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R&D and Price Elasticity of Demand

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Abstract

This note explores the relationship between the price elasticity of demand and the R&D intensity of the product. We introduce the concept of R&D intensity into a standard Dixit-Stiglitz/Krugman-type setting. R&D activity is treated as a fixed cost of production. Within this framework, sectors with a higher R&D intensity show a lower price elasticity of demand. This proposition is confirmed by an empirical investigation of export demand for manufactured goods from major industrialised countries. Consequently, real exchange rate changes have an impact on the commodity structure of exports.

Keywords: R&D intensity, price elasticity, exports

JEL code: F14, D40, F12

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1 Introduction

Changes in real exchange rates have an impact on the volume of trade flows depending on the price elasticity of export demand. If the price elasticity varies by groups of products, exchange-rate changes also have an effect on the commodity structure of foreign trade. The present note examines this possibility with respect to R&D intensity, and shows, in theoretical as well as empirical terms, that the price elasticity of demand depends negatively on the R&D intensity of the products.

Estimating the price elasticities of foreign trade flows by countries and product groups has a long tradition, see in particular the work of Houthakker and Magee (1969), the compilation by Stern, Francis and Schumacher (1976) and estimates by Wilson and Takacs (1979). Goldstein and Khan (1985) give an overview of the state of the art at the time of writing. More recent estimations of price elasticities of foreign trade (e.g. Senhadji and Montenegro, 1999, or Hooper, Johnson and Marquez, 2000) differ from those of the 1970s and 1980s mainly in that the methods of estimation now take account of unit roots in the variables of the export demand equation. The existing literature does not, however, systematically explore the relationship between price elasticity and characteristics of products. A growing number of studies exist on the relationship between R&D and the export performance of firms or countries, see e.g. Barrios, Gorg and Strobl (2003), Martinez-Zarzoso and Suarez-Burguet (2000), and Beise and Rammer (2003). These studies emphasize the important role of R&D for high exports, but they do not consider the issue of price elasticity – the topic of this paper.

The formal approach used here is Chamberlinian monopolistic competition, which builds on the seminal work of Dixit and Stiglitz (1977). We model an economy that features a large number of sectors, each consisting of monopolistic competitive firms. Each sector is distinguished by its degree of R&D intensity, which constitutes a fixed production cost to firms. Consumers value variety within each sector. We use the term sector interchangeably with the terms "industry" or "product group". The Dixit-Stiglitz specification we propose has been used widely in the literature. Since Krugman (1980) in particular, this approach has been one of the workhorses for explaining international intra-industry trade. We discuss the effects of trade between two countries within the above specification. Our empirical approach testing the theoretical finding that sectors with higher R&D intensity feature lower price elasticity is based on the exports of the seven major industrialised countries, subdivided into R&D-intensive and non-R&D-intensive products.

The remainder of the paper is organised as follows. In Section 2 we introduce the model and present the theoretical results. Section 3 describes the empirical approach and the data used in more detail, and presents the estimation method and the estimation results. Section 4 concludes.

2 A simple Model

Consider an economy with M sectors, producing differentiated products and separated by their degree of R&D activity/intensity. Each sector consists of a large number of firms (and products), n_j, which feature economies of scale in production and engage in monopolistic competition in a market with free entry and exit.[4] The labour force, L, is the only factor of production, and each worker supplies one unit of labour at the economy-wide wage rate, ω. Constant marginal costs, β, are assumed to be equal across all sectors, while R&D activity is represented by the sector-specific fixed cost α_j. The cost function of firm i in sector j thus becomes, $l_{j,i} = \alpha_j + \beta x_{j,i}$, where $x_{j,i}$ is the per-firm output quantity. Sectors are labelled such that $\alpha_{k+1} > \alpha_k \ \forall\, k = 1,\ldots,M-1$. The profits of firm i in sector j are thus

$$\pi_{j,i} = p_{j,i} x_{j,i} - (\alpha_j + \beta x_{j,i})\omega \,. \tag{1}$$

Consumer utility is represented by the Dixit-Stiglitz preferences:

$$U = \sum_{j=1}^{M} \ln \sum_{i=1}^{n_j} c_{j,i}^{\theta_j} \,, \tag{2}$$

where $c_{j,i}$ is the consumption of the i's variant from the j's sector. Consumers value variety, and hence $0 < \theta_j < 1$ applies, where the parameter θ_j varies across sectors. In this specification, a lower θ_j corresponds to larger weight on variety in consumer tastes. In the inverse case, as θ_j approaches *1,* consumers care mostly about consumption volume and little about consumption variety, i.e. products are perceived as fairly homogenous and as close substitutes.[5] For simplicity we assume that $\frac{\sum_{j=1}^{M}\theta_j}{M} = 1/2$. The budget constraint reads $\sum_{j=1}^{M}\sum_{i=1}^{n_j} p_{j,i} c_{j,i} = \omega$. Maximisation of (2) implies that the share of total income spent on products from sector j is $\frac{2\theta_j}{M}$.

[4] Note that we adopt the standard (e.g. Krugman, 1980) interpretation where there is no distinction between firms and products, i.e. each firm is assumed to produce only one product and each product is only produced by one firm. It is straightforward to re-interpret this assumption such that each firm provides several product lines, and thus the number of firms would be smaller than the number of products. Yet, no matter which way the relation between firms and products is viewed, the fundamental mechanisms and results of the model are not affected.

[5] With this specification, we follow the vast majority of the literature originating from Dixit and Stiglitz (1977). Yet, the limitations of this approach should also be kept in mind; see for example Benassy (1996) for a discussion on the implied link between taste for variety and market power.

Since the expenditure share for each sector is constant, the demand function facing a firm active in any sector j can be obtained by maximisation of $\ln \sum_{i=1}^{n_j} c_{j,i}^{\theta_j} - \lambda(\sum_{i=1}^{n_j} p_{j,i} c_{j,i} - \omega \frac{2\theta_j}{M})$. The first-order condition for the consumption of product k in sector j reads

$$\lambda \varsigma p_{j,k} = \theta_j c_{j,k}^{\theta_j - 1}, \tag{3}$$

where $\varsigma = \sum_{i=1}^{n_j} c_{j,i}^{\theta_j}$. Provided that there are a large number of firms in each sector, the pricing decision of any one firm has a negligible effect on the marginal utility of income and hence ζ can be treated as constant, i.e. $\lim_{n_j \to \infty} \frac{\partial \varsigma}{\delta c_{j,k}} = 0$. Finally, assuming that the number of consumers equals the labour force, and evoking market clearing, $x_{j,i} = Lc_{j,i}$, demand can be expressed as

$$p_{j,i} = \frac{\theta_j}{\lambda \varsigma L^{\theta_j - 1}} x_{j,i}^{\theta_j - 1}. \tag{4}$$

Before solving the model, consider the role of R&D. Notice that with the above specification each sector is distinguished by its degree of R&D intensity, represented by the fixed production cost α_j. It is reasonable to assume that R&D activity helps firms to differentiate their products. Thus, some relation

$$\theta_j = f(\alpha_j)\ ,\ f'(\alpha_j) < 0 \tag{5}$$

must exist, stating that higher R&D activity is associated with products becoming more heterogenous. Accordingly, inter-sectoral heterogeneity is driven by R&D intensity, which in turn creates intra-sectoral product heterogeneity.

Realising that all firms in each sector are symmetrical in this setting, we can omit sub-script i in the remainder. Plugging (4) into (1) and maximising yields the profit-maximising price set by firms in sector j

$$p_j = \frac{\beta \omega}{\theta_j} \tag{6}$$

Furthermore, using (3), the price elasticity of demand in sector j, i.e. $-\left(\frac{dp_j}{dc_j}\frac{c_j}{p_j}\right)^{-1}$ can be calculated as

$$\varepsilon_j = \frac{1}{1-\theta_j}. \tag{7}$$

Next the per-firm output volume in each sector can be derived. Due to free entry and exit, there must be zero profits in equilibrium. Equating the profit maximising price derived in (6) with the zero profit price, $p_j^{(0)} = \frac{(\alpha_j + \beta x_j)\omega}{x_j}$ and solving for x_j, yields the single firm output

$$x_j = \frac{\alpha_j \theta_j}{(1-\theta_j)\beta} \tag{8}$$

The number of firms (and therewith the number of products) active in a sector can be calculated from the market clearing condition, which states that the total sales of all firms in a sector must equal the expenditure share of total income allocated to this sector, i.e. $n_j p_j x_j = \omega L \frac{2\theta_j}{M}$. Using (6) and (8) and solving for n_j, yields

$$n_j = \frac{2L}{\alpha_j}(\theta_j - \theta_j^2). \tag{9}$$

Notice that the number of firms active in a sector thus depends both on the interaction of firm entry and exit with monopolistic pricing and scale economies. Furthermore, the size of the economy, represented by its labour force, L, and consumers' expenditure patterns – i.e. the share of their total income that they spend on a particular sector – affect the entry and exit choice.

Finally consider the effects of trade (e.g. Krugman 1980). For simplicity suppose that two countries of the above type, with identical tastes, production technologies and the same sectoral structure, open trade with one another; and that there are no trade costs. Since labour is the only factor of production, there are no differences in factor endowments. Furthermore, assume that even though both countries feature the same sectoral structure, the product varieties within each sector are different at home and abroad. Then, the primary effect of trade is that the economies are able to provide a wider diversity of goods to their consumers. Each firm, driven by economies of scale, will offer its product variety to both domestic and foreign consumers. Consumers, on the other hand, by maximising (2), will allocate their expenditure within each sector evenly across product varieties from both home and abroad, resulting in intra-industry trade. For example, with equal-sized countries, the total number of sector *j* varieties consumed at home becomes $2n_j$, where n_j is given in (9). This increase in the number of consumed varieties creates gains from trade for both countries. Export volumes for sector *j* in the symmetric case are $\theta^2 L / \beta$. However, the number of active home firms (9), the per-firm output level (8) and the price elasticity of demand (7) remain unaffected by the opening of trade.

Results of the Model

In order to state testable results for our empirical investigation, the R&D activity must be viewed in relation to other market parameters. In particular, via the function $f(\alpha_j)$, we have a fairly general relation that allows us to derive results concerning the price level, the price elasticity and the number of firms in the different sectors with respect to the R&D intensity of those sectors.[6] For the price level of different sectors, we differentiate (6) with respect to α_j to obtain:

$$\frac{\partial p_j}{\partial \alpha_j} = -\frac{\beta\omega f'(\alpha_j)}{(f(\alpha_j))^2} > 0. \tag{10}$$

This can be stated as follows:

Result 1. *Sectors that feature a higher R&D-intensity command a higher price level for their products. In particular,* $p_{k+1} > p_k \forall k = 1,\ldots,M-1$.

Similarly, for the price elasticity of demand, one obtains the following sign when differentiating (7):

$$\frac{\partial \varepsilon_j}{\partial \alpha_j} = \frac{f'(\alpha_j)}{(1-f(\alpha_j))^2} < 0 \tag{11}$$

Result 2. *Sectors that feature a higher R&D-intensity also feature a lower price elasticity of demand. In particular,* $\varepsilon_{k+1} < \varepsilon_k \; \forall\, k = 1,\ldots,M-1$.

Result 2 states that increased R&D activity leads to a more price-inelastic demand; in fact, it is for this reason that such sectors will be able to command higher prices for their goods (Result 1).

[6] Recall that the present specification assumes equality between the number of firms and the number of products. Alternatively, the below results can be interpreted such that *n* referees to the number of products only and the actual number of firms is less than *n*, each firm produces several product lines, but still large enough to ensure the assumptions of monopolistic competition to be fulfilled.

Finally, the size of sectors, given by the number of firms, can be examined with respect to R&D intensity. Differentiating (9) yields:

$$\frac{\partial n_j}{\partial \alpha_j} = \frac{2L}{M\alpha_j^2}(\alpha_j f'(\alpha_j)(1-2f(\alpha_j)) + (f(\alpha_j)(f(\alpha_j)-1)) \tag{12}$$

Obviously the sign of (12) depends on the sign of $\alpha_j f'(\alpha_j)(1-2f(\alpha_j)) + f(\alpha_j)(f(\alpha_j)-1)$. Notice that the second term is always negative, since $f(\alpha_j) < 1$. Then, since, $f'(\alpha_j) < 0$, a sufficient condition for $\frac{\partial n_j}{\partial \alpha_j} < 0$ is that $1-2f(\alpha_j) > 0$, which will be the case for a class of relatively research-intensive sectors: these are sectors where $f(\alpha_j) < 1/2$. Define α_{j*} such that $f(\alpha_{j*}) = 1/2$ This enables us to state the following result:

Result 3. *Among the group of research-intensive sectors, where $\alpha_j > \alpha_{j*}$, sectors with higher R&D-intensity will be populated by fewer firms. In particular, $n_{k+1} < n_k \ \forall\, k = j^*,\ldots,M-1$.*

Result 3 states that research-intensive sectors are populated by relatively few firms.[7] The higher R&D costs in these sectors are one of the reasons. Yet, the inverse conclusion does not hold – sectors with low R&D intensity are not populated by a large number of firms. To see this notice that even though, in the class of sectors with relatively low R&D activity, the term $\alpha_j f'(\alpha_j)(1-2f(\alpha_j))$ will be positive, since $(1-2f(\alpha_j)) < 0 \ \forall\, j < j^*$, the term $f(\alpha_j)(f(\alpha_j)-1)$ might still dominate the overall sign of $\frac{\partial n_j}{\partial \alpha_j}$. In particular, for low enough R&D activity and reasonable specifications of $f(\alpha_j)$, there will be a class of low-R&D sectors, where the absolute size of $f(\alpha_j)(f(\alpha_j)-1)$ is so close to zero that the positive portion in (12) would dominate and we would have $\frac{\partial n_j}{\partial \alpha_j} > 0$. This implies that the less R&D is carried out in such low-R&D intensity sectors, the smaller the number of firms active in those sectors. Or to put it differently, and in line with common intuition, the more homogenous the goods of a sector with lower R&D activity, the fewer its firms. In this case, both very R&D-intensive sectors and sectors with very low R&D activity feature relatively few firms. Yet the driving forces for firm exit at the two extreme ends of the population are rather different. For sectors

[7] Recall, however that throughout *n* is assumed to be large enough such that ζ in (4) can be treated as constant. Or put differently, for this and all the following discussion, *n* must remain so large that the model of monopolistic competition is a suitable specification. In contrast, the interaction of R&D-activity and firm entry and exit in monopoly or duopoly settings – which accordingly feature some form of entry/exit costs – is a very distinct problem.

with very low R&D activity, products are not very differentiated, and consumers thus switch easily between the products of different firms in the same sector. Hence there is little room for firm profits, and accordingly relatively little entry. For R&D-intensive sectors on the other hand, profit potentials are good, but the resulting high prices (driven by higher R&D expenditures) lead, via the consumers' income allocation, to a situation where only relatively few firms manage to break-even in sectors with high R&D activity.

3 Empirical Investigation

In the following, our central finding – that sectors with a higher R&D intensity feature a lower price elasticity of demand – will be examined empirically with export demand of the G7 countries each consisting of two sectors which can be distinguished by the R&D intensity of their goods (thus, M = 2 in terms of the above model). Sector 2 produces goods with high and very high shares of R&D expenditure in total sales, and according to the OECD, comprises ISIC Rev.2 industries 351, 352, 382, 383, 384 (excluding 3841) and 385. Sector 1 is made up of other exports of manufacturing that are characterized by low shares of R&D expenditure according to the OECD. The time series range from 1970 to 2000.

Estimation of export demand elasticities has attracted renewed attention in recent years. These estimations differ from those of the 1970s and 1980s mainly in that methods of estimation now take account of unit roots in the variables of the export demand equation.[8] The modeling of export demand, however, has not changed fundamentally.[9] We start from this conventional treatment of real exports of a country as a function of relative prices and real incomes, and also assume that there is no substitutability between goods of the two sectors j. Domestic and foreign goods of the same R&D intensity are imperfect substitutes. Further, we assume that trade elasticities are constant over time.

It would be ideal to measure the influence of relative price changes on real exports using the adequate sectoral price deflators on both sides of the estimating equation. However, as these are not available, we deflate export values of both sectors of each country m (published in mill. US$ by the OECD) with the respective export price deflator for manufacturing to get E_{mj}. Similarly, we approximate relative prices of goods with the same R&D intensity and different countries of origin by the countries' aggregate relative prices, which we call relative currency values. Thus, the estimations show whether changes in aggregate currency relations have an equal influence on exports of the two sectors.

The relative currency value of country m is defined as follows:

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[8] E.g. Senhadji and Montenegro (1999) Hooper, Johnson and Marquez (2000).

[9] Hooper, Johnson and Marquez (2000). Senhadji (1998) shows that the conventional modeling of export demand is compatible with individual utility maximization.

e_m is the nominal currency value of country m measured in US$ per currency of country m, and e_m^{PPP} is the nominal currency value of country m measured in US$ per currency of country m that guarantees the validity of the purchasing power parity (PPP) of the currency of country i with the US$ (i.e. $\left(e_m^{PPP} \cdot p_m / p_{US}\right) = 1$). Again, e_m and e_m^{PPP} are given by the OECD. Then, the real currency value of country i 's currency against the US$ is

$$z_m = \frac{e_m * p_m}{p_{US}} = \frac{e_m}{e_m^{PPP}}. \tag{13}$$

The relative currency value of country m, $zrel_m$, is its real currency value relative to the real currency value of the OECD, z_{OECD}. The latter comprises the real currency values of the member countries weighted by their shares in OECD gross domestic product measured at PPP US$. Thus $zrel_m$ is a proxy for $m's$ real effective exchange rate.

As a measure of income abroad, we take GDP in the OECD assuming that each of the considered countries is small compared to the aggregate. This is appropriate for all countries considered, but not for the USA. It can be shown, however, that the empirical results for the USA are not dependent on that assumption.

OECD nominal income measured in US$ is

$$\sum_m Y_m \cdot p_m \cdot e_m = p_{US} \cdot Y_{OECD}^{PPP} \cdot z_{OECD}. \tag{14}$$

As a measure of real income abroad of country m, YF_m, we measure OECD nominal income in the currency of country i and deflate it by that country's GDP deflator, p_{mindex}

$$YF_m = \frac{Y_{OECD}^{PPP} p_{US} \cdot z_{OECD}}{e_m \cdot p_{mindex}} = \frac{Y_{OECD}^{PPP} \cdot p_m}{p_{mindex}} \cdot \frac{1}{zrel_m}. \tag{15}$$

The first component is real foreign income measured at currency values guaranteeing PPP with the US$. The second component is the inverse of that country's relative currency value. Therefore "real" changes in foreign income are separable from those simply caused by changes in relative prices.

The export demand for goods from sector j of country m measured at constant export prices in manufacturing is then:

$$E_{mj} = \alpha * \left(\frac{YF_m}{zrel_m} \right)^{\delta_{mj}} \cdot \left(\frac{1}{zrel_m} \right)^{\gamma_{mj}} . \tag{16}$$

Estimation Method

We have two sectors in each of the countries and thus 14 export demand equations. Export demand for goods from different sectors but produced in the same country and for goods from the same sector produced in different countries are not mutually independent, i.e. there is correlation among the residuals of the demand equations. Therefore, it is necessary to estimate all 14 equations in one model. The SUR estimation method takes into account the correlation between residuals and is thus more efficient than the estimation of single export demand equations.

ADF tests show that the disaggregated exports, GDP and the relative currency values are non-stationary in most cases. It is not possible, however, to combine a cointegration analysis that takes account for the non-stationarity of variables with a pooled estimation as in the SUR. Cointegrating relationships between export demand, relative currency values and foreign GDP resulting from single sector estimation become insignificant if the export demand equations are pooled in a second step. It is also impossible to estimate the cointegrating relationships within a pooled model. Therefore – and since relative currency changes take place in the short run – we concentrate on deviations from trend values. We obtain detrended values of all variables by filtering the series with a Hodrick-Prescott filter and defining detrended exports as the relation between exports and their Hodrick-Prescott trend value. Thus the detrended series move around 1. They are stationary, and the relationships between the detrended series can therefore be estimated within a SUR system.[10] Taking logarithms, we can separate the trend values from the detrended series, such that detrended export demand (~ marks detrended values in logarithms) is given by

$$\tilde{E}_{mj} = \beta_{mj} * \widetilde{YF}_m - \left(\delta_{mj} + \gamma_{mj} \right) * \widetilde{zrel}_m . \tag{17}$$

Detrended real income abroad captures business cycle movements abroad. It can have positive or negative effects on real sectoral exports. Detrending the relative currency value does not change the fluctuations of the series considered.[11] In the case of Japan, it excludes the continuous appreciation of

[10] This short-run perspective justifies the assumption made above that there is no substitutability between goods of different R&D intensity.
[11] The European currencies have non-stationary relative currency values between 1970 and 2000, whereas the USA, the UK and Japan (with a deterministic trend) have stationary relative currency values.

the yen since 1970, but again preserves the fluctuations of the Japanese currency value.[12] For simplicity, in the following we always mean the detrended series when referring to exports, incomes, and relative currency values.

There is a problem of simultaneity. Sectoral exports and the relative currency value of a country will be interdependent. Therefore, we estimate the unlagged relative currency values by instrumental variable estimations using the unlagged nominal exchange rates against the US$ and lagged values of the relative currency value as instruments. The estimated value of the unlagged relative currency value, then, is used as an explanatory variable in the SUR system.

In order to obtain a parsimonous parametrization, two lags of all endogenous and exogenous variables have been tested and considered when significant at the 5% level. Further lags are only included if autocorrelation is otherwise inacceptable. As the estimating equations are in logs, the coefficients can be interpreted as elasticities.

Estimation Results

The estimation results are presented in Table 1 and Table 2. The first gives the parameter estimates of the explaining variables of our SUR system. These show the direct immediate or lagged effects caused by a permanent percentage change of the detrended relative currency value and detrended foreign income on sectoral detrended real exports of the G7 countries.[13] The last column presents the P values of the Q statistic.

In Table 2, we present the total effects of a percentage change of the detrended relative currency value on detrended exports one and two years after the change of the relative currency value, and in the long run.

In all countries except for Germany, the direct influence of changes in the relative currency value on exports of sector 1 is significantly stronger than on exports of sector 2. In the UK and the USA, this result can be supported by Wald coefficient tests. Germany is different from all other countries in that there is no significant reaction of exports to changes in the relative currency value at all, which is true for the exports of both sectors. The reason for this finding could be that in Germany, even goods belonging to sector 1 according to the OECD definition are R&D–intensive. Thus our findings for Germany do not invalidate our theoretical results, but show the difficulties in the OECD classification. Obviously, German and, for example, American exports classified as non–R&D–intensive are very different goods.

[12] Our results therefore do not answer the question of how the continuous appreciation of the yen has influenced exports, but only how the movements of the relative currency value around its deterministic trend have influenced exports.
[13] We will not go into the interpretation of income effects.

This is also the reason for the general finding that elasticities of export demand to changes in the real currency value in the same sector are quite different in different countries.

In the long run, the differences between the two sectors are decreasing in France, the UK and the USA. In all G7 countries except for Canada,[14] the persistence of export demand for goods with high or very high R&D intensity is higher than for non–R&D–intensive goods. This could be interpreted as a closer relationship between producers and customers in the sector of high and very high R&D intensity. Thus, the smaller direct effects in the sector of high and very high R&D intensity are more persistent than the stronger direct effects in the sector of low R&D intensity.

4 Conclusions

This paper introduces the concept of R&D intensity into a standard Dixit-Stiglitz/Krugman–type setting. R&D activity enters as a fixed cost in production. Within the model, sectors with a higher R&D intensity show a higher price level and a lower price elasticity of demand. Furthermore, among the group of R&D–intensive sectors, we find that the more R&D–intensive a sector is, the smaller the number of firms that will exist in it.

The empirical test focuses on the price elasticity of export demand and confirms the theoretical proposition. In general, price elasticity is significantly lower for R&D intensive goods than for non–R&D–intensive goods. Consequently, real exchange rate changes also have an impact on the commodity structure of exports. A real appreciation increases the share of R&D–intensive goods, and a real depreciation decreases it. Among the major industrialised countries, only Germany is an exception. The demand for German exports of both R&D–intensive and non–R&D–intensive goods is not affected by price changes. German exporters appear to avoid price competition and to rely on high quality levels in all types of goods.

[14] There the persistence of export demand is almost identical in both sectors.

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Table 1: Parameter Estimates of the SUR Export Demand System (t- values in brackets)

		lagged endogenous variables				exogenous and lagged exogenous variables						Q Statistic P value at lag 4
		detrended real exports				detrended real income abroad			detrended relative currency value			
		lags				lags			lags			
	R&D intensity	-1	-2	-3	-4	0	-1	-2	0	-1	-2	
France	high, very high	0,90	-0,38			0,97	-0,99	0,58	-0,17			0,7
		(9.1)	(-4.0)			(8.4)	(-6.6)	(4.9)	(-3.1)			
	low	0,24	-0,35			0,82		0,44	-0,32		-0,17	0,3
		(3.0)	(-3.0)			(6.7)		(2.8)	(-5.2)		(-2.7)	
Germany	high, very high	0,49						-0,78				0,4
		(5.1)						(-3.4)				
	low	0,44	-0,20				0,73					0,3
		(4.5)	(-2.4)				(3.1)					
UK	high, very high	0,50								-0,36		1
		(6.0)								(-5.9)		
	low		0,24							-0,53		0,5
			(2.8)							(-8.3)		
USA	high, very high	0,75	-0,17			1,87				-0,31		0,9
		(8.6)	(-2.1)			(5.7)				(-3.5)		
	low		0,20				3,47			-0,77		0,6
			(4.3)				(9.4)			(-8.4)		
Italy	high, very high	0,25		-0,35		-0,32	0,26					0,6
		(2.8)		(-4.3)		(-3.5)	(3.1)					
	low	0,33			-0,50				-0,51			0,7
		(4.0)			(-6.3)				(-7.4)			
Japan	high, very high	0,34				0,25		-0,30		-0,30		0,7
		(2.8)				(2.4)		(3.0)		(-3.6)		
	low					-0,46			-0,65		-0,31	0,7
						(-5.2)			(-7.7)		(-4.0)	
Canada	high, very high					1,18		-1,7	-0,61	0,62		0,7
						(4.1)		(-6.3)	(-5.3)	(8.4)		
	low	0,25	-0,24			1,49		-0,72		-0,42		0,9
		(4.2)	(-4.0)			(7.2)		(-3.2)		(-6.8)		

Source: Authors' calculations.

Table 2: Short and long run elasticities of detrended real exports
permanent percentage change in the detrended relative currency value
onto detrended real exports of G7 countries

	R&D intensity	Total effect in % after 1 year	2 years	long run
France	high, very high	-0,32	-0,40	-0,35
	low	-0,40	-0,47	-0,44
Germany	high, very high	0,00	0,00	0,00
	low	0,00	0,00	0,00
UK	high, very high	-0,36	-0,54	-0,72
	low	-0,53	-0,53	-0,70
USA	high, very high	-0,31	-0,54	-0,74
	low	-0,77	-0,77	-0,96
Italy	high, very high	0,00	0,00	0,00
	low	-0,68	-0,73	-0,44
Japan	high, very high	-0,30	-0,40	-0,45
	low	-0,65	-0,96	-0,96
Canada	high, very high	0,01	0,01	0,01
	low	-0,42	-0,53	-0,42

Source: Authors' calculations.