INSTITUT NATIONAL DE LA STATISTIQUE ET DES ETUDES ECONOMIQUES
Série des Documents de Travail du CREST
(Centre de Recherche en Economie et Statistique)

n° 2008-27

The Dynamics of Firms' Product Portfolio in Response to Low-Cost Country Competition : An Empirical Assessment

C. LELARGE[1]
B. NEFUSSI[2]

1 CREST – OECD. Mail : claire.lelarge@ensae.fr or claire.lelarge@gmail.com
2 MINEFE-DGTPE. Mail : benjamin.nefussi@dgtpe.fr

The Dynamics of Firms' Product Portfolio in Response to Low-Cost Country Competition : An Empirical Assessment *

Claire LELARGE and **Benjamin NEFUSSI**

Abstract

We rely on a new dataset containing detailed information about firm level production decomposition and innovation activities in order to investigate whether the observed aggregate reallocation of French production may be driven (at least partly) by firm level product portfolio strategies, in particular when firms experience a high competitive pressure arising from low-cost countries. Using an instrumental variable strategy, we obtain that firms experiencing a high low-cost country competitive pressure are significantly more diversified in their productions, and are involved in (either) more frequent or higher reallocation of their product portfolios towards products they were not previously producing. Further analysis shows that more productive firms only are able to introduce true product innovations, which may explain why they achieve higher survival rates.

La dynamique des portefeuilles de produits des entreprises soumises à la concurrence des pays à bas coûts : Quelques éléments empiriques

Résumé

Nous tirons profit d'une nouvelle base de données qui contient une information détaillée sur la structure de la production des entreprises françaises, ainsi que sur leurs activités d'innovation afin d'analyser les comportements micro-économiques à l'origine des réallocations de production observées au niveau macro-économique, en particulier les stratégies de portefeuille de produits des entreprises soumises à la concurrence des pays à bas coûts. Nous mettons en œuvre une stratégie d'estimation par variables instrumentales et montrons que les entreprises soumises à ce type de concurrence sont significativement plus diversifiées, et modifient davantage, et plus fréquemment leur profil de production. Notre analyse montre que seules les entreprises les plus productives y associent un véritable effort d'innovation, ce qui est susceptible d'expliquer pour partie leurs meilleures performances en termes de survie.

JEL classification : D21, E23, F14, L60, O31
Keywords : International Trade, R&D, Heterogeneous Firms, Product Differentiation

---

* We would like to thank E. Caroli, M. Crozet, M.-A. Diaye, E. Gautier, N. Greenan, F. Kramarz, T. Mayer, M. Roger, S. Roux, J. Oliveira-Martins, M. Thoenig, J. Van Reenen and seminar participants at the CONCORD, 2008 ZEW Innovation and Patenting, EEA (Milan), EARIE (Toulouse) and ASSET (Firenze) Conferences, Fourgeaud Seminar, EEP Jourdan Trade Seminar, CREST Internal and Research Seminars, INSEE Firm Statistics Seminar and CEE-AISE workshop. All remaining errors are our own

1 Introduction

Analyzing firms responses to globalization is one of the core empirical challenges in both micro- and macro-economics, and it is at the heart of an important policy debate. At stake is the firms' ability to face new, worldwide competitive pressures, with consequences in terms of employment, economy-wide industrial structures, and economic growth.

As stated by Bernard and Koerte [2007], theories such as the international product life-cycle (Vernon [1966]) or the technological gap theory (Posner [1961]) suggest that competing with less-developed countries is fundamentally different from competing with developed countries. Indeed, competitors from advanced economies (as well as domestic competitors) have access to similar technologies, absorptive capacities and factor costs, whereas less developed countries lack access to more recent technologies, but enjoy significant advantages in factor (especially labor) costs. Responses to these two kinds of competitive pressure may therefore be contrasted: in particular, firms in advanced countries cannot rely on *price-based* strategies in order to rule out low-cost competitors[1]. Instead, they have to focus on strategies based on their comparatives advantages, e.g. skill- intensive *technologies* which cannot be immediately imitated in low-cost countries: Thoenig and Verdier [2003] show that when globalization triggers an increased threat of technological leapfrogging or imitation, firms tend to respond to that threat by biasing the direction of their innovations towards skilled labor intensive technologies, which they call "defensive skill-biased innovation". However, their modeling relies on innovations in the production process[2], which is, in other words, a cost reduction strategy as a response to low-cost country competition. On the contrary, the literature in management (Bernard and Koerte [2007]) makes the point that that firms in developed countries would seldom find profitable to engage a race with low-cost countries in terms of costs of production, since this domain is far from being their comparative advantage. It rather suggests the more intuitive idea that low-cost country (henceforth southern) competition leads to product innovation rather than to process innovation, so that the skill-bias may be more related to R&D activities than to standard production activities[3].

[1] Bernard and Koerte [2007] built on Porter [1980, 1985] to itemize different answers to low-cost countries competition: "Organizational strategies" include costs reduction, product differentiation, and relocation of production to low cost countries; "Environmental strategies" include changing products ("avoidance") and deterrence of entry through pricing strategies or government action. The "avoidance" strategy is seen as a switch to other products that are more skill intensive.

[2] More precisely, their modeling of these kind of "defensive innovation" strategies is a very reduced form, since they only argue that "firms render their products *or* technologies more immune to imitation at the cost of reinforcing the skill intensiveness of their production process".

[3] Note that R&D expenditures typically consist in wages of high-skilled workers (researchers), so that in regard of this aspect, the modeling of Thoenig and Verdier [2003] could indeed be considered as a reduced form of a more complex productive reality. However, the literature in industrial organization often considers R&D expenditures as a sunk cost, and not as a variable production cost as they do.

The previous theoretical as well as empirical literature has identified several margins of adjustment to higher international trade exposure. However, very few papers distinguish between northern (relatively high-tech) and southern competitive pressure, although the comparative advantages of both sets of countries may be highly differentiated. Similarly, very few empirical papers are akin of articulating firm level together with product level information, which is necessary to get a complete view of firm level strategic responses.

Among analyses performed on product level data, Hummels and Klenow [2005] investigate the export gap between large and small economies. They show that the extensive margin (wider set of goods) accounts for around 60 percent of the greater exports of larger economies, while within categories, richer countries export higher quantities at modestly higher prices. Their empirical evidence suggests that product reallocation may play an important role in explaining country level specialization processes. However, their contribution is silent about the underlying micro-dynamics: is it driven by firms' exits and entries, or rather by changes in firm-level portfolio strategies? What are the drivers of these micro-dynamics?

At the firm level, the previous literature has focused on entry/exit (Bernard, Jensen and Schott [2006] and export participation (Eaton, Kortum and Kramarz [2005]) decisions as responses to globalization and increased international competition. Bernard, Jensen and Schott [2006] investigate the relations between low-cost country competition and plant survival or growth, and also plants' main industry switching - on this last aspect, the results obtained by the authors are barely significant, most probably because the main activity is a too coarse indicator of the firms' productive activity. Indeed, in the absence of more direct indicators, Bernard, Jensen and Schott [2006] assume that a plant's input intensity provides a signal about its mix of products (and thus about its exposure to low-wage country imports). However, this assumption is misleading if firms perform R&D activities, i.e. employ high-skilled workers outside their productive activities, for example as a prerequisite to product switching.

Overall, this body of empirical literature provides only a partial view about firms' responses to the increase in international trade competition they experienced, since it broadly suggests that the only trade-off is between survival (of the more productive firms) or exit. We rather investigate whether firms also adjust their productive activities through dynamic (long-term) strategies, or in other words, firm-level investments in productivity-enhancing activities such as R&D allowing them to improve their competitiveness, and therefore to decrease the probability of exit. This hypothesis has been suggested by Aw, Roberts and Xu [2008] and Costantini and Melitz [2007] and empirically investigated by Aw, Roberts and Xu [2008], Bustos [2007] or Bloom, Draca and Van Reenen [2008]. In particular, we focus on firms' product portfolio strategies, which also encovers the launching of product innovations.

Expected gains associated to these strategies first depend on the ability of southern firms to imitate or leapfrog high-tech, "northern" technologies. This aspect is an important component of the competitive pressure generated by these southern, low-cost firms. More importantly, the profitability of northern product portfolio strategies also depends on consumers' demand, in particular on the magnitudes of the elasticities of substitution between products or varieties (Broda and Weinstein [2004]). The importance of the aspects related to demand behaviour had already been underlined in the literature about endogeneous growth, where horizontal or vertical differentiation strategies (described in Grossman and Helpman [1989, 1991a, 1991c, 1991d] or Caballero and Jaffe [1993] among others) were profitable due to the assumption of CES utility functions. Recent contributions (Siebert [2003], Eckel and Neary [2006], Feenstra and Ma [2007]) underline however the potential importance of "cannibalization" (demand linkage) effects which may undermine the profitability of product switching strategies: indeed, when a given product is a subsitute for some components (goods) of a firm's product portfolio, then producing it may be un-profitable. Lastly, another benefit of selling several products that are neither subsitutes nor complements, i.e. of being active on relatively independent markets is that, in a dynamic setting, this provides insurance against bankruptcy (i.e. exiting all markets at the same time). This aspect is present in the theoretical contribution of Klette and Kortum [2004], and Bernard, Jensen, and Schott [2006] show consistently that exits occur less frequently at multi-product plants.

On the cost side, the (fixed) cost of entry into new activities may be differentiated depending on the productivity of firms (see Brambilla [2006] or Eckel and Neary [2006]). In models with single product firms[4], trade integration leads to the selection of the most productive firms that increase their production at the expense of less productive firms. The existing literature addressing the phenomenon of multi-product firms[5] relies most frequently on the assumption that firms have a specific *core competency* for which they achieve the highest level of efficiency. As a consequence, trade integration leads firms to shed marginally less productive products and therefore to re-center on their core activities[6],

[4] Melitz [2003], Eaton and Kortum [2002], Bernard *et al* [2003], Eaton *et al.* [2005].

[5] E.g. Yeaple and Nocke [2006], Bernard Redding and Schott [2006b], Eckel and Neary [2006].

[6] However, Eckel and Neary [2006] obtain that with symmetric industries, an increase in the productivity of foreign firms raises industry output, increases the product range of multi-product firms and lowers the domestic real wage. It also flattens the distribution of outputs within a multi-product firm's product range: products at the margin of the

as demonstrated by Bernard, Redding and Schott [2006b].

In this paper, we rather investigate an opposite assumption, i.e. the fact that in a dynamic setting, firms may alter the nature of their core competencies thanks to investments in knowledge (R&D) in the same way they are able to increase their efficiency level in the framework of Costantini and Melitz [2007]. Our empirical analysis relies on a new dataset containing level information enabling to track the firms' R&D expenditures, i.e. firm level innovation effort, along with their product mix or the structure of their exports at a detailed (up to 6 digit level) level. These two types of information (about innovative activities and firm level product portfolios) provide us with the appropriate tools to scrutinize firm level portfolio strategies, both for standard products and for new-to-market innovations.

Our work yields the following results. Firms experiencing a high southern competitive pressure are significantly more diversified in their productions, and are involved in (either) more frequent or higher reallocation of their product portfolios, in particular towards products they were not previously producing. These results are robust to a variety of competition indicators, and to IV estimation strategies. Further analysis shows that only more productive firms are able to introduce true product innovations, which may explain why they achieve higher survival rates (Bernard, Jensen and Schott [2006]).

The paper is organized as follows. Section 2 motivates our empirical strategy; section 3 describes the data and the empirical indicators of international trade competitive pressure and of firm level product portfolio strategies. Section 4 presents the obtained results and section 5 concludes.

2 Investigating the Firms' Product Portfolio Strategies as "Defensive Innovation" Strategies

2.1 Preliminary Empirical Evidence

Preliminary descriptive statistics suggest that facing low-cost country competition is indeed associated with specific product portfolios. Over the 1999 to 2004 period, on average 45% of our sample firms[7] report more than one activity, which is close to the proportion reported by Bernard, Redding and Schott [2006a] for US manufacturing plants (41%). Many of these multi-sector firms report non manufacturing activities, e.g. trade or accounting services. Leaving these non manufacturing activities

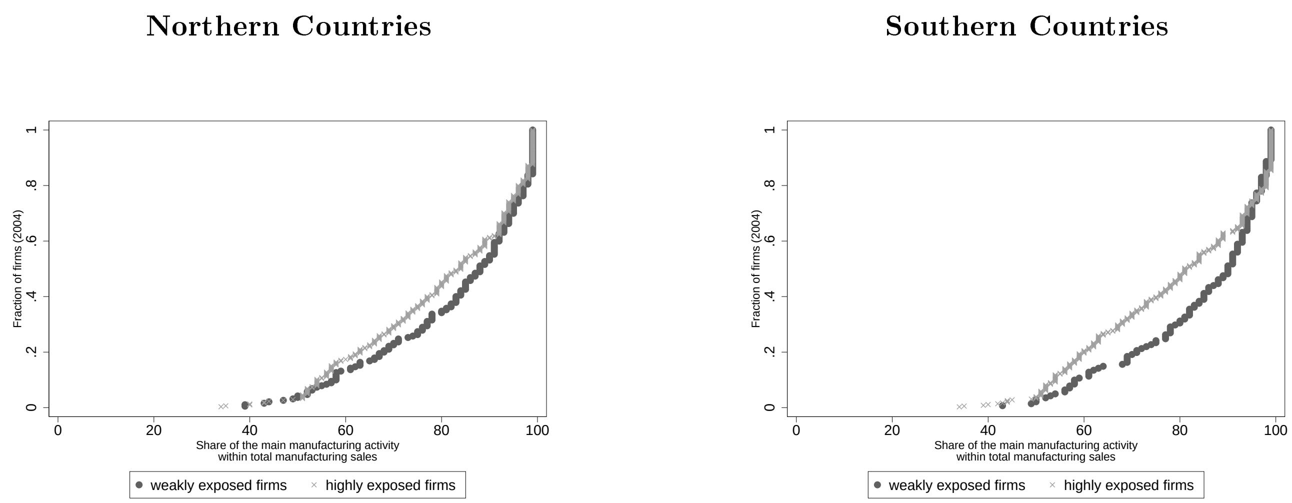
product range always expand while those near the core may contract. Note also that Feenstra and Ma [2007] do not make the same assumption of core competencies, so that in their modeling, opening trade leads to fewer firms surviving in each country but more varieties produced by each of those firms.

[7] See below for a precise description of the sample construction.

aside, we obtain a proportion of 16% of manufacturing multi- product firms.

However, this proportion varies a lot with the degree of exposure to southern competition[8]: 17.6% of highly exposed firms are multiproduct, whereas the proportion drops to 10.7 among weakly exposed enterprises. Among multi-product firms, highly exposed firms are also more diversified than weakly exposed firms. Figure 1 reports the cumulative density function of such a (inverse) diversification indicator: the share represented by the firm's main activity in total sales. 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. It is also important to note that when performing the symmetrical experiment with the northern import penetration index, the difference is not significant.

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



Kolmogorov-Smirnov Test

$\mathbf{H_0}$: $\mathbf{F_W}(\bullet) < \mathbf{F_H}(\bullet)$, $\mathbf{D^+} = \max_{\mathbf{x}} \{\mathbf{F_W}(\mathbf{x}) - \mathbf{F_H}(\mathbf{x})\}$

$D^+ = 0.033$, p-val $= 0.550$	$D^+ = 0.048$, p-val $= 0.342$

$\mathbf{H_0}$: $\mathbf{F_W}(\bullet) > \mathbf{F_H}(\bullet)$, $\mathbf{D^-} = \min_{\mathbf{x}} \{\mathbf{F_W}(\mathbf{x}) - \mathbf{F_H}(\mathbf{x})\}$

$D^- = -0.061$, p-val $= 0.138$	$D^- = -0.094$, p-val $= 0.017$

$\mathbf{H_0}$: $\mathbf{F_W}(\bullet) = \mathbf{F_H}(\bullet)$, $\mathbf{D} = \max\{|\mathbf{D^+}|, |\mathbf{D^-}|\}$

$D = 0.061$, p-val $= 0.251$	$D = 0.094$, p-val $= 0.028$

Note: Multi-product firms only, manufacturing activities only. These descriptive statistics relate to the year 2004.

The bulk of the paper consists in investigating this correlation between foreign (low-cost country,

[8] "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).

or "southern") competition and product portfolios in greater details, and in checking whether it may be linked to "defensive innovative" strategies on the part of French firms.

2.2 Underlying Firm Level Policy Functions

It is useful at this point to outline the short dynamic theoretical framework underlying our empirical analysis. We consider the program faced by a firm when defining its product scope; for simplicity, we abstract from all other decisions, such as the more radical decision to enter or exit from all markets, the decision to export or to invest.

Let E_i^g, $g = 1, ..., G$ denote the dummy variables indicating whether the firm i decides to produce good g or not. We assume that entering market g involves an (R&D) fixed cost γ^g which may depend on the firm's stock of knowledge $G_{i,t}$ at the beginning of the period. This stock of knowledge may change as a result of depreciation and of the flow of new knowledge investment spendings following a standard permanent inventory equation which may be written as follows:

$$G_{i,t} = (1-\delta).G_{i,t-1} + \sum_g (E_{i,t}^g - E_{i,t-1}^g = 1).\gamma^g[G_{i,t}]$$

Let Φ_t capture all the aggregate states that firms take as exogenous; this vector contains in particular the state variable describing the magnitude of international (southern and northern) competition, as well as domestic competition arising due to the elasticity of substitution between product varieties.

The firm's value function can be written as:

$$V\left[G_{i,t-1}, \left(E_{i,t-1}^g\right)_g; \Phi_t\right] = \max_{\left(E_{i,t}^g\right)_g} \left\{ \sum_g (E_{i,t}^g = 1) .\pi_i^g \left[\left(E_{i,t}^k\right)_{k \neq g}; \Phi_t\right] - \sum_g (E_{i,t}^g - E_{i,t-1}^g = 1).\gamma^g[G_{i,t-1}] + \beta.V\left[G_{i,t}, \left(E_{i,t}^g\right)_g; \Phi_{t+1}\right] \right\} \quad (2.1)$$

These programs result in policy functions describing the dynamic evolution of firm i's product portfolio that are implicit functions of the state variables at the beginning of the period:

$$E_{i,t}^g = E^g(G_{i,t-1}, \left(E_{i,t-1}^k\right)_k; \Phi_t), \quad g = 1, ..., G \quad (2.2)$$

Variations in the assumptions of this modeling alter the form of the policy functions. In particular, if knowledge is not cumulative, then the fixed costs γ^g of entering the various product markets do not depend on previous knowledge investment, and neither do the policy functions.

This simple specification is at the heart of our empirical investigations. However, in the empirical analysis which follows, we do not estimate one equation per potential market, which would require to run more than 400 equations (at the four digit level, for manufactured goods). We rather use more synthetic indices describing the firms' product portfolios as proxies for $\left(E_{i,t}^{g}\right)_{g}$ (e.g. diversification index, see below section 3.3 for further details), or its evolution over time. These indicators are introduced in the regression either as explained variables, or as lagged explanatory variables (SPE_{it-1}). Furthermore, in the absence of long R&D time series, we proxy the firms' knowledge stock $G_{i,t}$ by their lagged TFP, interpreted here as a Solow residual measuring the achieved level of technological efficiency. Indicators of the firm's size (EMP_{it-1}), capital intensity ($(\frac{K}{VA})_{it-1}$) and share of exports to developed, "northern" countries in the firm's total turnover ($SHXN_{it-1}$) are included as additional controls. Lastly, the vector Φ_t includes the various indicators of domestic (HHI_{it-1}) and international (PEN_{it-1}^{S}, PEN_{it-1}^{N}) competition which are described in details below. In our estimates, the coefficients obtained for this last set of explanatory variables (Φ_t) are of main interest in order to disentangle whether product switching may be a response to higher international trade exposure, either from high-tech or from low-cost countries.

2.3 Empirical Strategy

2.3.1 Specification of the Estimated Equations

We therefore examine the correlations between LCC competitive pressure (as measured by LCC penetration indices) and the firms' product portfolio strategies in estimating an equation of the following form :

$$\begin{aligned} \text{STRATEGY}_{it}^{*} = \alpha \quad &+ \quad \beta_1 . \ln TFP_{it-1} + \beta_2 . \ln EMP_{it-1} + \beta_3 . \ln \left(\frac{K}{VA}\right)_{it-1} \\ &+ \quad \theta_1 \ln PEN_{it-1}^{S} + \theta_2 \ln PEN_{it-1}^{N} + \theta_3 \ln TFP_{it-1} \times \ln PEN_{it-1}^{S} \\ &+ \quad \theta_4 \ln HHI_{it-1} + \theta_5 \ln SPE_{it-1} + \theta_6 \ln SHXN_{it-1} + \delta_t + \eta_i + \epsilon_{it} \end{aligned} \tag{2.3}$$

In this equation, the dependent variable STRATEGY_{it}^{*} is one of the indicators of product portfolio strategies that are described in detail below: these are either (i) dummy variables indicating whether the firm has added or dropped at least one product from its portfolio, or (ii) continuous zero to one indices measuring the concentration of the firm's activities or the magnitude of the reallocation from one period to the other, or (iii) more standard innovation indicators such as R&D activities or expenditures and patent applications. TFP, capital, employment and value added are denoted as TFP_{it-1}, K_{it-1}, EMP_{it-1} and VA_{it-1}. Together with the share of exports to developed, "northern" countries in the firm's total turnover $SHXN_{it-1}$, these variables are introduced into the regression as empirical counterparts of $G_{i,t}$. We refer respectively to HHI_{it-1} and (PEN_{it-1}^{S}, PEN_{it-1}^{N}) as to indicators of domestic (Herfindahl index) and foreign (penetration indices defined below) competition respectively. These variables describe the environment of the firm and are the empirical counterparts of Φ_t. SPE_{it-1} is an indicator of the firm's specialization and is introduced into the regression as a synthetic description of the lagged structure of the firm's product portfolio $\left(E^g_{i,t-1}\right)_g$

Lastly, the interaction between southern penetration and productivity aims at assessing whether more productive firms tend to react more to foreign competition[9].

In the absence of a thorough structural model, this specification is therefore essentially descriptive when describing firms' portfolio strategies "in response to" the (increasing) competitive pressure of low-wage countries, as in Bernard *et al.* [2006]. However, it is also quite standard in the empirical literature on innovation (e.g. Bond *et al.* [2004]), since in the case of R&D investment, the previous equation can be interpreted as the policy function (R&D factor demand) directly derived from a standard investment model[10].

2.3.2 Estimation

Due to the limited nature of most of the indicators introduced as dependent variables in the regression analysis, we present results obtained through maximum likelihood estimation under gaussian assumption with respect to the error terms (except in the case of patent applications):

- In the case of 0 to 1 continuous indices (e.g. share of the main activity, similarity or reallocation indices), tobit estimations are performed with both left (0) and right (1) censoring.

[9] All results are robust to the further inclusion of interactions between northern penetration and productivity.

[10] Indeed, a profit maximizing firm with a constant return to scale CES production function gets the following function for its desired R&D capital stock (in logarithms):

$$\underbrace{g_{it}}_{\substack{\text{desired}\\ \text{R\&D capital stock}}} = a + \underbrace{y_{it}}_{\text{output}} - \sigma. \underbrace{j_{it}}_{\substack{\text{user cost}\\ \text{of capital}}} \tag{2.4}$$

which is similar to Caballero, Engel and Haltiwanger [1995] for capital stock. The analogy with equation 2.2 or 2.3 is straightforward when paralleling g_{it} with $E^g_{i,t}$, y_{it} with $G_{i,t}$ and j_{it} with Φ_t.
Furthermore, in this equation, the R&D capital stock is not observed, but it can be approximated by its stationary state value (rather than computing it thanks to a permanent inventory method), for which the growth rate ν_i of the R&D capital stock is constant: $G_{it} = (1+\nu_i).G_{it-1}$. In this case, if we denote the firm specific R&D depreciation rate by δ_i, then:

$$R_{it} = (\delta_i + \nu_i).G_{it-1} = \frac{\delta_i + \nu_i}{1+\nu_i}.G_{it} \Longleftrightarrow r_{it} = \ln\left(\frac{\delta_i + \nu_i}{1+\nu_i}\right) + g_{it}$$

Unfortunately, it turns out that our panel is too short to estimate firm fixed effect specifications. We will then assume that δ and ν are sufficiently homogeneous at the industry level to be controlled for thanks to industry and time dummies. The second difficulty is that the user cost of capital is not observed, and we assume that it can also be controlled for using additive year- and sector-fixed effects. To retrieve equation 2.3 from equation 2.4, one should simply notice that the level of output y_{it} is decomposed into TFP, capital intensity and employment, and that various additional controls of competition - in particular, international competition have been introduced. Note that R&D is not taken into account as a specific factor in this decomposition of the output y_{it} since this investment is already taken into account in the standard capital and employment information (see Schankerman [1981]).

- In the case of dummy indicators (introduction / dropping of new products or new activities, R&D activity), we rely on standard probit estimation, except when attempting to introduce firm fixed effects, or when taking selection into account on a large estimation sample. In these cases, linear probability models are preferred since the computational burden is far more limited, but note that all equations that are presented with a probit specification are robust to alternative choices (LPM or logit estimation).
- For R&D expenditures, generalized tobit estimation is performed.
- In the case of patent applications, we rely on count models with a negative binomial assumption which is standard in the literature (e.g. Blundell *et al.* [1995]).
- Lastly, we simply rely on OLS estimates in the case of unit values or their growth rates (since these both indicators are continuous variables).

Endogeneity and Selectivity Issues

Several potential endogeneity problems arise in this simple setting. First, we may be confronted to a simultaneity problem which is similar to the simultaneity problem occurring in the framework of the estimation of production functions[11]. In order to mitigate this problem, we first lag all control variables in all regressions. Second, we check that our results are robust when using linear specifications and GMM estimates[12] (using lagged differences of the potentially endogenous variables as IVs).

However, this standard linear approach is not always applicable when dealing with limited dependent variables. We therefore use the Rivers-Vuong [1988] approach in order to take account of the potential endogeneity of the various suspected variables in the probit specification. This approach amounts to introducing the estimated residuals of the first-stage (OLS) regressions in the probit equation. It provides furthermore a simple test of the exogeneity of the various suspected variables, since the usual probit t-statistic on the estimated residuals introduced in the regressions is a valid test that the corresponding variable is exogenous. A shortcoming of this strategy is however that if the residuals are significant, then the usual probit standard errors and test statistics are not strictly valid, and we only estimate the coefficients up to scale (see Wooldridge [2001]).
The Smith-Blundell [1986] procedure relies on the kind of control function approach for Tobit specifications: it also amounts to introducing the first-stage regression residuals as additional controls in the

[11] See above the interpretation of our specification as a factor demand.
[12] Results available upon request.

original equation. This procedure gives consistent estimates of all the coefficients (there is no problem of scale here), but as in the Rivers-Vuong approach, when the estimated residuals are siginificatively different from zero, the second-stage tobit standard errors and t-statistics are not asymptotically valid.

Most importantly, we also recognize that the import penetration indices may be endogeneous in all estimated equations: indeed, our setting is similar to a standard supply estimation framework, in which some shocks provide identification variation, whereas others may generate endogeneity biases. More precisely, Thoenig and Verdier [2003] argue that unobserved technological (most probably skill-biased) shocks experienced by French firms may have an impact on both French firms' product portfolio strategies *and* on their competitivity and the overall degree of openness of the French economy. This kind of shock would most probably generate amplification biases on the import penetration indices in our estimation[13]. Furthermore, unobserved domestic (French) demand shocks may also generate endogeneity issues since it may affect both the level of domestic demand directed towards domestic producers, and the level of domestic demand directed towards foreign producers (imports). This kind of shock would therefore generate attenuation biases in our setting.

Several features of our setting help mitigate these potential biases. First, in order to mitigate the pure simultaneity bias[14], we use lagged values of the penetration indices, which amounts to present the first-step estimates of IV regression using the lagged value of penetration indices. Second, the second type of indicator of competition, defined as changes in import unit values, are price based indices which are furthermore specified as time differences, and therefore less suspected of endogeneity - they are at least more robust to the unobserved technological shocks described above. Last, we also report estimates obtained with an instrumental variable strategy.

Thoenig and Verdier [2003] or Bernard, Jensen and Schott [2006] also use prices (exchange rates or tariff or freight rates) as IVs in their regression analysis, but this kind of information is not (readily) available at a detailed level of industry classification for all the countries considered here[15]. We rather rely on a proxy of freight (transportation) rates interpreted as a component of costs faced by foreign firms; our variables are described in full details in section 3.2 below. We argue that these kind of costs have a direct impact on openness and penetration indices, but do not affect directly the portfolio strategies of French firms.

[13]The same reasoning holds for worldwide technology shocks. Note that on the contrary, southern technological shocks are not a source of endogeneity, but of identification in our setting.

[14]Note however that simultaneity is not very likely since it will probably take a quite long time for the firm to switch across sectors after experiencing a shock on the competitive pressure it faces.

[15]For example, Thoenig and Verdier [2003] only consider the exchange rate between the French Franc and the dollar or the Deutsche Mark, which seems inappropriate in order to study the southern competitive pressure

3 Data and Measurement Issues

3.1 Data Sources

The firm level information required in our analysis has been sourced from a varitety of datasets. First, exhaustive firm level information on imports and exports over the period 1999 - 2004 are sourced from the files of the French Customs administration[16]. They provide information on the value and volume of each firm's export flow, defined at the product 6 digit level. The symmetrical information is available for import flows, for which we also use the country of origin (see below the definition of the pentration indices).

Second, complementary information about the firms' innovative effort is sourced from the "Innovation" (CIS) and "R&D" surveys. These two sources matched together enable us to determine which firms do invest in innovation, which ones *do not*, and the corresponding amount of R&D expenditures. These surveys are not exhaustive[17] but cover the population of manufacturing firms having more than 20 workers. Together, these two sources provide information on 10,000 firms over the 1999-2004 period, each of them being present on average three (adjacent) years. This sample is also matched with the exhaustive datasets of patent applications to the French National Patent Office (INPI) and to the European Patent Office (EPO), with priority years ranging from 1999 to 2003.

Laslty, standard accounting information such as value added, employment, capital, labor costs, and the main firm industry affiliation are sourced from fiscal files (FUTE files), as well as the whole decomposition of each firm's sales into each of the 4 digit market where it operates[18]. This very detailed information enables us to compute penetration variables while taking account of multi-product firms. It also enables us to track the product portfolio strategies of our sample.

We end up with a file containing 30,790 observations when broken down in the firm and year dimensions[19]. This set of firms corresponds to a yearly total of 1.3 millions of employees, where the median firm has 62 employees over the period. On average, 44% of the sample firms report positive investments in innovation. This slight over-representation of innovative firms is due to the over-representation of large firms in the CIS and R&D surveys, which provide the sampling structure of our

[16]See Eaton, Kortum, and F. Kramarz [2005] as an example of analysis performed on the same information. Exports are reported "franco-on-board" (FOB), i.e. exclusive of tariffs and freights, whereas imports are reported CAF, inclusive of tariffs and transport costs.

[17]Except for firms having more than 250 employees.

[18]See Acemoglu *et al.* [2006] as an example of analysis performed on the same data. Note that the industry affiliation of multi-product firms corresponds to the largest sales ratio, and that there is correspondence between the (NAF) activity classification of the FUTE files and the (CPF) product classification used in the customs files when both aggregated at the 3 digit level.

[19]Our file also has a product dimension, see below.

dataset.

3.2 Measuring Low-Cost Country (and High-Tech Country) Competitive Pressure

Baseline Indicators

Our indicator of southern competition is directly derived from Bernard, Jensen and Schott [2006], except that we furthermore explicitly take account of multi-product firms. First, countries are classified as low-cost, or "southern" if their GDP per capita is lower than 5% of the French GDP per capita[20]. 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.

Second, the industry level southern penetration indices proposed in Bernard, Jensen and Schott [2006] are computed from the *exhaustive* (six digit) product level information in the import records of the custom administration, and then aggregated at the firm level using weights according to the different (four digit) markets where the firm operates. The obtained indicator takes the following form:

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

where ω_{ijt} denotes the share of sales of firm i in sector j at year t. We refer respectively to M_{Ft} and M_{Fjt}^{S} to French total imports and imports in sector j at year t from low-cost countries, and to Q_{Ft} and X_{Ft} as domestic production and French exports[21].

The northern penetration index is defined symmetrically as:

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

where M_{Ft}^{N} denotes French imports form northern countries in sector j at year t.

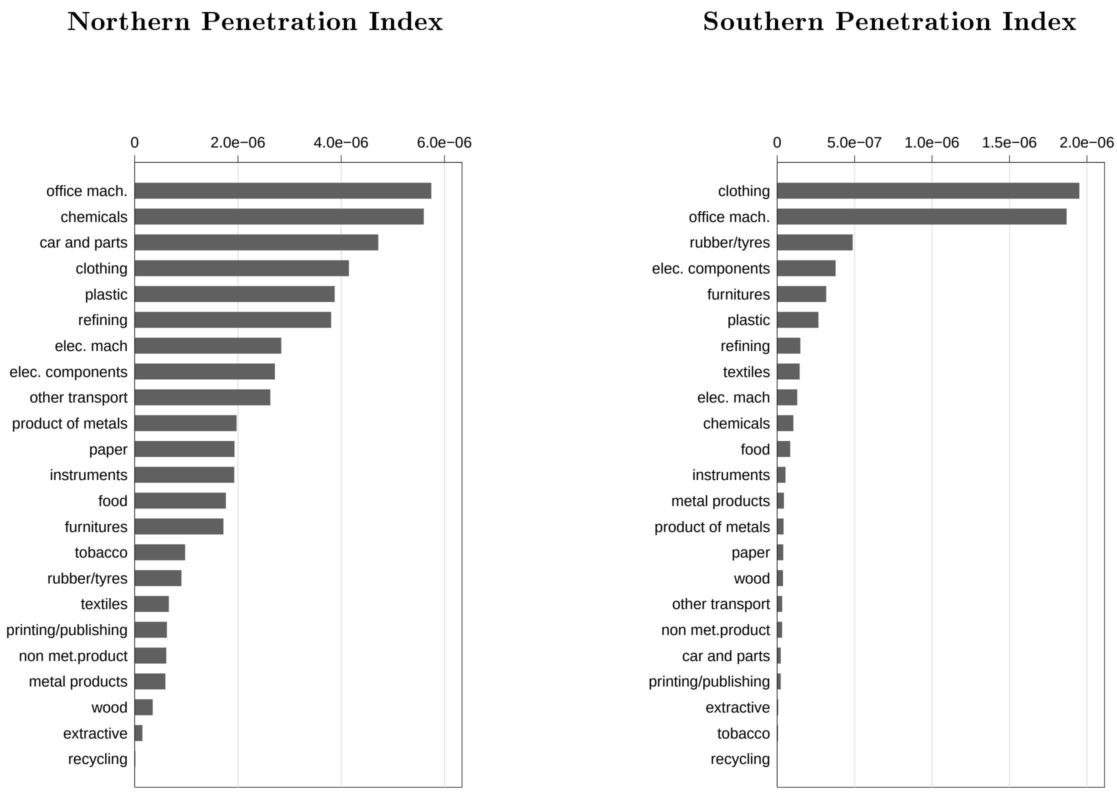
These two variables are therefore defined at the firm level due to the weights used to aggregate the product / industry level penetration indices experienced on each of the markets of the firm. However, it is useful to check that the obtained indicators are close to common wisdom when they are aggregated according to the firms' main activity. Graph 2 depicts the average penetration indices experienced in 2004 by firms whose two-digit main activity belongs to the specified category. Unsurprisingly, the

[20] This definition is motivated theoretically by the standard factor proportions framework.

[21] A noticeable difference with Bernard, Jensen and Schott [2006] is that the denominator (absorption) is not industry specific. This is due to the fact that the information about domestic production is not available in the same detailed classification in a consistent way with the custom data (aggregating "exhaustive" firm level datasets does not always provide a consistent information...). We therefore simply normalize the import flows with a more aggregated indicator (economy wide in the descriptive statistics, and at the 2-digit level in the regression analysis due to the inclusion of industry fixed effects).

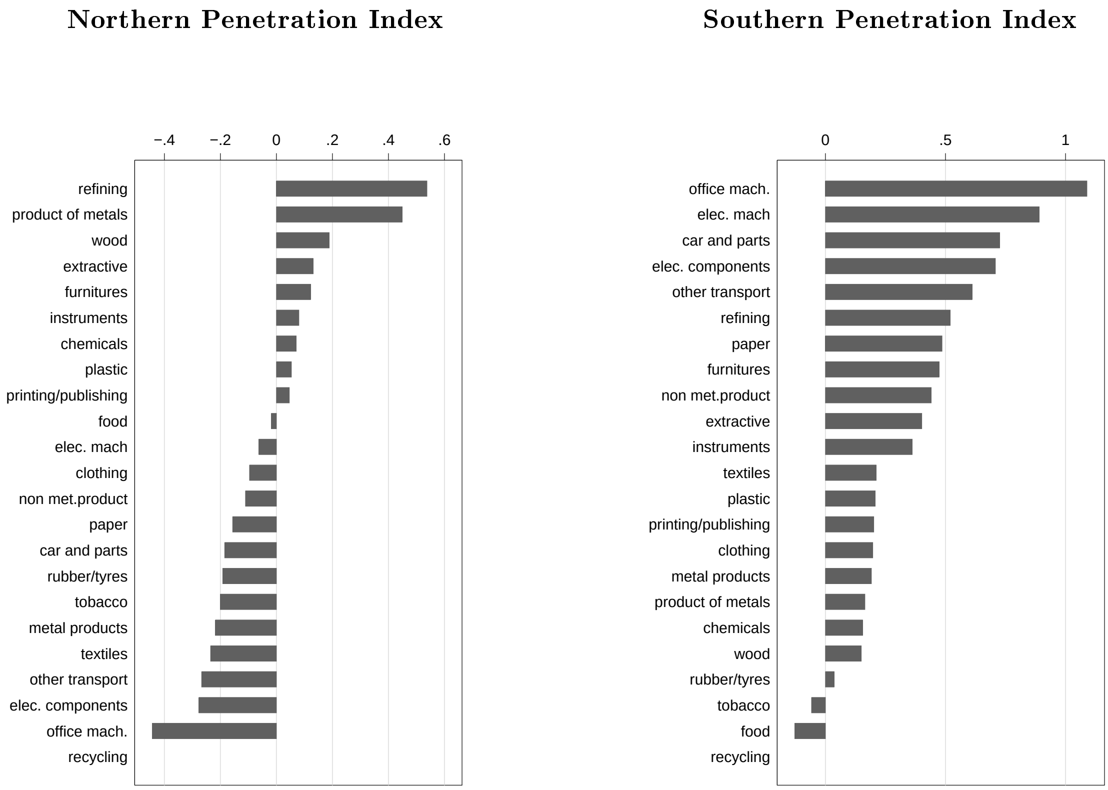
southern import penetration index suggests that French firms operating in the clothing and office machinery are most exposed to low-wages countries competition. Furthermore, the southern competitive pressure index is much lower but more differentiated across industries than the northern index, which provides a greater industry level potential for identifying variability. Graph 3 shows further that even on a short time period (5 years between 1999 and 2005), the rise of the southern penetration indices has been substantial in many industries, which describes the global opening-up of the world economy, in particular due to the Chinese liberalization (see Bloom *et al.* [2008]).

Figure 2: Low-Cost ("Southern") Country and High-Tech ("Northern") Country Penetration Indices Across Firms' Main Industries (2004)



Note: These descriptive statistics relate to the year 2004 and are based on the average penetration indices experienced by the sample firms whose main activity belongs to the specified category.

Figure 3: Variation of Northern and Southern Penetration Indices over the 1999-2004 Period



Note: These descriptive statistics relate to the log-difference of northern and southern penetration indices between 1999 and 2004. They are based on the average penetration indices experienced by the sample firms whose main activity belongs to the specified category.

Price Based Indicators

A concern with the previous indicators of penetration is that the actual flow of southern imports is not an appropriate measure of competitive pressure, since what matters is rather the *threat* (Dutt and Traca [2005]) of the flow of imports. We therefore introduce alternative proxies that follow Hallak [2006][22] and Schott [2004][23] and are based on prices (e.g. Bertrand [2007]), namely the average annual change in unit values of LCC import:

$$PEN\_UV_{it}^X = \sum_j \omega_{ijt} \Delta_{t/t-1} \ln(UV_j^X), \quad X = S, N \tag{3.3}$$

[22]Hallak [2006] suggests that southern countries sell lower quality goods which explains why export prices are lower for poorer countries. This implies both that export prices used to construct real GDP should be quality-corrected, but also that price changes may be interpreted as quality changes in these poorest countries (as a first approximation).

[23]See also our indicator of quality presented below in section 3.4.

where unit values (UV_{jt}^X) are computed as the ratio between values and quantities of southern or northern import flows at the product level. Assuming that the production shipped from low-cost countries is sold very close to its production cost (or at least that price competition is not relevant with low-cost countries), these indicators can be interpreted as measuring the competition in terms of quality arising from low-cost countries. In the case of northern, high-tech countries, the latter assumption is less relevant, and the interpretation is therefore more ambiguous.

Graph 4 shows the average price based indices experienced in 2004 by firms whose two-digit main activity belongs to the specified category. Several aspects are worth noticing. First, the southern index has much higher industry level variation than its northern counterpart, for which only a small number of industries have experienced significant year-to-year changes in import unit values. Second, the ranking of industries obtained for northern and southern imports are very contrasted, which legitimates this break-down of competition indicators across countries. Last, the obtained ranking of industries is globally consistent with what is obtained in term of *variation* of the penetration indices (graph. 3), which is reassuring since both indices aim at capturing the same dimension (southern competitive pressure) while relying on a very different source of variability.

Instrumental Variables

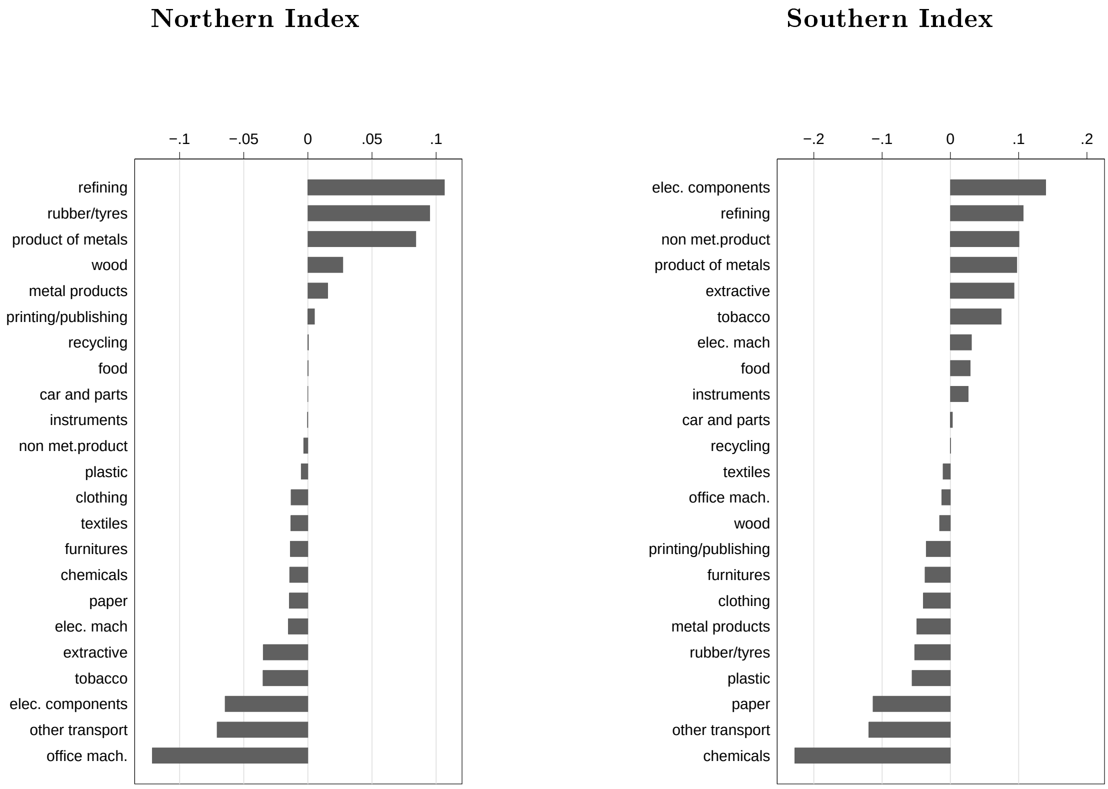
Lastly, as explained is section 2.3.2, we use proxies of freight (transportation) rates as instrumental variables for the penetration indices presented above. More precisely, assuming that transportation costs are proportional to distances, our IVs are computed as the average distance between France and the exporting countries:

$$DIST\_IMP_{it}^X = \sum_j \omega_{ijt_0} \left(\sum_c \frac{M_{Fjt}^c}{M_{Fjt}^X} .d_{cF} \right), \quad X = S, N \tag{3.4}$$

where c denotes countries, d_{cF} denotes the distance in kilometers between France and country c, and $\frac{M_{Fjt}^c}{M_{Fjt}^X}$ denotes the share of imports accounted for by country c (for good j) in the total of French imports. The geographical information is sourced from Mayer and Zignago [2006]; bilateral distances are calculated following the great circle formula, which uses latitudes and longitudes of the most important city (in terms of population) or of the official capital of each considered country. Note also that in equation 3.4, the firm specific weights ω_{ijt_0} are taken at the first period where the considered firm enters our sample in order to avoid any endogeneity bias generated by the variation of these weights[24].

[24] There is a direct relationship between these weights and the firm product portfolio strategies, see below.

Figure 4: Low-Cost Competition and High-Tech Competition Price-Based Indices Across Firms' Main Industries (2004)



Note: These descriptive statistics relate to the year 2004 and are based on the average price (unit value)-based indices experienced by the sample firms whose main activity belongs to the specified category.

3.3 Describing Firms' Product Portfolios

Bernard, Jensen and Schott [2006] provide the first evidence that firms adjust their product mix in response to pressure from international trade. However, their analysis remains coarse since their only empirical indicator relies on main industry switching. In the present paper, we rely on the information about the yearly decomposition of each firm's sales at the four digit level (and about the six digit level strucuture of their exported production) in order to track more refined portfolio strategies.

The basic indicators follow Bernard, Redding and Schott [2006a] and 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 whether on the contrary it has removed at least one[25]:

[25] The choice of this time spell is mainly driven by the length of our panel. Appendix B.1 provides estimates for year-to-year strategies, but fewer changes are observed yearly so that estimates are less precise. This is why our main specification relies on a longer difference.

$$ADD_{it} = \mathbf{1}\{ \sum_{p/\omega_{ipt-2}=0} \omega_{ipt} > 0\} \tag{3.5}$$

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

where $\omega_{ipt} = \frac{S_{ipt}}{\sum_j S_{ijt}}$ is the share of sector / product p sales in total turnover for firm i at year t. We also investigate several features of the firms' sales profile such as its concentration, using an empirical indicator of the share represented by the firm's main product:

$$SH_{it}^{max} = \max_p \{\omega_{ipt}\} \tag{3.7}$$

Lastly, two synthetic indicators are used to describe first, the magnitude of within portfolio reallocation:

$$REALL_{it} = \sum_{\left\{p/ \substack{\omega_{ipt} > 0, \omega_{ipt-2} > 0 \\ \Delta\omega_{ipt} > 0} \right\}} \Delta\omega_{ipt} \tag{3.8}$$

and second, (the opposite of) the magnitude of all types of portfolio reallocations:

$$INERTIA_{it} = 1 - \frac{1}{2} \sum_j |\Delta\omega_{ijt}| \tag{3.9}$$

Descriptive statistics are reported in table 1 and show that over two years, the similarity index is typically as high as 0.97 when computed at the four-digit level (0.80 at the six-digit level for exported production). However, R&D performing firms drop and add new four-digit productions more frequently, are more diversified, and have higher reallocation indexes than their non-R&D counterparts.

3.4 Measures of Firms' Innovative Effort

It should be noted that all of the previously described indicators heavily rely on the existing activity or product classifications, which renders them in particular inadequate to measure "true" (new to market) product innovation. We therefore rely on three additional indicators in order to capture this additional dimension.

The innovative effort of our sample firms is first proxied by their Research and Development (R&D) expenditures. This indicator is preferred to the indicators available from the Innovation (CIS) surveys[26] because of his yearly availability over the 1999-2004 period, and for his (often argued) higher "objectivity": accounting information is often more reliable than self-assessed innovative performances.

We also use patent applications, either at the French National Patent Office (INPI) or at the European Patent Office (EPO), in order to assess whether firms have launched new products on to the market over the estimation period. The advantage of these patent based indicators is that they are not restricted to the sub-population of exporting firms. All patents do not induce new marketable products, but it has be shown that patent applications are biased towards product innovations (and against process innovation, see e.g. Duguet and Lelarge [2006]).

However, the main limit of these indicators is that due to the costs of patenting and due to the novelty requirement associated to patent applications[27], they are only able to capture a small proportion of all innovations introduced by the firms, in particular in low-tech industries where the patenting propensity is low, but southern competition high, and evolving rapidly. However, in contrast to previous work (e.g. Bloom *et al.* [2008], see below), we have information about national French patents, which are typically more accessible and less costly for French firms, and therefore more widespread - and more useful to track firms' innovations in these industries.

Lastly, following Schott [2004][28], we also use export unit values to proxy the evolution of the quality of a firm's exports, with the assumption that quality increases are related to product innovations. Unit values (UV_{ipct}) are computed as the ratio between values and quantities of a firm i's export flows at the finest product p classification (6 digits). Our final indicators of product quality are computed as the maximum and mean unit values at the firm and (times) product level:

$$UV_{ipt}^{max} = \max_{c} \{UV_{ipct}\} \tag{3.10}$$

$$\overline{UV}_{ipt} = \frac{1}{N_c} \sum_{c} UV_{ipct} \tag{3.11}$$

where c denotes the destination country of each export flow. A limitation of this indicator is its availability for exporting firms only.

[26]The CIS surveys provide alternative indicators of produc or process innovation introduced over the observation period. However, only one wave of the survey (2000-2004) is available over the period for which we got access to the custom data.

[27]EPO applications are likely to be even more demanding than INPI applications, at least in terms of transaction costs due to the specific european procedure.

[28]See also Hallak and Schott [2005] or Fontagne *et al.* [2007].

3.5 Descriptive Statistics

Our empirical analysis also relies on a variety of standard firm level controls such as employment, capital intensity, Total Factor Productivity (TFP), the share of the firm' s exports shipped to northern countries (see section 4.2), an indicator of diversification[29] and the Herfindahl index measuring the average concentration of the firm's domestic markets (at the four-digit level):

$$HH_{it} = \sum_{p} \omega_{ipt} . \left[\sum_{i'} \left(\frac{S_{i'pt}}{S_{pt}} \right)^2 \right]$$

Descriptive statistics are reported in table 1 ; TFP is computed here using industry level averages of labour costs as a share of value added, but all results are robust to alternative specifications (e.g. Levinsohn - Petrin [2003] estimates, see appendix B.2). Exporting firms in our sample are both larger and more diversified, and experience on average a higher magnitude of domestic competition. R&D performing firms, especially those that are also active on the international market, show higher TFP levels and are also more capital intensive; these findings are consistent with previous empirical evidence (e.g. Bond *et al.* [2004] among others).

4 Empirical Results

4.1 Southern Competitive Pressure and Reallocations in the Firms' Product Portfolios

Tables 2 and 4 document the relationship between southern competition and firms' product portfolios. In table 2 columns (1) to (4), we examine the relationship between the concentration of the product portfolio (at the four-digit level) and exposure to international trade. When the northern penetration index is introduced alone in the regression, then the obtained coefficient is negatively significant, which means that the more the considered firm is exposed to international trade pressure, the less it is specialized in a single activity. However, the southern penetration index, when introduced in the regression, attracts this significatively negative sign, and the coefficient obtained for the northern index becomes non-significant and positive. The negative relationship between international trade competition and firms' diversity seems therefore be mainly driven by the southern competitive pressure rather than by the northern competitive pressure. It should be noted, however, that the herfindahl index of concentration on the domestic markets remains positive and significant, which means that the greater

[29] This indicator is computed as the inverse of the Herfindahl index computed over each firm's sales decomposition (at the four-digit level):

$$DIV_{it} = \left(\sum_{p} \omega_{ipt}^2 \right)^{-1}$$

Table 1: Descriptive Statistics

Type of Firms:	**Non-Exporting Non-R&D**	**Exporting Non-R&D**	**Non-Exporting R&D**	**Exporting R&D**
Description of the Dynamics of Product Portfolios (3-year Periods, 4 Digit Classification)				
Share of Main Activity	0.979	0.980	0.973	0.937
Inertia Index	0.986	0.978	0.918	0.956
Nb. of Activities	1.138	1.196	1.216	1.696
Reallocation Index	0.014	0.022	0.082	0.044
New Activity	0.010	0.029	0.054	0.057
Drop Activity	0.027	0.037	0.108	0.097
Innovation Indicators				
R&D Expenditures	0	0	1200	10732
OEB Patents	0.000	0.016	0.042	0.702
National (INPI) Patents	0.005	0.031	0.077	1.747
Max. Unit Value	-	199.450	-	998.427
Mean Unit Value	-	121.144	-	485.772
$\Delta_{t/t-1}$ ln Max. Unit Value	-	0.034	-	0.038
$\Delta_{t/t-1}$ ln Mean Unit Value	-	0.013	-	0.036
Measures of International Competition				
Northern Penetration (%)	0.164	0.212	0.302	0.339
Southern Penetration (%)	0.017	0.026	0.019	0.013
Northern $\Delta \ln UV$	0.008	0.005	-0.019	-0.002
Southern $\Delta \ln UV$	0.018	-0.026	-0.005	-0.029
Average Distance of Northern Imports (km)	1624	1726	2100	2119
Average Distance of Southern Imports (km)	7488	7709	7687	7936
Share of Northern Exp. in Total Firm Exp. (%)	0.000	17.394	0.000	32.926
Control Variables				
Employment	56.49	128.38	97.27	685.83
Capital Intensity	40.126	69.011	45.025	231.958
TFP	17.041	17.915	22.714	19.930
Diversification Indicator	1.108	1.182	1.058	1.367
Herfindahl Index	0.147	0.128	0.136	0.114
Observations	4462	7768	209	6378

Note: French manufacturing firms over the 1999-2004 period (except for patent applications for which the priority dates range from 1999 to 2003). All amounts are expressed in thousand euros.

the domestic competition, the more diversified firms are. This domestic indicator may attract most of the effect of the technologically advanced competitive pressure and therefore explain why the northern index is not significant in our specification.

In column (3), we introduce the interaction between the southern penetration index and the firm level (lagged) TFP, but the obtained coefficient is weak and non-significant, which means that more productive firms are neither more nor less diversified when they experience southern competitive pressure. However, Bernard, Jensen and Schott [2006] show that the probability of plant death is relatively lower for more productive plants the higher the level of low wage country import penetration; explaining this higher survival rate desserves further investigations regarding their product portfolio choices.

Laslty, in column (4), we present the results obtained with the alternative, price based measures of international trade penetration as a robustness check. Results are consistent with previous findings since the southern penetration index remains negative and significant. We also obtain that the northern price-based penetration index is positive, while the herfindahl index becomes non-significant; this is due to the fact that higher prices in northern countries may most probably be associated with negative productivity shocks instead of quality increases, which are associated with a lower competitive pressure.

It is also useful to provide the orders of magnitude implied by these regressions. A one percent increase in the baseline southern penetration index is associated with a decrease of 0.08 percentage point of the sales share associated to the average firm's main activity. Moreover, increasing the southern penetration index by one (sample) standard deviation induces an increase of 20 percentage points (1.854×0.080) of the specialization index, which represents more than 20% of the sample mean[30]. However, the values obtained with the alternative indicator of southern competition is lower by a factor ten, either because these indices miss the "volume" part of the international trade competitive pressure, or because of reduced endogeneity.

Last, we report in table 3 the results obtained using the average geographical distances as IVs. Column (1) reports the results obtained in the reduced form specification; we obtain as expected that the more distant are the southern exporting countries, i.e. the lower the competitive pressure they generate, the more the considered firm is specialized (i.e. the less it is diversified). The IV estimates reported in column (2) show that the magnitude obtained in table 2 is globally preserved (although the IV estimates are less precise), which shows that endogeneity concerns seem limited.

[30] An analogous linear prediction based on the difference between the average northern and southern penetration indices leads to a decrease of 20 percentage points (2.536×0.080) of the concentration index.

Table 2: International Competition and Activity Switching

Dependent Variable:	**Share of the Main Activity In Sales (t)**				**Inertia Index ($t/t-2$)**			
	(1)	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*	*(7)*	*(8)*
ln TFP_{t-3}	0.017	0.016	0.016	0.032^{***}	0.018	0.017	0.016	0.016
	(0.011)	(0.011)	(0.011)	(0.011)	(0.014)	(0.013)	(0.014)	(0.014)
ln $Employment_{t-3}$	-0.029^{***}	-0.029^{***}	-0.029^{***}	-0.028^{***}	-0.016^{***}	-0.016^{***}	-0.016^{***}	-0.017^{***}
	(0.005)	(0.005)	(0.005)	(0.005)	(0.006)	(0.006)	(0.006)	(0.006)
ln $(Capital/VA)_{t-3}$	-0.002	-0.004	-0.004	-0.013^{**}	0.007	0.005	0.005	0.006
	(0.006)	(0.006)	(0.006)	(0.006)	(0.007)	(0.007)	(0.007)	(0.007)
ln $Herfindahl_{t-3}$	0.028^{***}	0.031^{***}	0.031^{***}	-0.012^{*}	0.001	0.004	0.004	-0.001
	(0.009)	(0.009)	(0.009)	(0.006)	(0.011)	(0.011)	(0.011)	(0.011)
ln $Diversification_{t-3}$	-0.607^{***}	-0.585^{***}	-0.585^{***}	-0.583^{***}	-0.438^{***}	-0.419^{***}	-0.418^{***}	-0.449^{***}
	(0.020)	(0.020)	(0.020)	(0.019)	(0.024)	(0.024)	(0.024)	(0.024)
ln North Exp. Sh_{t-3}	-0.002	-0.002	-0.002	-0.002	-0.005^{**}	-0.004^{**}	-0.004^{**}	-0.005^{***}
	(0.002)	(0.002)	(0.002)	(0.001)	(0.002)	(0.002)	(0.002)	(0.002)
ln North $Pen._{t-3}$	-0.086^{***}	0.008	0.008	-	-0.074^{***}	0.018	0.017	-
	(0.016)	(0.021)	(0.021)		(0.019)	(0.025)	(0.025)	
North $\Delta_{t-3/t-4} \ln UV$	-	-	-	0.181^{**}	-	-	-	0.123
				(0.083)				(0.140)
ln South $Pen._{t-3}$	-	-0.080^{***}	-0.080^{***}	-	-	-0.080^{***}	$- 0.080^{***}$	-
		(0.012)	(0.012)			(0.015)	(0.015)	
South $\Delta_{t-3/t-4} \ln UV$	-	-	-	-0.061^{**}	-	-	-	-0.087^{*}
				(0.030)				(0.047)
ln South $Pen._{t-3}$	-	-	0.001	-	-	-	0.003	-
$\times$ ln TFP_{t-3}			(0.006)				(0.008)	
South $\Delta_{t-3/t-4} \ln UV$	-	-	-	0.011	-	-	-	0.033
$\times$ ln TFP_{t-3}				(0.050)				(0.058)
Mean Dep. Var.	0.961	0.961	0.961	0.961	0.969	0.969	0.969	0.969
Observations	4468	4468	4468	4468	4468	4468	4468	4468
Estimation Method	Tobit	Tobit	Tobit	Tobit	Tobit	Tobit	Tobit	Tobit

Note: Robust standard errors in parentheses with *** , ** and * respectively denoting significance at the 1%, 5% and 10% levels. Tobit ML estimations are all both left (0) and right (1) censored. In col. (5) to (8), the estimation period covers 2000/2002 and 2002/2004.

In columns (5) to (8) of table 2 and columns (3) and (4) of table 3, we replicate the same experiments using the synthetic inertia index, also defined at the four-digit classification level and using two-years time spells[31]. We obtain very close results, either in terms or significance, or in terms of magnitude, although the dependent variable is specified in growth rates instead of levels, so that the explained variability is very different in nature from the specification reported in columns (1) to (4). Table 4 helps disentangling what is behind this synthetic inertia index. First, results reported in column (3) provide evidence that the product portfolio is longer (greater number of activities) when firms experience a higher southern competitive pressure, which is consistent with the "insurance" against exiting the market suggested in Klette and Kortum [2004]. Second, results reported in column (4) show that southern competitive pressure brings about higher within - portfolio reallocation, but we obtain no significant effect for product adding or dropping (columns (5) and (6)). However, columns (7) and (8) suggest that this is due to the fact that the 4-digit classification used for the construction of our baseline indicators is not detailed enough to track these kinds of changes. Using 6-digit level information about firm level exports, we obtain that firms facing higher southern competitive pressure both introduce and remove products more frequently from the list of shipments. Note however that introducing a new product in the portfolio is unambiguously a volontary strategy on the part of the firm, whereas removing a product from its portfolio may be either a volontary strategy (e.g. recentering of activities on a specific segment) or an involontary consequence of southern competiton (crowding-out of the market). The coefficient obtained for the northern index is negative and weakly significant in both cases[32]. Again, we obtain sizeable correlations: a one standard-deviation increase in the southern penetration index is associated with a four percentage point increase in the probability of adding (or removing) a product in (from) the average firm's list of shipments, which represents 4 percent of the base probability. These results are more clear cut than in Bernard, Jensen and Schott [2006] due to the fact that we do not limit our analysis to the firms' main activities[33].

[31]See appendix B.1 for a robustness check using year-to-year changes.

[32]Unobservables (explaining either export participation or exported product reallocation) appear to be negatively correlated, which is consistent with the fact that these (gross) strategies do not seem more pronounced among more productive firms. However, the comparability of these findings is limited since we consider the structure of exports in the second case rather than the structure of production in the first case.

[33]A back of the enveloppe calculation shows the importance of accessing to a detailed level of information in this regard, either in terms of precision of the activity / product classification or in terms of the decomposition of the whole firm level product portfolio. For example, assuming that our 6 digit estimates describe a continuous firm level transfer of sales (at a constant speed) from one activity to the other, we obtain that an increase of 1% in the southern penetration index is associated to a 0.048 ppt increase of the probability to switch 6 digit activity over 5 years, but only 0.003 ppt at the four digit level. The sample size required to obtain significant estimates at this level of detail is therefore much higher.

Table 3: International Competition and Activity Switching: IV Evidence

Dependent Variable:	**Share of the Main Activity in Sales (t)**		**Inertia Index ($t/t-2$)**	
	(1)	*(2)*	*(3)*	*(4)*
ln TFP$_{t-3}$	0.021*	0.000	0.025**	-0.021
	(0.011)	(0.019)	(0.013)	(0.037)
ln Employment$_{t-3}$	-0.027***	-0.042***	-0.014***	-0.048**
	(0.005)	(0.010)	(0.005)	(0.021)
ln (Capital/VA)$_{t-3}$	-0.010*	-0.019	-0.005	-0.032
	(0.006)	(0.012)	(0.007)	(0.024)
ln Herfindahl$_{t-3}$	0.018**	0.031**	-0.004	0.005
	(0.008)	(0.013)	(0.009)	(0.025)
ln Diversification$_{t-3}$	-0.614***	-0.534***	-0.423***	-0.239***
	(0.020)	(0.039)	(0.022)	(0.080)
ln North Exp. Sh$_{t-3}$	-0.003**	-0.003	-0.004**	-0.007
	(0.002)	(0.002)	(0.002)	(0.004)
ln North Pen.$_{t-3}$	-	1.753	-	4.321*
		(1.075)		(2.210)
ln South Pen.$_{t-3}$	-	-0.781**	-	-1.947**
		(0.410)		(0.850)
Av. Dist. North. Imp.$_{t-3}$	-0.032*	-	-0.067***	-
	(0.019)		(0.023)	
Av. Dist. South. Imp.$_{t-3}$	0.128**	-	0.115*	-
	(0.051)		(0.063)	
Mean Dep. Var.	0.959	0.959	0.969	0.969
Observations	4206	4206	4206	4206
Estimation Method	Tobit	IV Tobit	Tobit	IV Tobit

Note: Robust standard errors in parentheses with ***, ** and * respectively denoting significance at the 1%, 5% and 10% levels. Tobit ML estimations are all both left (0) and right (1) censored. In columns (2) and (4), the average distances of imports are used as IVs for the import penetration indices.

Table 4: International Competition and Activity / Product Switching (cont.)

Dependent Variable: (change $t/t-2$ exc. col 1)	**Max Share** *(1)*	**Inertia Index** *(2)*	**ln Nb. Act.** *(3)*	**Reall. Index** *(4)*	**New Prod.** *(5)*	**Drop Prod.** *(6)*	**New Prod.** *(7)*	**Drop Prod.** *(8)*
ln TFP_{t-3}	0.016	0.016	-0.005	-0.006	0.009^{*}	-0.006	0.038^{***}	0.021^{**}
	(0.011)	(0.014)	(0.010)	(0.013)	(0.005)	(0.007)	(0.010)	(0.010)
ln $Employment_{t-3}$	-0.029^{***}	-0.016^{***}	0.060^{***}	0.017^{***}	0.002	0.015^{***}	0.030^{***}	0.035^{***}
	(0.005)	(0.006)	(0.005)	(0.005)	(0.003)	(0.004)	(0.005)	(0.005)
ln $(Capital/VA)_{t-3}$	-0.004	0.005	0.002	-0.006	-0.004	-0.007^{*}	-0.012^{**}	-0.007
	(0.006)	(0.007)	(0.007)	(0.007)	(0.004)	(0.004)	(0.006)	(0.007)
ln $Herfindahl_{t-3}$	0.031^{***}	0.004	-0.025^{**}	-0.007	-0.001	0.009	0.003	0.000
	(0.009)	(0.011)	(0.010)	(0.010)	(0.005)	(0.007)	(0.007)	(0.006)
ln $Diversification_{t-3}$	-0.585^{***}	-0.418^{***}	0.624^{***}	0.356^{***}	0.066^{***}	0.055^{***}	0.026^{*}	0.007
	(0.020)	(0.024)	(0.026)	(0.021)	(0.014)	(0.017)	(0.014)	(0.014)
ln North Exp. Sh_{t-3}	-0.002	-0.004^{**}	0.002^{*}	0.005^{***}	0.002^{***}	0.001	0.016^{***}	0.019^{***}
	(0.002)	(0.002)	(0.001)	(0.002)	(0.001)	(0.001)	(0.003)	(0.003)
ln North $Pen._{t-3}$	0.008	0.017	-0.021	0.000	0.013	0.003	-0.019^{*}	-0.022^{**}
	(0.021)	(0.025)	(0.040)	(0.023)	(0.041)	(0.039)	(0.010)	(0.010)
ln South $Pen._{t-3}$	-0.080^{***}	-0.080^{***}	0.142^{***}	0.068^{***}	0.007	0.036^{*}	0.019^{***}	0.016^{**}
	(0.012)	(0.015)	(0.021)	(0.014)	(0.019)	(0.019)	(0.007)	(0.007)
ln South $Pen._{t-3}$ × ln TFP_{t-3}	0.001	0.003	0.005	-0.002	0.000	0.002	-0.007	-0.008
	(0.006)	(0.008)	(0.005)	(0.007)	(0.003)	(0.004)	(0.005)	(0.006)
Inv. Mill's Ratio	-	-	-	-	-	-	-0.162^{***}	-0.107^{***}
							(0.041)	(0.041)
Mean Dep. Var.	0.961	0.969	0.228	0.031	0.038	0.062	0.881	0.882
	(4 dig.)	(4 dig.)	(4 dig.)	(4 dig.)	(4 dig.)	(4 dig.)	(6 dig.)	(6 dig.)
Observations	4468	4468	4468	4468	4468	4468	3784	3784
Estimation Method	Tobit	Tobit	OLS	Tobit	OLS	OLS	OLS	OLS

Note: Robust standard errors in parentheses with ***, ** and * respectively denoting significance at the 1%, 5% and 10% levels. In col. (1) to (6), estimation is performed on a sample of exporting and non-exporting firms, and activities are defined at the NAF level. In columns (1), (2) and (4), the tobit estimations are both left (0) and right (1) censored. In col. (7) and (8), estimation is performed on a sample of exporting firms only, and activities are defined at the CPF6 level. The estimation period covers 2000/2002 and 2002/2004.

4.2 More Evidence about Induced Product Innovation?

An important limit of the previous analysis is that it heavily relies on the existing product or activity classification. 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 further analysis based on alternative indicators, aiming at investigating whether the previous estimates concerning (new) product introduction may be lower bounds or even whether they underestimate the real innovative effort of firms in response to southern international trade competition. At stake is our ability to inerpret the skill bias of defensive innovation (Thoenig and Verdier [2003]): is the role of skilled work (human capital) confined to production activities, or is it more related to R&D activities[34]? Bloom *et al.* [2008] provide evidence that the Chinese competitive pressure fostered IT investment on the part of European firms, and previous literature has shown that this type of investment generates skill bias. However, empirical evidence on the impact on southern competitive pressure on the internal innovative efforts of firms and their product innovations remains scarce, although Bustos [2007] is a recent (additional) exception.

R&D Activities

Tables 5 and 6 provide estimates obtained when estimating the correlation between international trade pressure and firm level R&D effort, both at the extensive (col. (1) to (4)) and the intensive (col. (5) to (8)) margins.

We obtain that southern competition is associated with more frequent R&D activities, and that this is all the more true that the firm is productive, since in column (3) the interaction term between southern penetration and TFP becomes significantly positive. The total marginal effect at the sample mean is as large as 0.045. A one standard deviation increase in the southern penetration index is therefore associated to an increase of 9 percentage point of the probability of being involved in R&D activities. The obtained coefficients are even higher for R&D expenditures: the marginal effect at the sample mean is 0.2, which means that a one standard deviation increase in the southern index is associated to a 38% increase in the R&D expenditures. Note however that (unsurprisingly) for R&D expenditures, the northern penetration index is also significatively positive, with the same underlying orders of magnitude.

Columns (4) and (8) show that the panel is too short (in the time dimension) to allow for fixed effect estimation, but table 6 provides further robustness checks. In columns (3) and (4) (to be compared to

[34] In the first case, skilled work would be interpereted as a variable input as in Thoenig and Verdier [2003], whereas in the second case, it would be considered as a sunk cost (IO literature).

Table 5: International Competitive Pressure and Firms' Innovative Effort

Dependent Variable:	**Dum. R&D Activities**				**ln R&D Expenditures**			
	(1)	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*	*(7)*	*(8)*
ln TFP_{t-1}	0.090^{***}	0.090^{***}	0.085^{***}	0.002	0.625^{***}	0.625^{***}	0.590^{***}	0.058^{***}
	(0.014)	(0.014)	(0.015)	(0.002)	(0.032)	(0.032)	(0.032)	(0.016)
ln EMP_{t-1}	0.129^{***}	0.129^{***}	0.129^{***}	0.000	1.096^{***}	1.096^{***}	1.094^{***}	0.106^{***}
	(0.007)	(0.007)	(0.007)	(0.002)	(0.020)	(0.020)	(0.019)	(0.023)
ln $(K/VA)_{t-1}$	0.059^{***}	0.060^{***}	0.060^{***}	0.004^{*}	0.321^{***}	0.322^{***}	0.325^{***}	0.045^{**}
	(0.008)	(0.008)	(0.008)	(0.002)	(0.019)	(0.019)	(0.019)	(0.020)
ln $Herfindahl_{t-1}$	0.051^{***}	0.050^{***}	0.050^{***}	-0.001	0.172^{***}	0.169^{***}	0.167^{***}	-0.006
	(0.011)	(0.011)	(0.011)	(0.003)	(0.025)	(0.025)	(0.025)	(0.022)
ln $Diversification_{t-1}$	-0.001	-0.007	-0.008	0.001	-0.318^{***}	-0.338^{***}	-0.337^{***}	0.102^{**}
	(0.025)	(0.025)	(0.025)	(0.006)	(0.055)	(0.056)	(0.055)	(0.046)
ln North Exp. Sh_{t-1}	0.031^{***}	0.031^{***}	0.031^{***}	0.000	0.084^{***}	0.084^{***}	0.083^{***}	0.003
	(0.002)	(0.002)	(0.002)	(0.000)	(0.008)	(0.008)	(0.008)	(0.002)
ln North $Pen._{t-1}$	0.068^{***}	0.038	0.037	0.001	0.268^{***}	0.151^{**}	0.150^{**}	-0.030
	(0.020)	(0.026)	(0.026)	(0.005)	(0.053)	(0.070)	(0.069)	(0.035)
ln South $Pen._{t-1}$	-	0.027^{*}	0.029^{**}	0.002	-	0.100^{**}	0.102^{***}	0.022
		(0.015)	(0.014)	(0.014)		(0.040)	(0.040)	(0.014)
ln South $Pen_{t-1} \times$ ln TFP_{t-1}	-	-	0.016^{**}	0.000	-	-	0.096^{***}	0.000
			(0.007)	(0.001)			(0.019)	(0.008)
Mean Dep. Var.	0.354	0.354	0.354	0.354	7.163	7.163	7.163	2.630
Observations	18494	18494	18494	18494	18817	18817	18817	18817
					(6587)	(6587)	(6587)	
Estimation Method	Probit	Probit	Probit	OLS	Heckit	Heckit	Heckit	OLS
	(ME)	(ME)	(ME)	FE				FE

Note: Robust and clustered standard errors in parentheses with ***, ** and * respectively denoting significance at the 1%, 5% and 10% levels. In columns 4 and 8, firm level fixed effects have been introduced in the regression. In column 8, the dependent variable is ln (R&D Exp+1).

columns (1) and (2)), we implement the Rivers-Vuong and Blundell-Smith approaches to take account of potential endogeneity problems concerning, first, the production factors, and second, the penetration indices. We use lagged differences of the production factors and the lagged (log) average distances of imports as instrumental variables. We obtain that the coefficients obtained in the tobit specification may be affected by downward biases (if anything), and that none of the penetration indices appears to be endogeneous.

In columns (7) and (8) (to be compared to columns (5) and (6)), we report estimates obtained when using the price-based measure of southern competition. The interaction between TFP and southern competition is no longer significant, but the southern index remains significant and correctly signed, as opposed to the northern index.

Patent Applications

The previous regressions documented the fact that firms facing southern competitive pressure may react through increased innovative (R&D) effort. However, it is unclear whether this effort is directed towards process innovation, or rather towards product innovations, i.e. changes in the firm's product portfolio. Analyzing the patenting behaviour of these firms helps providing a more detailed assessment in this regard, since it is well-known that patent protection is biased towards product innovation, which are more threathened by reverse engineering than process innovations[35].

Results are reported in table 7, for both national patent applications (col. (1) to (4)) and applications to the European Patent Office (col. (5) to (8)). We find evidence that only the more productive firms react significantly to southern competitive pressure through increased patenting. However, although these marginal effects are statistically significant, the implied economic magnitudes are low: an one standard deviation increase in the southern penetration index leads to a 1.28 % increase of national patent applications, and the effect is lower by a factor 100 for OEB applications. Bloom *et. al.* [2008] obtain that a 10 percent increase in Chinese imports is associated with a 3% increase in patenting, which is half what we obtain for French patent applications, and much higher than what we obtain for OEB applications, perhaps due to the fact that their estimation sample is highly biased towards larger firms.

[35]This is not in contradiction with the assumption (of weak intellectual protection in low-cost countries) underlying the theoretical modeling in Thoenig and Verdier [2003], since we consider competition on the French market, where patent protection is backed by the French law, rather than competition on the "southern" market.

Table 6: International Competitive Pressure and Firms' Innovative Effort (Cont.)

Dependent Variable:	**R&D Dum.** *(1)*	**R&D Exp.** *(2)*	**R&D Dum.** *(3)*	**R&D Exp.** *(4)*	**R&D Dum.** *(5)*	**R&D Exp.** *(6)*	**R&D Dum.** *(7)*	**R&D Exp.** *(8)*
ln TFP_{t-1}	0.090***	0.625***	0.087***	0.361***	0.085***	0.590***	0.092***	0.732***
	(0.014)	(0.032)	(0.016)	(0.046)	(0.015)	(0.032)	(0.014)	(0.036)
ln EMP_{t-1}	0.129***	1.096***	0.158***	0.455***	0.129***	1.094***	0.123***	1.136***
	(0.007)	(0.020)	(0.022)	(0.094)	(0.007)	(0.019)	(0.006)	(0.024)
ln $(K/VA)_{t-1}$	0.060***	0.322***	0.092**	0.245***	0.060***	0.325***	0.058***	0.344***
	(0.008)	(0.019)	(0.017)	(0.065)	(0.008)	(0.019)	(0.007)	(0.021)
ln $Herfindahl_{t-1}$	0.050***	0.169***	0.047***	0.308***	0.050***	0.167***	0.055***	0.247***
	(0.011)	(0.025)	(0.013)	(0.042)	(0.011)	(0.025)	(0.009)	(0.026)
ln $Diversification_{t-1}$	-0.007	-0.338***	-0.018	0.329**	-0.008	-0.337***	0.013	-0.324***
	(0.025)	(0.056)	(0.038)	(0.158)	(0.025)	(0.055)	(0.024)	(0.062)
ln North Exp. Sh_{t-1}	0.031***	0.084***	0.005	0.029	0.031***	0.083***	0.031***	0.090***
	(0.002)	(0.008)	(0.005)	(0.023)	(0.002)	(0.023)	(0.002)	(0.010)
ln North $Pen._{t-1}$	0.038	0.151**	0.007	-1.051	0.037	0.150**	-	-
	(0.026)	(0.070)	(0.018)	(0.829)	(0.026)	(0.069)		
North $\Delta_{t-1/t-2} \ln UV$	-	-	-	-	-	-	-0.099*	-0.242
							(0.055)	(0.257)
ln South $Pen._{t-1}$	0.027*	0.100**	0.011	0.913**	0.029**	0.102***	-	-
	(0.015)	(0.040)	(0.011)	(0.067)	(0.014)	(0.515)		
South $\Delta_{t-1/t-2} \ln UV$	-	-	-	-	-	-	0.033**	0.250***
							(0.017)	(0.080)
ln South Pen_{t-1}	-	-	-	-	0.016**	0.096***	-	-
$\times$ ln TFP_{t-1}					(0.007)	(0.019)		
South $\Delta_{t-1/t-2} \ln UV$	-	-	-	-	-	-	0.012	0.147
$\times$ ln TFP_{t-1}							(0.037)	(0.132)
u_{it} North Pen. Eq.	-	-	0.034	1.168	-	-	-	-
			(0.036)	(0.835)				
u_{it} South Pen. Eq.	-	-	0.009	-0.877*	-	-	-	-
			(0.021)	(0.522)				
Mean Dep. Var.	0.354	7.163	0.363	7.391	0.354	7.163	0.344	7.134
Observations	18494	18817	11245	11488	18494	18817	15785	15785
		(6587)		(4105)		(6587)		(5425)
Estimation Method	Probit (ME)	Heckit	Rivers-Vuong (ME)	Blundell-Smith	Probit (ME)	Heckit	Probit (ME)	Heckit

Note: Robust and clustered standard errors in parentheses with ***, ** and * respectively denoting significance at the 1%, 5% and 10% levels. The estimation period in col. (7) and (8) is 2000-2004. In columns (3) and (4), penetration indices, TFP, employment, capital intensity and the share of northern exports are considered as potentially endogenous. The underlying instrumental variables are the lagged (log) average distances of imports, and the lagged differences of TFP, capital intensity, employment, value added and share of northern exports.

Table 7: International Competition and Patent Applications

Dependent Variable:	National (French) Patents				OEB Patents			
Model :	*(1)*	*(2)*	*(3)*	*(4)*	*(5)*	*(6)*	*(7)*	*(8)*
ln TFP_{t-1}	0.235^{***}	0.255^{***}	0.249^{***}	0.318^{***}	0.020^{***}	0.014^{***}	0.019^{***}	0.022^{***}
	(0.067)	(0.072)	(0.072)	(0.071)	(0.004)	(0.003)	(0.004)	(0.004)
ln EMP_{t-1}	0.533^{***}	0.575^{***}	0.576^{***}	0.581^{***}	0.032^{***}	0.023^{***}	0.033^{***}	0.033^{***}
	(0.046)	(0.050)	(0.050)	(0.050)	(0.004)	(0.003)	(0.004)	(0.004)
ln $(K/VA)_{t-1}$	0.209^{***}	0.226^{***}	0.226^{***}	0.213^{***}	0.027^{***}	0.019^{***}	0.027^{***}	0.026^{***}
	(0.044)	(0.048)	(0.047)	(0.047)	(0.004)	(0.003)	(0.004)	(0.004)
ln $Herfindahl_{t-1}$	-0.043	-0.060	-0.060	-0.067	-0.007^{*}	-0.005^{**}	-0.007^{**}	-0.007^{**}
	(0.049)	(0.053)	(0.053)	(0.052)	(0.003)	(0.002)	(0.004)	(0.004)
ln $Diversification_{t-1}$	-0.025	-0.059	-0.059	-0.068	-0.000	0.000	0.000	0.000
	(0.101)	(0.111)	(0.111)	(0.110)	(0.007)	(0.005)	(0.008)	(0.008)
ln North Exp. Sh_{t-1}	0.123^{***}	0.131^{***}	0.140^{***}	0.130^{***}	0.004^{***}	0.003^{***}	0.004^{***}	0.004^{***}
	(0.012)	(0.013)	(0.015)	(0.013)	(0.001)	(0.001)	(0.001)	(0.001)
ln North $Pen._{t-1}$	0.107	-0.101^{***}	-0.102	-0.085	-0.000	-0.000	-0.002	-0.001
	(0.097)	(0.123)	(0.189)	(0.121)	(0.006)	(0.005)	(0.007)	(0.007)
ln South $Pen._{t-1}$	-	0.182	0.076	0.175^{**}	-	0.000	0.002	0.002
		(0.076)	(0.112)	(0.075)		(0.004)	(0.005)	(0.005)
ln South $Pen._{t-1}$ × ln TFP_{t-1}	-	-	0.077	0.490^{**}	-	-	0.005^{***}	0.008^{***}
			(0.049)	(0.235)			(0.002)	(0.003)
ln North $Pen._{t-1}$ × ln TFP_{t-1}	-	-	-	-0.187^{**}	-	-	-	-0.007^{*}
				(0.073)				(0.005)
Mean Dep. Var.	0.468	0.468	0.468	0.468	0.245	0.245	0.245	0.245
Observations	14,288	14,288	14,288	14,288	14,310	14,310	14,310	14,310

Note: Robust standard errors in parentheses with ***, ** and * respectively denoting significance at the 1%, 5% and 10% levels. Estimation by maximum likelihood (marginal effects at the sample mean and multiplied by 100 reported) with negative binomial specifications. The estimation period is restricted to 1999-2003 (due to data availability).

Quality Upgrading

Schott [2004] provides evidence that countries do not specialize *across* products but *within* products (vertical differentiation), with developed countries exporting high quality goods while developing countries export low quality products. We therefore investigate whether firms may reallocate their product portfolio towards higher quality goods when they experience tougher southern competition, and whether their innovative effort may be directed towards product upgrading. It is difficult to measure the quality of all products, and we are not aware of any source including information on the quality of domestic goods. Therefore, we restrict ourselves to the quality of French firms' *exports* and investigate whether a higher southern competitive pressure is associated to increases in the quality of exported goods. More precisely, following Shott [2004], we use the maximum unit values in order to proxy for the highest quality that a firm can achieve within a product variety. Hallak [2006] suggests that wealthier countries tend to purchase higher quality products, and we therefore add the share of northern exports in firm's total exports to control for the correlation between product quality and destination countries, which indeed appears to be positive and significant in the equations specified in levels.

Results are reported in table 8. All regressions are run at the product (6 digit) level and include product fixed effects. In the equation specified in levels (col. (4)), we obtain that firms facing a large southern competitive pressure on average on *all of their markets*[36] tend to ship higher quality goods relative to French firms producing the same product, but operating on average on more sheltered areas due to their specific product diversification. A one standard deviation increase in the southern penetration index is associated to a 11 percentage point increase in maximum product quality. However, in the equation describing the evolution of the firm's *maximum* unit value (col. (1)), the only significatively positive coefficient is the correlation coefficient between TFP and the southern penetration index, which shows that more productive firms *only* are potentially able to increase the quality of their products when facing southern competition. At the sample mean (in particular in terms of TFP), a standardized shock on the southern penetration index is associated to a 2.5 percentage point difference in quality growth. Furthermore, all of these findings are conserved if we use an alternative indicator of product quality based on the firm's average unit value instead of maximum unit value[37].

All of these analysis provide evidence on the fact that all French firms tend to respond to southern

[36]Controls are defined at the firm level whereas all regressions are run at the product level in this section. They do include product fixed effects and standard deviations are corrected for clustering at the firm level.

[37]The advantage of this last indicator is that it is potentially more robust to outliers.

Table 8: Export Unit Values

Dependent Variable:	$\Delta_{t/t-2}$ $\ln \mathbf{UV}^{\mathbf{max}}_{\mathbf{ipt}}$	$\Delta_{t/t-2}$ $\ln \overline{\mathbf{UV}}_{\mathbf{ipt}}$	$\ln \overline{\mathbf{UV}}_{\mathbf{ipt}}$	$\ln \mathbf{UV}^{\mathbf{max}}_{\mathbf{ipt}}$
	(1)	*(2)*	*(3)*	*(4)*
ln TFP$_{t-3}$	-0.009	-0.021	0.148***	0.185***
	(0.017)	(0.016)	(0.018)	(0.020)
ln Employment$_{t-3}$	0.000	-0.007	0.034***	0.089***
	(0.009)	(0.008)	(0.009)	(0.010)
ln (Capital/VA)$_{t-3}$	-0.008	-0.012	-0.018*	-0.004
	(0.009)	(0.009)	(0.010)	(0.011)
ln Herfindahl$_{t-3}$	0.000	0.014	0.108***	0.101***
	(0.012)	(0.012)	(0.014)	(0.015)
ln Diversification$_{t-3}$	-0.047*	-0.020	-0.206***	-0.121***
	(0.026)	(0.025)	(0.031)	(0.033)
ln North Exp. Sh$_{t-3}$	-0.007	-0.010	0.051***	0.077***
	(0.008)	(0.007)	(0.004)	(0.005)
ln North Pen.$_{t-3}$	0.044	0.031	0.024	0.006
	(0.047)	(0.031)	(0.043)	(0.043)
ln South Pen.$_{t-3}$	-0.032	0.005	0.057**	0.064***
	(0.027)	(0.017)	(0.024)	(0.024)
ln South Pen.$_{t-3}$ × ln TFP$_{it-3}$	0.016**	0.012*	0.001	0.008
	(0.008)	(0.006)	(0.008)	(0.008)
Inv. Mill's Ratio	-0.034	-0.004	-0.050	0.107
	(0.072)	(0.070)	(0.070)	(0.076)
Mean Dep. Var.	0.023	0.016	3.434	3.765
Observations	41777	41777	224110	224110
R^2	0.024	0.025	0.567	0.538

Note: Estimation by OLS; robust standard errors in parentheses with ***, ** and * respectively denoting significance at the 1%, 5% and 10% levels. All regressions include (6 dig.) product fixed effects, and the standard deviations are clustered at the firm level. Exporting firms only.

competitive pressure through portfolio reallocations. However, the most productive firms only are able to associate these switches with increased innovative efforts and to the widening of their portfolios to "new-to-market" products. Indeed, their R&D effort seems at least partially targeted at product innovations, since they tend to patent more, and the quality of their products rise. These findings contribute to the understanding of their higher ability to survive demonstrated by Bernard, Jensen and Schott [2006].

5 Conclusion

In this paper, we relied on very detailed information about firm level production decomposition and innovation activities in order to investigate the firm level product portfolio strategies. We obtain that southern competition is an incentive for more dynamic product portfolio strategies, and this is true for all firms whatever their efficiency level. However, more productive firms only are able to respond to this competitive pressure through increased innovation effort leading to true product innovations. This may explain why these firms achieve higher survival rates.

Our analysis may help to explain what are the micro-level phenomena underlying aggregate production reallocations and specialization. Moreover, it contributes to the understanding of what is behind the associated skill bias of northern production specialization: indeed, this skill bias may be more associated to sunk costs of production switching, rather than to variable cost of skill-biased production processes.

We let a series of open questions that may be investigated in future work on this topic, e.g. are these product portfolio strategies differentiated across industries? Are there specific patterns of product to product transitions? It may also be useful to assess the consequences of acquisitions and mergers (which have been removed from our estimation sample) on these strategies. Lastly, further analysis (and information) is required to assess the relative contributions of firms' intensive (output per product)and extensive (number of products) margins in determining firm growth (either in terms of employment or of TFP), and the aggregate firm size distribution.

References

[2006] Acemoglu, D., Aghion, P., Lelarge, C. , Van Reenen, J. et Zilibotti, F. (2006), "Technology, Information and the Decentralization of the Firm", *NBER Working Paper*, n°12206.

[2005] Allanson, P. and C. Montagna (2005), "Multiproduct Firms and Market Structure: an Explorative Application to the Product Life Cycle", *International Journal of Industrial Organization*.

[2008] Aw, B.Y., Roberts, M. and D.Y. Xu (2008), "R&D Investment, Exporting, and the Evolution of Firm Productivity", *American Economic Review, Papers and Proceedings*, 98(2), 451-456.

[2006] Baldwin, R.E. and F. Robert-Nicoud (2006), "Trade and Growth with Heterogenous Firms", NBER Working Paper No. 12326.

[2003] Bernard, A.B., Eaton, J., Jensen, J.B., and S. Kortum (2003), "Plants and productivity in international trade", *American Economic Review*, 93, 1268-1290.

[1999] Bernard, A.B. and J.B. Jensen (1999), "Exceptional Exporter Performance: Cause, Effect, or Both?", *Journal of International Economics*, 47, 1-25.

[2006] Bernard, A.B., J.B. Jensen and P. K. Schott (2006), "Survival of the Best Fit: Exposure to Low-Wage Countries and the (Uneven) Growth of U.S. Manufacturing Plant". *Journal of International Economics*, vol 68, 219-237

[2007a] Bernard, A.B., J.B. Jensen and P. K. Schott (2007), "Firms in international trade". *Journal of Economic Perspectives*, forthcoming.

[2007b] Bernard, A.B., J.B. Jensen and P. K. Schott (2007), "Falling Trade Costs, Heterogeneous Firms and Industry Dynamics", NBER working Paper no 9639.

[2007] Bernard, A.B., and P. Koerte (2007), "Strategic responses to multiple dimensions of low-cost country competition", *mimeo*

[2006a] Bernard, A.B., S.J. Redding and P. K. Schott (2006), "Multi-Product Firms and Product Switching", CEPR Working Paper, 5708.

[2006b] Bernard, A.B., S.J. Redding and P. K. Schott (2006), "Multi-Product Firms and Trade Liberalization", NBER Working Paper No. 12782.

[2006c] Bernard, A.B., S.J. Redding and P. K. Schott (2006), "Products and productivity", CEPR Working Paper, 5708.

[2007] Bernard, A.B., S.J. Redding and P. K. Schott (2007), "Comparative advantage and Heterogeneous Firms", *Review of Economic Studies*, 74, 31-66.

[2007] Bertrand, M. (2004), "From Invisible Handshake to Invisible Hand? How Import Competition Changes the Employment Relationship", *Journalof Labor Economics*, 22(4), 723-765.

[2008] Bloom, N., Draca M. and J. Van Reenen (2008), "Trade Induced Technical Change? The Impact of Chinese Imports on Technical Change", *mimeo*, LSE.

[1995] Blundell, R., Griffith, R. and J. Van Reenen (1995), "Dynamic Count Data Models of Technological Innovation", *Economic Journal*, 105, 333-344.

[2004] Bond, S., Harhoff D. and J. Van Reenen (2004), "Investment, R&D and Financial Constraints in Britain and Germany", CEP Discussion Papers 0595, *Annales d'Economie et Statistiques*, forthcoming.

[2006] Brambilla, I. (2006), "Multinationals, Technology, and the Introduction of Varieties of Goods", NBER Working Paper No. 12217.

[2004] Broda, C. and D. Weinstein, "Variety Growth and World Welfare", *American Economic Review, P&P*, 94(2), pp. 139-144.

[2007] Bustos, P. (2007), "Multilateral Trade Liberalization, Exports and Technology Upgrading: Evidence on the Impact of MERCOSUR on Argentinean Firms", *CREI and Pompeu Fabra University mimeo.*

[1995] Caballero R., Engel E. and J. Haltiwanger (1995), "Plant-Level Adjustment and Aggregate Investment in Dynamics", *Brookings Papers on Economic Activity*, 2.

[1993] Caballero R. and A. Jaffe (1993), "How High are the Giants' Shoulders: an Empirical Assessment of Knowledge Spillovers and Creative Destruction in a Model of Economic Growth", NBER Working Paper No. 4370.

[2007] Costantini, J. and M. Melitz (2007), "The Dynamics of Firm-Level Adjustment to Trade Liberalization", forthcoming in Helpman, E., D. Marin, and T. Verdier, *The Organization of Firms in a Global Economy*, Harvard University Press, 2008

[2006] Duguet, E. and C. Lelarge (2006), "Does Patenting Increase the Private Incentives to Innovate? A Microeconometric Analysis", *CREST Working Paper*, 2006-09.

[2005] Dutt, P. and D. Traca (2005), "Trade and the Skill-bias - It's not how much, but with whom, you trade", *mimeo*, INSEAD.

[2005] Eaton, J., Kortum, S., and F. Kramarz, (2005), "Anatomy of International Trade: Evidence from French Firms", *Crest mimeo.*

[2002] Eaton, J. and S. Kortum, (2002), "Technology, geography and trade", *Econometrica* 70, 1741-1779.

[2006] Eckel, C. and J. Neary (2006), "Multi-Product Firms and Flexible Manufacturing in the Global Economy", CEPR Discussion Paper No. 5941.

[2007] Feenstra, R. and H. Ma (2007), "Optimal Choice of Product Scope for Multiproduct Firms under Monopolistic Competition", NBER Working Paper No. 13703.

[1987] Flam, H. and E. Helpman (1987), "Vertical Differentiation and North-South Trade", *American Economic Review*, 77, 810-22.

[2007] Fontagné, L., Gaulier G. and Zignago S. (2007), "Specialisation across Varieties within Products and North-South Competition", CEPII working paper no 2007-06.

[1989] Grossman, G. and E. Helpman (1989), "Product Development and International Trade", *Journal of Political Economy*, 97, 1261-83.

[1991a] Grossman, G. and E. Helpman (1991), "Quality Ladders and Product Cycle", *Quarterly Journal of Economics*, 106, 557-586.

[1991b] Grossman, G. and E. Helpman (1991), "Quality Ladders in the Theory of Growth", *Review of Economic Studies*, 58(1), 43-61.

[1991c] Grossman, G. and E. Helpman (1991), "Endogeneous Product Cycles", *Economic Journal*, 101, 1214-1229.

[1991d] Grossman, G. and E. Helpman (1991), *Innovation and Growth in the Global Economy*, MIT Press.

[2007] Gustasson, P. and P. Segerstrom (2007), "North-South Trade with Increasing Product Variety", *mimeo.*

[2005] Hallak, J. and P. Schott (2005), "Estimating cross country differences in product quality", *mimeo.*

[2006] Hallak, J. (2006), “Product Quality and the Direction of Trade”, *Journal of International Economics*, 68, 238-265.

[2005] Hummels, D. and P.J. Klenow (2005), “The Variety and Quality of a Nation’s Exports”, *American Economic Review*, 95, 704-23.

[2004] Klette, T. J. and S. Kortum (2004), “Innovating Firms and Aggregate Innovation”, *Journal of Political Economy*, 112, 986-1017.

[2003] Levinsohn, J. and A. Petrin (2003), “Estimating Production Functions Using Inputs to Control for Unobservables”, *The Review of Economic Studies*, 70(2), 317-341

[2006] Mayer, T. and S. Zignago (2006), “Notes on CEPII’s distances measures”, *CEPII Working Paper.*

[2003] Melitz, M. (2003), “The Impact of Trade on Intra-Industry Reallocations and Aggregate Industry Productivity”, *Econometrica*, 71, 1695-1725.

[2006] Nocke, V. and S. Yeaple (2006), “Globalization and endogeneous firm scope”, *NBER Working Paper* No. 12322

[1980] Porter M. (1980), “Competitive Strategy”, The Free Press.

[1985] Porter M. (1985), “Competitive Advantage”, The Free Press.

[1961] Posner, M. (1961), “International trade and technological change”, *Oxford Economic Papers*, vol. 13, 232-341.

[1988] Rivers, D. and Q.H. Vuong (1988), “Limited Information Estimators and Exogeneity Tests for Simultaneous Probit Models”, *Journal of Econometrics*, 39, 347-366.

[1981] Schankerman, M. (1981), "The Effects of Double-Counting and Expensing on the Measured Returns to R&D", *Review of Economics and Statistics*, 63(3), 454-458

[2004] Schott, P. (2004), “Across-Product versus Within-Product Specialization in International Trade”, *Quarterly Journal of Economics*, 119, 647-678.

[2003] Siebert, R. (2003), “The Introduction of New Product Qualities by Incumbent Firms: Merket Proliferation versus Cannibalization”, *WZB Working Paper* SPII 2003-11.

[1986] Smith, R. and R. Blundell (1986), “An Exogeneity Test for a Simultaneous Tobit Model with an Application to Labor Supply”, *Econometrica*, 54, 679-685.

[2003] Thoenig, M. and T. Verdier (2003), “A Theory of Defensive Skill-Biased Innovation and Globalization”, *American Economic Review*, 93, 709-728.

[2002] Tybout, J., (2002), “Plant and Firm Level Evidence on “New” Trade Theories”, NBER Working paper 8418.

[1966] Vernon R. (1966), “International Investment and International Trade in the Product Cycle”, *Quarterly Journal of Economics*, 80, 190-207.

[2001] Wooldridge, J. (2001), *Econometric Analysis of Cross Section and Panel Data*, MIT Press.

Appendices

A High-Tech ("Northern") and Low-Cost ("Southern") Countries

Table 9: Northern and Southern Countries (2004)

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 Robustness Checks

B.1 Year-to-Year Product Portfolio Reallocations

Table 10: International Competition and Year-to-Year Activity Switching

Dependent Variable:	**Max Share**	**Inertia Index**	**Reall. Index**	**New Act.**	**Drop Act.**
Model :	(1)	(2)	(3)	(4)	(5)
ln TFP_{t-3}	0.012^{**}	0.018^{***}	-0.013^{**}	-0.002	-0.003
	(0.006)	(0.006)	(0.006)	(0.003)	(0.003)
ln $Employment_{t-3}$	-0.025^{***}	-0.017^{***}	0.012^{***}	0.003^{**}	0.006^{***}
	(0.002)	(0.003)	(0.002)	(0.001)	(0.002)
ln $(Capital/VA)_{t-3}$	-0.003	0.005	-0.004	-0.004^{**}	-0.005^{**}
	(0.003)	(0.003)	(0.003)	(0.002)	(0.002)
ln $Herfindahl_{t-3}$	0.025^{***}	-0.001	-0.002	0.001	0.005
	(0.004)	(0.005)	(0.004)	(0.003)	(0.004)
ln $Diversification_{t-1}$	-0.513^{***}	-0.351^{***}	0.289^{***}	0.016^{**}	0.048^{***}
	(0.010)	(0.011)	(0.009)	(0.007)	(0.009)
ln North Exp. sh_{t-3}	-0.001	-0.003^{***}	0.002^{***}	0.001^{***}	0.001^{*}
	(0.001)	(0.001)	(0.001)	(0.000)	(0.000)
ln South $Pen._{t-3}$ × ln TFP_{t-1}	-0.004	0.000	0.001	0.001	0.000
	(0.003)	(0.003)	(0.003)	(0.002)	(0.002)
ln North $Pen._{t-3}$	0.016	-0.011	0.003	0.010	0.014
	(0.011)	(0.012)	(0.010)	(0.017)	(0.018)
ln South $Pen._{t-3}$	-0.073^{***}	-0.061^{***}	0.052^{***}	0.001	0.023^{**}
	(0.006)	(0.007)	(0.006)	(0.008)	(0.009)
Mean Dep. Var.	0.963	0.980	0.020	0.027	0.030
Observations	14158	14158	14158	14158	14158
Estimation Method	Tobit	Tobit	Tobit	OLS	OLS

Note: Robust standard errors in parentheses with ***, ** and * respectively denoting significance at the 1%, 5% and 10% levels. Exporting and non-exporting firms, activities are defined at the CPF3 level. In columns (1) and (2), the tobit estimations are both left (0) and right (1) censored.

B.2 Alternative Measure of TFP: Levinsohn - Petrin Estimates

Table 11: International Competition and Activity / Product Switching: TFP as Levinsohn-Petrin

Dependent Variable:	**Max Share**	**Inertia Index**	**Reall. Index**	**New Prod.**	**Drop Prod.**	**New Prod.**	**Drop Prod.**
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
ln TFP_{t-3}	0.014	-0.004	0.012	0.011^{**}	-0.008	0.035^{***}	0.027^{***}
	(0.012)	(0.014)	(0.012)	(0.006)	(0.006)	(0.010)	(0.010)
ln Employment_{t-3}	-0.029^{***}	-0.012^{**}	0.012^{**}	0.001	0.014^{***}	0.034^{***}	0.035^{***}
	(0.005)	(0.006)	(0.005)	(0.003)	(0.004)	(0.005)	(0.005)
ln $(\text{Capital/VA})_{t-3}$	-0.009	-0.007	0.005	-0.002	-0.005	-0.009	-0.000
	(0.007)	(0.008)	(0.007)	(0.004)	(0.004)	(0.007)	(0.007)
ln Herfindahl_{t-3}	0.022^{***}	-0.003	0.001	0.000	0.007	-0.000	0.002
	(0.009)	(0.010)	(0.009)	(0.004)	(0.006)	(0.007)	(0.007)
ln $\text{Diversification}_{t-3}$	-0.615^{***}	-0.437^{***}	0.372^{***}	0.064^{***}	0.062^{***}	0.020	0.007
	(0.022)	(0.025)	(0.022)	(0.014)	(0.017)	(0.015)	(0.015)
ln North Exp. Sh_{t-3}	-0.002	-0.003	0.004^{**}	0.001^{**}	0.001^{*}	0.017^{***}	0.019^{***}
	(0.002)	(0.002)	(0.002)	(0.001)	(0.001)	(0.003)	(0.003)
ln North Pen._{t-3}	0.005	0.005	-0.001	0.000	0.004	-0.016	-0.035^{***}
	(0.012)	(0.014)	(0.013)	(0.006)	(0.008)	(0.012)	(0.011)
ln South Pen._{t-3}	-0.034^{***}	-0.026^{***}	0.022^{***}	0.002	0.001	0.021	0.021
	(0.007)	(0.008)	(0.008)	(0.003)	(0.004)	(0.007)	(0.007)
ln South Pen._{t-3} × ln TFP_{t-3}	0.002	0.007	-0.007	0.000	-0.002	-0.006	-0.006
	(0.007)	(0.008)	(0.007)	(0.002)	(0.004)	(0.006)	(0.006)
Inv. Mill's Ratio	-	-	-	-	-	-0.117^{***}	-0.080^{*}
						(0.044)	(0.042)
Mean Dep. Var.	0.963	0.970	0.030	0.035	0.062	0.878	0.881
	(4 dig.)	(4 dig.)	(4 dig.)	(4 dig.)	(4 dig.)	(6 dig.)	(6 dig.)
Observations	4085	4085	4085	4085	4085	3494	3494
Estimation Method	Tobit	Tobit	Tobit	OLS	OLS	OLS	OLS

Note: Robust standard errors in parentheses with ***, ** and * respectively denoting significance at the 1%, 5% and 10% levels. In col. (1) to (5), estimation is performed on a sample of exporting and non-exporting firms, and activities are defined at the NAF level. In columns (1) to (3), the tobit estimations are both left (0) and right (1) censored. In col. (6) and (7), estimation is performed on a sample of exporting firms only, and activities are defined at the CPF6 level. The estimation period covers 2000/2002 and 2002/2004.