-0.012***	-0.042***	-0.020***	-0.050***	-0.017***	-0.050***
	(0.008)	(0.004)	(0.004)	(0.009)	(0.004)	(0.009)	(0.004)	(0.009)
ln (Capital/VA)$_{t-1}$	0.014	0.032***	0.011***	-0.027***	0.023***	-0.008	0.023***	-0.011
	(0.009)	(0.004)	(0.004)	(0.009)	(0.004)	(0.009)	(0.004)	(0.009)
ln Herfindahl$_{t-1}$	0.248***	0.179***	0.158***	0.254***	0.219***	0.322***	0.220***	0.339***
	(0.017)	(0.009)	(0.008)	(0.016)	(0.009)	(0.017)	(0.009)	(0.017)
ln Diversification$_{t-1}$	0.221***	-0.056***	-0.081***	0.184***	-0.067***	0.195***	-0.070***	0.196***
	(0.033)	(0.016)	(0.015)	(0.034)	(0.017)	(0.035)	(0.017)	(0.036)
ln TFP$_{t-1}$	0.116***	0.019***	0.024***	0.093***	0.005	0.075***	0.004	0.067***
	(0.007)	(0.004)	(0.003)	(0.006)	(0.004)	(0.006)	(0.004)	(0.006)
Av. Dist. North. Exp.$_{t-1}$	1.347***	0.568***	-	-	-	-	-	-
	(0.047)	(0.019)						
Av. Dist. South. Exp.$_{t-1}$	0.996***	-0.345***	-	-	-	-	-	-
	(0.095)	(0.040)						
Av. growth of exchange rate $_{t-1}$,	-	-	3.353***	7.774***	-	-	-	-
North (base 2005)			(0.298)	(0.746)				
Av. growth of exch. rate $_{t-1}$,	-	-	0.309***	1.870***	-	-	-	-
South (base 2005)			(0.102)	(0.234)				
(ln) av. Tariff / North, $_{t-1}$	-	-	-	-	0.252***	0.514***	-	-
					(0.019)	(0.053)		
(ln) av. Tariff / South, $_{t-1}$	-	-	-	-	-0.249***	-0.011	-	-
					(0.015)	(0.043)		
Change in tariff / South, $_{t-1/t-3}$	-	-	-	-	-	-	0.007	0.117***
							(0.014)	(0.034)
Change in tariff / North, $_{t-1/t-3}$	-	-	-	-	-	-	0.028	0.084*
							(0.019)	(0.043)
Observations	14531	14531	14275	14275	14549	14549	14549	14549

Note: OLS estimation with robust standard errors in parentheses with *** , ** and * respectively denoting significance at the 1%, 5% and 10% levels. The estimation period is 2000 to 2004. All equations include year and industry 3 -digit fixed effects.