Sectoral dynamics of international trade and technological change

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1 Introduction

The aim of this paper is to investigate, from an empirical perspective, the relative importance of technological vis à vis other non-technological determinants of the dynamics of international competitiveness in manufacturing industries over the period 1980-2005.

The econometric analysis of the effects of technology on trade has a well established tradition. Using US patent data in 22 countries and 40 industrial sectors, Soete (1981) has carried out the first study highlighting the role of technological factors (measured as patents shares) in explaining the inter-country variations in market shares, although within a cross-sectional and purely static framework. Since then, several papers have explored the issue in a dynamic setting. Within the tradition of the technological gap approach to international trade, most studies find a positive and significant impact of technological variables on export performance overall industries (Dosi et al. 1990, Amendola et al. 1993, Amable and Verpagen 1995, Amendola et al. 1998, Laursen 1999, Laursen and Drejer 1999, Meliciani 2001, Laursen and Meliciani 2000, 2002, Montobbio 2003, Anderson and Ejermo 2008).

However, there have been only few attempts that simultaneously account for the short and the long run effects of technological factors on export performance, and for the effects of broad sectoral factors in the relationship between technology and trade. Using USPTO patents, Amendola et al. (1993) and Laursen and Meliciani (2000, 2002) show that technological factors (respectively as patent share and patent count of a country in a industry) appear to be the only relevant determinants of a country's export performance (export shares and trade balance) in the long run, while non-technological factors (labor costs and lagged export performance) are only significant in the short run. Moreover, Laursen and Meliciani (2002) find that the sectoral dimension matters over both the long and the short run, as technology indeed affects the trade balance only in some sectors. More recently Laursen and Meliciani (2010), using USPTO patents find, over all industries, that unit labour costs (ratio of wages per worker over value-added per worker) have a negative and significant impact on export shares in both the short run and the longer run. Moreover the patent variable shows a significant and positive impact in the long and the shorter run, although very low. However they are mainly interested in the effects of domestic and foreign ICT knowledge flows on export market shares and they use patents over population.

In this paper we are interested in the effects of technological and non-technological competitiveness on export shares dynamics. As Amendola et al. (1993) we use an autoregressive distributed lags model to investigate the long and short run effects of labor costs, patent and investment shares on the dynamics of relative international performances. At a general level, our contribution departs from previous studies as we simultaneously consider the impact of absolute advantages and disadvantages in technology creation on relative export performances at the sectoral level. More specifically, and improving upon Amendola et al.(1993), we do take into account the sector-specific variations in the degree to which countries' innovations affect trade performances. Moreover, contrary to Laursen and Meliciani (2000, 2002), we account for overall export performances and for the effects of embodied innovation, as generally proxied by investments in tangible assets. While Laursen and Meliciani (2010) look at the effects of patents over populations and investment per employee we look for the impact of countries absolute advantages/disadvantages in the creation and adoption of technology, proxied by patents and investment shares across sectors. Moreover the long run estimates are obtained using instrumental variables regression in which instruments are selected on the basis of the Bayesian Information Criterion (BIC). Finally, a further contribution is represented by the availability of different data. We use a panel dataset of 13 OECD countries and 20 industrial sectors (ISIC Rev 3) over the period 1980-2005. The use of EPO patents is new in this context, and allows to compare our results to previous studies based on USPTO patents and to avoid traditional concerns about home market bias towards the United States that arises when using USPTO data. Over the sample period, we witness an important rise in patents granted by the EPO, making it even more relevant to look for their possible economic impact.

Hence the purpose of the paper is to study the effects of lagged export shares, unit labor costs, patents and investment shares on the dynamics of export market shares of countries in manufacturing industries over the period 1980-2005. The paper is organized as follows. Section 2 depicts the dynamic econometric specification of the model. Section 3 describes the data and variables used for the empirical analysis. In section 4 we present the results of the estimations considering all countries and industries and we look more precisely at the possible inter-industry differences in the relationship between technology and trade. Finally section 5 concludes.

2 The data and variables

The economic rationale behind models based on the technological gap approach to international trade is that export shares depend on the competitiveness of a country. In these dynamic models, competitiveness results from the interplay of both technological and non-technological or price factors. Price factors are generally proxied by wages per worker or unit labor costs. Technological competitiveness is generally captured by measures of both embodied and disembodied innovativeness. Disembodied technical change is measured using either RD (Montobbio 2003) or patents statistics (Amendola et al. 1993, Amable and Verspagen 1995, Laursen and Meliciani 2000, 2002, 2010, Anderson and Ejermo 2008). Embodied innovations are generally measured by investment (Amendola et al. 1993, Laursen 1999, Laursen and Drejer 1999, Meliciani 2001, Laursen and Meliciani 2010), and this indicator could also reflect the imitation efforts from firms in different national sectors.

In keeping with the literature, our dependent variable is defined as

$EXP_{i,j,t} = \frac{X_{i,j,t}}{\sum_i X_{i,j,t}}$, where $X_{i,j,t}$ denotes the exports of country i in sector j in period t. In order to account for the effects of prices changes, exports are expressed in current prices (Amendola et al. 1993, Laursen and Meliciani 2010).

As explanatory variables we consider:

- the lagged values of exports shares of country i in sector j, $EXP_{i,j,t-r}$, accounting for persistence in export patterns.

- the share of patents by country and sector at time t:

  $PATS_{i,j,t} = \frac{PAT_{i,j,t}}{\sum_i PAT_{i,j,t}}$, where $PAT_{i,j,t}$ denotes the number of patents of country i in sector j at time t. As we are interested in the effects of the innovation output, we prefer this measure of disembodied innovation over the alternative based on RD statistics.

- a proxy for absolute advantages in embodied innovation (in capital) defined as:

  $INV_{i,j,t} = \frac{GFCF_{i,j,t}}{\sum_i GFCF_{i,j,t}}$, where $GFCF$ stands for Gross Fixed Capital Formation. Ideally we would like to use the ratio between the Gross Fixed Capital Formation and the Stock of Gross Capital. However the latter displays too many missing values for many sectors and countries over the period.

- a proxy of price/cost factors obtained as the ratio of labor costs per person relative to the country sectoral average:

  $LCpers_{i,j,t} = \frac{LC/pers_{i,j,t}}{Averagej(LC/pers_{i,j,t})}$,

The data applied in the paper cover the period 1980-2005. Export, labor costs and investment variables are extracted from the OECD STAN (2008) dataset. Patent data are taken from the European Patent Office (EPO) database. In order to obtain patent data decomposed by industrial sector we use the SPRU-OST-ISI correspondence (Ulrich Schmoch et al. 2003) between 43 manufacturing sectors (2- and 3-digits level; 15t36, ISIC Rev.3) and 631 International Patent Classes. This concordance table between industrial sectors and patent data from the EPO allows us to avoid the traditional concerns about domestic or home market effect towards United-States due to the use of USPTO patents data. It also allows a direct use of the OECD economic variables which are provided according to the same classification (ISIC); then avoiding possible biases introduced by the correspondence between classifications for these latest variables. However it is also important to note that this limits our initial dataset choice as we have to consider as a starting selection point the 43 manufacturing sectors for which the correspondence has been achieved. As in the concordance procedure from the report we use patents applications at the EPO, by country of application, by priority date between 1980 and 2005. The patent data is available for all countries for those 43 sectors. The availability of the other variables (exports, gross fixed capital formation and labor costs) will therefore determine the sample size.

Our final dataset includes 13 countries (Austria, Canada, Finland, France, Germany, Italy, Japan, Netherlands, Norway, Spain, Sweden, United Kingdom and United-States) and 20 manufacturing sectors (ISIC Rev 3) over the period 1980-2005. The sectors included are Food, Beverages (15), Tobacco products (16), Textiles (17), Wearing apparel (18), Leather (19), Wood and wood products (20), Pulp and paper (21), Coke, Refined petrolum products and nuclear fuel (23), Chemicals excluded pharmaceuticals (24-2423), Pharmaceuticals (2423), Rubber and plastics products (25), Other non-metallic mineral products (26), Basic metal (27), Fabricated metal products (28), Machinery and equipment n.e.c. (29), Office and accounting and computing machinery (30), Electrical machinery and apparatus n.e.c. (31), Radio, television and communication equipment, Medical precision and optical instruments (33) and Motor vehicles, trailers and semi-trailers (34).

3 Dynamic econometric specification

We adopt a dynamic specification of the determinants of the sector-country export performance. We consider the autoregressive distributed lags (ARDL) model that follows:

$$EXP_{i,j,t} = \sum_{l=1}^{k} \alpha_l EXP_{i,j,t-l} + \sum_{l=0}^{m} \beta_l PATS_{i,j,t-l} + \sum_{l=0}^{n} \delta_l INV_{i,j,t-l} + \sum_{l=0}^{g} \gamma_l LCPERS_{i,j,t-l} + \lambda_i + \psi_j + \varepsilon_{i,j,t} \qquad (1)$$

where i=1....N, j=1....S, t=1....T, λ_i denotes countries fixed-effects, ψ_j denotes sectors fixed-effects, and $\varepsilon_{i,j,t}$ is a random residual.

This specification has an evolutionary interpretation as it allows for selection dynamics that link competitiveness (fitness) and variations in export shares at the sectoral level (Amendola et al. 1993, Laursen and Meliciani 2002). Moreover it allows capturing several cumulative mechanisms that reinforce the competitiveness of firms on international markets (Amendola et al. 1993, Laursen and Meliciani 2000, 2002). According to Laursen and Meliciani (2000), this approach is preferred to other dynamic specifications that estimate adjustment equations (Amable and Verspagen 1995) as countries export market shares tend to be persistent over time.

However, one problem with specification (1) is that it is a short run equation. That is, point estimates and standard errors of the long-run multipliers $\Theta_P = \Phi \sum_{l=0}^{m} \beta_l$, $\Theta_I = \Phi \sum_{l=0}^{n} \gamma_l$, $\Theta_C = \Phi \sum_{l=0}^{g} \delta_l$ (with $\Phi = (1 - \sum_{l=1}^{k} \alpha_l)^{-1}$), respectively associated with patents, investment and labor costs, are only indirectly recovered from estimates of short run effects. A suitable alternative is to derive an equivalent long- run model, where long-run multipliers directly appear among the coeffcients to be estimated. As known since Wickens and Breusch (1988) this can be easily obtained by a simple reparametrisation where $\sum_{l=1}^{k} \alpha_l EXP_{i,j,t}$ is substracted from each side of eqution (1) and then one consequently re- arranges the variables related to patents, investment and labour costs. This gives the following long-run equation:

$$
\begin{aligned}
EXP_{i,j,t} = -\Phi \sum_{l=1}^{k} \alpha_l (EXP_{i,j,t} - EXP_{i,j,t-l}) + \Phi \sum_{l=0}^{m} \beta_l PATS_{i,j,t} - \Phi \sum_{l=1}^{m} \beta_l (PATS_{i,j,t} - PATS_{i,j,t-l}) \\
+\Phi \sum_{l=0}^{n} \delta_l INV_{i,j,t} - \Phi \sum_{l=1}^{n} \delta_l (INV_{i,j,t} - INV_{i,j,t-l}) \\
+\Phi \sum_{l=0}^{g} \gamma_l LCPERS_{i,j,t} - \Phi \sum_{l=1}^{g} \gamma_l (LCPERS_{i,j,t} - LCPERS_{i,j,t-l}) \\
+\Phi\lambda_i + \Phi\psi_j + \Phi\varepsilon_{i,j,t}
\end{aligned} \tag{2}
$$

where it is easy to see that the coefficients on $PATS_t$, INV_t and $LCPERS_t$ are indeed the long-run multipliers.

Now, while the short-run equation can be consistently estimated via OLS, the long-run equation clearly requires instrumental variables (Wickens and Breusch 1988). However, Wickens and Breusch show that estimating the long run equation by instrumental variables, using as instruments all the explanatory variables in the short run equation, provides the same estimates of long-run multipliers that would results from indirect estimate of the short run equation via OLS. Such a result holds if all variables are stationary or difference stationary, and it also necessary to include the lags of the dependent and explanatory variables to reduce small sample bias, and to achieve full efficiency of such coefficients (Wickens and Breuch 1988, Stock 1984).

After checking that our variables do display stationarity in first differences (via Unit roots tests for dynamic panel data based on Augmented Dickey-Fuller), we proceed in two steps. In the first step we focus on OLS estimates of the short run equation and perform model selection in search of the "best" ARDL model. We start with the inclusion of a high number of lags for both the lagged dependent and the explanatory variables, and then gradually select among models with lower order of lags, using the Bayesian Information Criterion. This allows us to obtain a model which favors parsimonious results, i.e. a model including the variables which are the most correlated with the dependent variable, and also allowing for a minimum correlation between explanatory variables. This selection procedure suggests that the short-run equation is better modeled as an ARDL(1,1,1,1) model, i.e. where we only include the 1-year lagged values of all the explanatory variables (lagged export shares, technological and cost factors). Thus, in the second step, the long run multipliers are estimated by applying two-stages least squares to the long run equation, where, following Wickens and Breusch (1988), the instruments are given by the explanatory variables appearing in the selected short run equation structure.

The same procedure is first applied to the entire sample, and then separately by each sector. Based on the literature, we expect technological variables to have a positive impact in the long run, while labor costs should negatively affect exports shares dynamics in a shorter run. We also expect, as in Laursen and Drejer (1999) and Laursen and Meliciani (2000, 2002 and 2010), to find heterogeneity across sectors. The rationale behind these comparisons is that these long run effects should be stronger in those industries where patents are privileged as a means of protection of innovation.

4 Estimation results

In Table 1 we show results of the analysis where we consider all countries and sectors together. We estimate the short run equation by simple pooled OLS (column 2) and pooled OLS with country and industry dummies (column 4). Accordingly, instrumental variable (2-stage least squares) estimates of the long run equation without and with country and industry dummies are also reported (in column 3 and column 5, respectively).

Table 1: Results of pooled regressions

EXP	Short-run coefficients	Long-run coefficients	Short-run coefficients	Long-run coefficients
EXP_{t-1}	0.98* (0.009)	-	0.97* (0.01)	-
ΔEXP	-	-40.8* (10,9)	-	-31.03* (7.23)
PATS	-0.014 (0.0142)	0.61* (0,15)	-0.01 (0.01)	0.765* (0.301)
$\Delta PATS$	-	-1.20 (0.7)	-	-1.09 (0.56)
$PATS_{t-1}$	0.029 (0.018)	-	0.03 (0.02)	-
INV	0.001* (0.0003)	0.017* (0.006)	0.0007* (0.0002)	-0.0026 (0.006)
ΔINV	-	0.027 (0.014)	-	0.025* (0.01)
INV_{t-1}	-0,0006* (0,0003)	-	-0.00078* (0.0003)	-
LCPERS	0.01* (0.002)	0.007 (0.009)	0.0098* (0.0019)	-0.02 (0.03)
$\Delta LCPERS$	-	0.44* (0.13)	-	0.33* (0.09)
$LCPERS_{t-1}$	-0.01* (0,002)	-	-0.01* (0.002)	-
Dummies	no	no	yes	yes
R^2	0.99	-	0.99	-
Adjusted R^2	0.99	-	0.99	-
Nb of obs	5842	5842	5842	5842
Root MSE	0.01	0.48	0.01	0.37

* Significant at 5% , Standard errors are in parenthesis.

Overall results appear to be consistent with previous empirical findings on the relative importance of technological factors for relative export performance in the long run. We find that patent shares always have a positive and significant impact on relative exports performances in the long run. The adoption of technology (proxied by investment share) also appears to have a positive and significant effect but only when we consider the estimation excluding country and industry dummies. As expected labor costs appear to be significant only in the short run. Indeed short run effects seem to be absorbed in the longer term (Amendola et al. 1993). Contrary to Amendola et al. (1993) instantaneous relationships occur between investment and export market shares. This effect seems to go against the rationale that firms always need to take a considerable time in embodying new knowledge in old and new products, in fully exploiting new equipment and in gathering advantage on international competition. However our results show that the coefficient of the first year lag appears to be significant and negative. As Amendola et al. (1993) we find an instantaneous positive and significant effect of labor costs and a negative and significant 1-year lagged effect of labor costs on exports market shares. According to the authors such an instantaneous relationship is likely to be a consequence of the time required for the market to react to the variations in labor costs.

Then we complete the analysis by taking into account the heterogeneity among sectors. To that purpose we estimate the effects of technological and non-technological factors on export performances for each individual industry, in the short and the longer run, and with country dummies (table 2).

Table 2: Results of regressions at the industrial level

	Food, Beverages		**Tobacco products**		**Textiles**	
EXP	**Short run**	**Long run**	**Short run**	**Long run**	**Short run**	**Long run**
EXP_{t-1}	0.13* (0.05)	-	0.79* (0.037)	-	0.9* (0.055)	-
PATS	-0.025 (0.077)	-0.143 (0.173)	0.018 (0.03)	0.86 (0.298)	0.0026 (0.02)	0.49 (0.36)
$PATS_{t-1}$	-0.1 (0.13)	-	0.158* (0.07)	-	0.033* (0.01)	-
INV	0.021* (0.008)	0.033* (0.009)	-0.0002 (0.0006)	-0.001 (0.003)	0.0049* (0.002)	0.025 (0.016)
INV_{t-1}	0.004 (0.013)	-	0.00007 (0.000)	-	-0.0037 (0.002)	-
LCPERS	0.013 (0.017)	-0.019** (0.01)	0.028* (0.012)	0.009 (0.012)	-0.001 (0.002)	0.0034 (0.011)
$LCPERS_{t-1}$	-0.037* (0.016)	-	-0.023** (0.064)	-	-0.0039* (0.002)	-
R^2	0.96	-	0.97	-	0.9976	-
Nb of obs	275	275	270	270	299	299
	Wearing apparel		**Leather**		**Wood, Wood products**	
EXP	**Short run**	**Long run**	**Short run**	**Long run**	**Short run**	**Long run**
EXP_{t-1}	0.90* (0.04)	-	0.76* (0.08)	-	0.83* (0.05)	-
PATS	-.0069 (0.007)	0.24 (0.42)	-0.02* (0.007)	-0.019 (0.818)	0.003 (0.017)	-0.069 (0.12)
$PATS_{t-1}$	0.025 (0.03)	-	0.01 (0.01)	-	-0.007 (0.007)	-
INV	-0.0005 (0.002)	-0.005 (0.02)	-2.9e-06 (0.0007)	-0.0017 (0.005)	-0.0039 (0.003)	-0.0148 (0.015)
INV_{t-1}	-0.0013 (0.002)	-	-0.0007 (0.0008)	-	0.0007 (0.0016)	-
LCPERS	-0.006 (0.005)	-0.003 (0.015)	-0.001 (0.002)	0.026* (0.006)	0.016* (0.007)	0.079* (0.024)
$LCPERS_{t-1}$	-0.005 (0.002)	-	-0.002** (0.001)	-	-0.016* (0.0026)	-
R^2	0.9969	-	0.9988	-	0.9944	-
Nb of obs	298	298	299	299	299	299

	Pulp paper		Coke, refined petrolum prod.		Chemicals excluded pharmaceuticals	
EXP	**Short run**	**Long run**	**Short run**	**Long run**	**Short run**	**Long run**
EXP_{t-1}	0.94* (0.016)	-	0.75* (0.03)	-	0.43* (0.19)	-
PATS	0.006 (0.0099)	0.18 (0.27)	-0.009 (0.02)	-0.07 (0.15)	0.45 (0.25)	0.0104 (0.25)
$PATS_{t-1}$	0.004 (0.016)	-	-0.01 (0.03)	-	-0.46 (0.23)	-
INV	-0.0001 (0.0007)	0.01 (0.006)	-0.0005 (0.0004)	0-.002 (0.002)	0.008 (0.006)	0.009 (0.006)
INV_{t-1}	0.00001 (0.0009)	-	0.00005 (0.0008)	-	-0.003 (0.004)	-
LCPERS	0.023* (0.005)	0.0027 (0.886)	0.007 (0.004)	0.0067* (0.002)	-.0025 (0.005)	0.003 (0.005)
$LCPERS_{t-1}$	-0.03* (0.00098)	-	-0.002 (0.004)	-	-0.0007 (0.0015)	-
R^2	0.9978	-	0.9929	-	0.9915	-
Nb of obs	299	299	272	272	275	275

	Pharmaceuticals		Rubber and plastic products		Other non-metallic mineral products	
EXP	**Short run**	**Long run**	**Short run**	**Long run**	**Short run**	**Long run**
EXP_{t-1}	0.57* (0.13)	-	0.87* (0.016)	-	0.88* (0.03)	-
PATS	-0.139 (0.13)	-0.2702* (0.121)	-0.026 (0.03)	-0.283 (0.36)	0.002 (0.05)	0-.127 (0.448)
$PATS_{t-1}$	0.019 (0.078)	-	-0.019 (0.04)	-	-0.04 (0.04)	-
INV	0.0017 (0.002)	0.0026 (0.004)	0.005* (0.0027)	0.028* (0.013)	-0.003 (0.002)	-0.025 (0.017)
INV_{t-1}	-0.001 (0.001)	-	-0.003 (0.0027)	-	0.0008 (0.001)	-
LCPERS	0.012 (0.007)	0.024* (0.007)	0.003 (0.003)	0.0012 (0.012)	0.005* (0.002)	0.042* (0.018)
$LCPERS_{t-1}$	-0.006* (0.002)	-	-0.008* (0.03)	-	-0.0096* (0.003)	-
R^2	0.9941	-	0.997	-	0.998	-
Nb of obs	299	299	299	299	299	299

	Basic metals		Fabricated metal products		Machinery and equipment nec	
EXP	**Short run**	**Long run**	**Short run**	**Long run**	**Short run**	**Long run**
EXP_{t-1}	0.7* (0.045)	-	0.85* (0.03)	-	0.7* (0.03)	-
PATS	-0.08 (0.046)	-0.031 (0.29)	0.013 (0.026)	-0.217 (0.426)	-0.06 (0.05)	0.382* (0.156)
$PATS_{t-1}$	0.05 (0.03)	-	-0.065 (0.04)	-	0.17* (0.03)	-
INV	-0.001 (0.001)	-0.0039 (0.004)	0.004** (0.08)	0.0188 (0.013)	0.009 (0.005)	0.01016* (0.0045)
INVt-1	0.00003 (0.004)	-	-0.003** (0.002)	-	-0.006 (0.004)	-
LCPERS	0.017* (0.004)	0.016 (0.011)	0.002 (0.003)	0.0077 (0.019)	0.004** (0.002)	0.006 (0.005)
$LCPERS_{t-1}$	-0.03* (0.003)	-	-0.01* (0.003)	-	-0.004 (0.003)	-
R^2	0.995	-	0.9962	-	0.9963	-
Nb of obs	299	299	299	299	299	299

	Office, computing machinery		Electrical machinery, apparatus nec		Radio, TV and communication equipment	
EXP	**Short run**	**Long run**	**Short run**	**Long run**	**Short run**	**Long run**
EXP_{t-1}	0.9* (0.087)	-	0.7* (0.036)	-	0.88* (0.03)	-
PATS	-0.006 (0.07)	1.909** (0.997)	-0.06 (0.079)	-0.219 (0.275)	-0.046 (0.085)	-0.209 (0.4)
$PATS_{t-1}$	0.17 (0.104	-	-0.012 (0.05)	-	0.02 (0.088)	-
INV	0.0005 (0.0004)	0.0011 (0.002)	0.003* (0.001)	0.00985** (0.006)	-0.0004 (0.001)	0.016 (0.01)
INV_{t-1}	-0.0005 (0.0004)	-	-0.0007 (0.001)	-	0.002 (0.001)	-
LCPERS	0.007* (0.002)	-0.0086 (0.016)	0.0008 (0.004)	0.0197* (0.005)	0.0013 (0.003)	-0.011 (0.014)
$LCPERS_{t-1}$	-0.009* (0.003)	-	-0.008* (0.002)	-	-0.0099* (0.004)	-
R^2	0.9959	-	0.9956	-	0.9931	-
Nb of obs	296	296	297	297	298	298
	Medical, precision, optical instrument		**Motor vehicles, trailers**			
EXP	**Short run**	**Long run**	**Short run**	**Long run**		
EXP_{t-1}	0.78* (0.04)	-	0.71* (0.06)	-		
PATS	0.086* (0.02)	0.3174 (0.22)	-0.124 (0.078)	0.0202 (0.137)		
$PATS_{t-1}$	-0.018 (0.036)	-	0.13 (0.09)	-		
INV	0.0006 (0.0006)	0.0052 (0.004)	0.0007 (0.0004)	0.0018 (0.0018)		
INV_{t-1}	0.00004 (0.0009)	-	-0.00005 (0.0004)	-		
LCPERS	0.004* (0.004)	0.0007 (0.0089)	0.012 (0.008)	0.0179* (0.005)		
$LCPERS_{t-1}$	-.006** (0.002)	-	-0.0046 (0.003)	-		
R^2	0.9973	-	0.9948	-		
Nb of obs	272	272	299	299		

* Significant at 5% ** significant at 10% Standard errors are in parenthesis.

As expected in the short run labor costs (1-year lag) appear to be significant and negative is almost all industries except in wearing apparel (18), coke refined, petroleum (23), chemicals (24 exc. 2423), machinery and equipment (29) and motor and vehicles. According to Laursen and Meliciani (2000) the significant negative impact of the cost variable in science-based industries as pharmaceuticals (2423), office, accounting and computing machinery (30), communication equipment (32) and medical, optical and precision instruments (33) may be due to the fact that firms in this sector are multinationals enterprises. Therefore they also have costs concerns when making the localization decisions in terms of production. As Laursen and Meliciani (2010) we find that in all ICT sectors, including office computing machinery, electrical machinery (31), radio, television and communication equipment (32) and medical, precision and optical instruments (33), labor costs appear to be significant and negative in the short run.

We find a significant and positive instantaneous relationship between investment and export shares in food, beverages (15), rubber and plastic products (25), fabricated metal products (28) and in electrical machinery (31). Besides patent shares have a significant positive impact on export shares in tobacco products (16), textiles (17), and machinery and equipment (29). Finally there is also a significant negative instantaneous relationship between patent shares (1-year lag) and export shares in leather and medical, precision and optical instruments. In the long run labor costs show up with a significant and positive impact in leather (19), wood and wood products (20), coke, refined petroleum (23), pharmaceuticals (2423), other non-metallic mineral products (26) and motor vehicles (34). Concerning the technology variables contrary to previous studies we do not find a general pattern of significance in the long run. Investment shares have a positive and significant effect only in rubber and plastic products, machinery and equipment and electrical machinery apparatus and patent shares only in machinery and equipment and office, accounting and computing machinery. As for the labor costs investment variable shows up with a negative and significant sign in food, beverages. Moreover the effect of patent shares on relative export performances is significant and negative in pharmaceuticals. This latter effect was not expected as pharmaceuticals industry is a highly intensive RD sectors in which patents appear to be a privileged means of protection.

5 Conclusion and further work

The aim of this paper has been to investigate the relative importance of technological vis à vis non-technological factors on export shares dynamics. The main result of the paper is that overall industries and countries technological factors, especially patent shares, have a positive impact on relative export performances. This result seems to hold when either United States Patents Trade Office or European Patent Office patent data is used. As expected labor cost variable show up with a significant and negative parameter only in the short run (1-year lag).

At the industrial level results appear to be more puzzling in the long run. First we find low evidence for the relevance of technological variables in the long run. Investment shares have a positive effect only in rubber and plastic products, machinery and equipment and electrical machinery apparatus and patent shares only in machinery and equipment and office, accounting and computing machinery. These results may be related to limitations in our database as the number of patent applications at the EPO, although increasing, has historically remained lower than applications at USPTO. Besides the fact that EPO has been recently created, other reasons for this difference relate to the advanced nature of technology producers and users in the United-States and the importance of the market for technology. Thus comparing to the EPO and given the period under analysis, United-States has been a primary place for patenting activities of world organizations. Second contrary to most previous studies we find as Laursen and Meliciani (2010) that labor cost may show up with a significant impact in the long run. We find a significant positive impact of labor cost in the long run in seven out of twenty sectors that include high-tech sectors (pharmaceuticals, electrical machinery), a medium technology sector (motor vehicles) and low or medium low technology sectors (leather, wood and wood products, coke, refined petroleum and other non-metallic mineral products). One possible explanation could be that given the origin of the data, patents may constitute, in our case, a poor measure of technological capabilities at least at the sectoral level. Thus labor costs would appear to be the closest variable after patents in our equation that may actually capture the degree of development or the technological level of countries. Labor costs could thus reflect the level of human capital in a country, and as such may have a positive impact on export performances in the long run. Finally we did not expect that patents show up with a negative sign in pharmaceuticals as it is a high technology industry in which patents are a privileged means of protection. This may come from the country-specific regulatory environment that leads firms in these industries to settle production plants in the host or destination market rather than exporting. However it might also be the case that given the multinational dimension of pharmaceuticals firms that they actually do not perform production activities in the same locations where they apply for patents, in our case at EPO. This assumption needs of course further investigations on production location choices of pharmaceuticals industry in the period we consider.

As the disaggregation at the individual industrial level may affect our results further works will include testing for the importance of broader sectoral characteristics. We may test for the effects of technological and non-technological factors on international market shares at higher level of aggregation, looking for instance at the industries in terms of Information and Communication Technologies'sectors, of RD intensity and also in terms of Pavitt'sectoral categories. This might help to overcome the potential small number problems of EPO patents by sector and reveal some significant differences across sectoral categories in the relationship between technological competitiveness.

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