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EXPORT MARKET PERFORMANCE OF OECD COUNTRIES: AN EMPIRICAL EXAMINATION OF THE ROLE OF COST COMPETITIVENESS*

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We investigate the relationship between export market shares and relative unit labour costs using a long panel of 12 manufacturing industries across 14 OECD countries. We ask how sensitive are export market shares to changes in relative costs and what determines this sensitivity? Both costs and embodied technology are important, but neither can fully explain changing export positions. We explore whether residual country-specific trends might be linked to 'deep' structural features of economies. Sensitivity to labour costs is lower in high tech industries and core ERM countries. Industry elasticities have increased, especially in industries subject to increasing product market competition.

Recent trends in international trade have two apparently contradictory consequences for the importance of relative costs in export market performance. On the one hand, the trend toward globalisation and the associated increase in international competition suggest a heightened sensitivity of exports to costs. Improved information and access to alternative suppliers would be expected to increase the responsiveness of purchasers to relative prices and costs. On the other hand, the increase in product sophistication and of competition based on quality differences implies that measured productivity growth and hence relative costs may have become less closely related to changes in the export market shares of OECD economies.

The objective of this paper is to establish the impact of cost competitiveness on export performance using industry-level data for 14 OECD countries over a period of more than 20 years. Two key questions are addressed. First, we ask to what extent changes in relative unit labour costs determine changes in the export market share. Can these measured costs explain the patterns in the data and if not, what other economic, technological and institutional features of economies are important? Secondly, we examine the determinants of the differences in the cost sensitivity of exports across industries and countries.

The first question is standard for trade economists. For example, Ricardian theory suggests that countries will specialise in industries in which they have a comparative cost advantage. In a dynamic context this comparative advantage may shift over time as conditions evolve, and it is the immobile factor costs (through wages, productivity and exchange rates) that determine changing shares. It may be, however, that this is not sufficient to explain the market

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share patterns between countries and that other factors such as differences in rates of technological progress and in institutions matter independently of costs. These factors may affect the quality of the products sold and not be fully captured in a measure of unit labour costs.

A number of studies have used variables reflecting labour costs and technology to explain export performance.[1] The wide variety of approaches taken has yielded little consensus about whether relative costs matter for the export performance of advanced economies. The first objective of this paper is to reach more robust conclusions through addressing issues of the dynamics of adjustment, level of aggregation and the role of technology.

Less attention has been paid to our second line of enquiry, which examines the heterogeneity in response to costs. Simple models suggest that the responsiveness of exports to changes in costs will depend on characteristics of the product market such as the degree of product market competition. This lies behind the view that costs are more important today as global markets are opened up and competition increases. We investigate these effects by estimating separate elasticities for different industries, countries and time periods and relating them to economic and institutional factors. This allows us to see whether globalisation really has increased the importance of costs in determining export shares over our time period.

The answers to these questions would not only clarify our understanding of the impact of globalisation and quality upgrading but also provide important information for policy makers in the spheres of labour market, industry and exchange rate policy. For example, claims that Europe cannot 'afford' its welfare state because social costs make labour costs too high for countries to be able to compete in international and domestic markets depend in part on an evaluation of the importance of labour costs for exports.[2] Technology and industrial policy need to be informed by knowledge of the impact of R&D or investment spending on export performance.

In the debate on exchange rate arrangements in Europe, proponents of EMU often justify the abandonment of the exchange rate as an instrument on the grounds that it is useless: changes in cost competitiveness associated with nominal exchange rate changes have little impact on trade flows (e.g. Buiter, 1995). Other proponents make quite the opposite claim. For them, the exchange rate is dangerously effective, making competitive devaluations tempting and threatening the Single Market programme of the European Union (e.g. Eichengreen and Ghironi, 1995). Empirical clarification of these matters is relevant not only for our understanding of trading patterns and adjustment costs within the Euro-zone but also for the evaluation of the benefits of membership for countries remaining outside.

[1] Multi-country studies of export competitiveness include Fagerberg (1988), Amendola *et al.* (1993), Magnier and Toujas-Bernate (1994), Landesmann and Pfaffermayr (1997), Amable and Verspagen (1995), Wakelin (1997), Wolff (1997), Fagerberg (1997) and Ioannidis and Schreyer (1997).

[2] Of course, a prior question is the extent to which social charges are indeed reflected in labour costs rather than offset by reductions in take-home pay (see Nickell and Layard, 1999).

The structure of the paper is as follows. Section 1 describes the data set and defines the key concepts of export market shares and cost competitiveness. The variation of export market shares, costs and technology indicators across countries, industries and over time is outlined. Section 2 discusses the econometric modelling strategy. Section 3 presents the results and provides answers to our questions concerning the role played by labour costs in the determination of changes in export market shares and the variability of the cost-sensitivity of exports across industries, countries and over time. A discussion of the robustness of our results concludes Section 3. The final section of the paper includes a discussion of some of the implications of our findings. To pre-empt the conclusion, we find that costs and technology when embodied in new equipment are important but cannot explain all the differences between countries. There are residual cross-country trends, which appear to be correlated with longer-run features such as schooling and ownership structure. Also, the estimated cost sensitivities vary systematically across industries and time depending on technology and the development of product market competition.

1. Preliminary Data Description

Before introducing the econometric model it is useful to have a brief description of the sources to be used, the key variables constructed and a preliminary analysis of the data.

1.1. *The International Panel*

The primary data set used is known as STAN (OECD, 1995). It is the most comprehensive source of internationally comparable data on the variables of interest at the industry level over an extended period. It is an industry level panel data set across many OECD countries. Its usefulness derives from several features (see Appendix 1 for more details).

- The availability of consistent earnings, employment, real output and trade data allows for the construction of relative unit labour costs (*RULC*) by industry, and for the decomposition of *RULC* into its component parts (exchange rate trends, wage trends and productivity trends).
- The data run from 1970 to the early 1990s (the last year with comprehensive data is 1992). The long time series allows an analysis of the adjustment dynamics of exports to cost changes, as well as an investigation of whether the sensitivity of exports to costs has changed over time.
- The disaggregated nature of the data set allows comparison of the role of cost competitiveness across industries. Although STAN provides data for 48 subcategories of manufacturing (see Appendix 1), the analysis in this paper is mainly confined to the 12 main divisions of manufacturing. For the three major exporting countries (the United States, Japan and Germany) at least two-thirds of manufactured exports are accounted for by four industries – chemicals, non-electrical machinery, electrical machinery and transport equip-

ment. Unfortunately it is not possible to disaggregate them satisfactorily, either because of lack of data (in particular for real output in the machinery sectors) or because of extremely large and erratic fluctuations (for some sub-categories of chemicals and transport equipment). Thus the potential to exploit further disaggregation for the analysis of exports is rather limited.[3]

- STAN allows the construction of an indicator of investment levels at industry level, and comparable data is available for R&D spending and for patenting. We are interested in whether such variables robustly add to the explanation of how export shares evolve once cost competitiveness is included.
- The cross-country dimension allows exploration of systematic variation in the importance of cost-competitiveness.

1.2. *Export Market Shares and Cost Competitiveness*

In this paper we measure performance by export market share. Export market share (*XMS*) for a particular industry is calculated by revaluing each country's exports into current dollars and then dividing it by the dollar sum of the industry's exports from the 14 countries. Although these countries account for around 90% of OECD exports, such market share calculations take no account of exports from non-OECD countries, which have been growing strongly in some categories. Since the explicit aim of the exercise is to investigate the comparative export performance of the group of countries for which we have appropriate data and there are no reliable data on costs and technology variables for the non-OECD countries at this level of disaggregation, we leave the analysis of exports from the South for future work (see Desjonqueres *et al.*, 1999).

Competitiveness has traditionally been measured by export prices or by unit labour costs. As there are no data in STAN for export volumes and thus no export price series, our focus is on *RULC* (relative unit labour costs). Unit labour costs (*ULC*) for the i-th industry, j-th country can be defined thus

$$ULC_{ij} = (W_{ij}/E_{ij})/(e_j Q_{ij}/N_{ij}),$$

where W is employee compensation (including non-wage labour costs) in national currency, E is the number of employees, e is the dollar exchange rate (national currency per dollar), Q is the volume of output (value added at constant prices), and N is employment (including the self-employed). Thus unit labour cost depends on wages per worker, labour productivity and the exchange rate. $RULC_{ij}$ is then calculated by dividing ULC_{ij} by a weighted average of the unit labour costs for all the countries in the sample. We have used export market share in 1980 as the weighting factor (see Appendix 1 for a further description of the sources and construction of the series used).

It is important to emphasise that *RULC* is constructed from indices of dollar

[3] Some experiments with greater disaggregation are presented in the Section 3. It is also evident from the STAN documentation that because of the way in which the data set was constructed, the extent of measurement error increases the more disaggregated the data.

wage costs per unit of output: this allows estimates only of changes in *RULC*, not of levels. The latter would require estimates of real output in a common currency. As is well known, exchange rates are an unreliable basis from which to calculate real productivity levels (Oulton, 1994). Although it is possible to use the OECD's estimate of PPP exchange rates to estimate *RULC* in level terms (as in Golub (1994)), PPPs calculated for GDP as a whole do not mirror very closely PPPs for individual manufacturing sectors (Van Ark, 1996). This has a methodological implication: cointegration-style analysis based on levels information is rather hazardous.[4] In this paper we therefore focus on changes in *RULC* based on data for real output growth within a country.

It has been conventional to analyse the impact of changes in *RULC* on trade performance without distinguishing between its component parts – wages per head in the national currency, the exchange rate and labour productivity. A 10% slower rise in money wages, a 10% depreciation in the exchange rate or a 10% faster increase in labour productivity all have an identical impact on measured *RULC*. Our method of constructing *RULC* allows us to disaggregate changes in *RULC* into these three components and hence to test whether each has an equal effect on export performance.

Fig. 1 presents the trends over the period 1970 to 1992 for export market

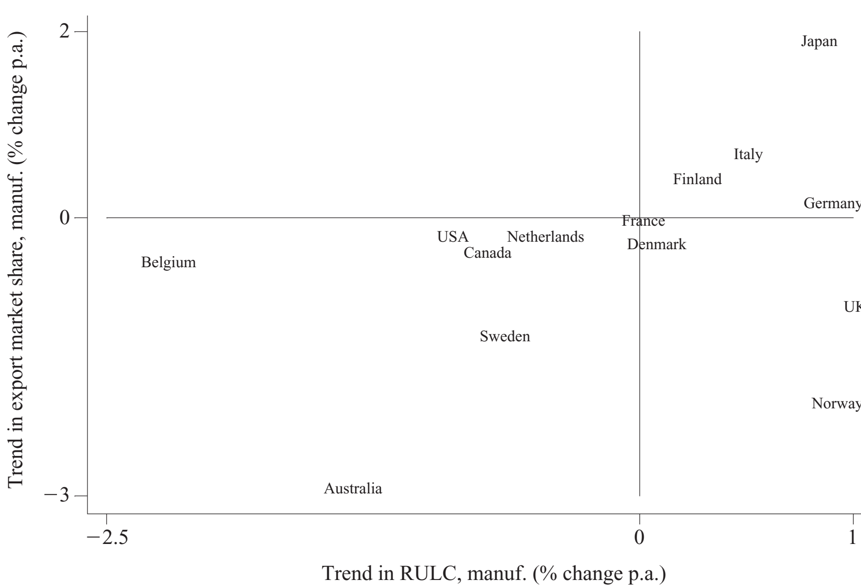


Fig. 1. *Total Manufacturing: Export Market Share and RULC Trends, 1970–92*

[4] The level of *ULC* calculated using *PPP* is:

$$ULC_{ij}(PPP) = (W_{ij}/E_{ij})/[(e_j/PPP_j^*)(Q_{ij}/N_{ij})]$$

where PPP_j^* is the exchange rate for the base year of the price index used to calculate Q_{ij}. *ULC* and *ULC*(*PPP*) differ only in the constant PPP^*. Thus apart from small differences due to weighting, the changes in *RULC* derived from *PPP* calculations would be the same as those used in this paper. See Section 3.3 for some attempts to compare our results with a cointegration approach using the level of *RULC*(*PPP*).

share and relative unit labour costs in manufacturing as a whole for each of the 14 countries. Looking first at export market share (measured on the vertical axis), Japan (and to a much lesser extent Italy and Finland) achieved substantial increases in market share; Germany's share was high (see Table 1, column (1)) and rather stable. France and the United States together with a number of smaller European countries also roughly maintained market shares but those of the United Kingdom, Australia, Norway and Sweden fell.

Changes in *RULC* for manufacturing are measured along the horizontal axis of Fig. 1. Two pairs of countries showed strong trend increases in *RULC* i.e. a deterioration in cost competitiveness: Germany and Japan on the one hand where export market shares increased (examples of the 'Kaldor paradox'[5]) and the United Kingdom and Norway on the other, where they declined. As Table 1 shows, Germany and Japan had appreciating nominal exchange rates over the period whilst in Norway and the United Kingdom the exchange rate depreciated (but insufficiently to counterbalance faster than average labour cost increases). In Belgium, the decline in relative costs (*RULC*) was fastest, followed by Australia, the United States, Canada and Sweden.

The trends in productivity growth (Table 1) show Japan as standing out less than is often imagined – Belgium ranks as the productivity growth leader in manufacturing over the period from 1970 to 1992. The UK productivity 'miracle' of the 1980s was sufficient to put Britain in fifth place out of fourteen in the productivity growth rankings. Measured labour productivity growth in German manufacturing was no higher than that in the United States.[6] Wage moderation and appreciating currencies were observed in Japan, Germany and the Netherlands, whilst the converse applied in Italy and the United Kingdom.

1.3. *Technology Variables: Investment, R&D and Patents*

Investment shares, defined as the ratio of gross domestic fixed capital formation to value added, can be calculated from STAN. In attempting to explain changes in export market shares it is the investment share relative to the industry average across the countries in the sample for the year in question (*RELINVSH*) which is relevant and this series has been constructed using export market shares in 1980 as weights.

The OECD's ANBERD data set (OECD, 1996) provides data on R&D expenditure for 12 countries and a limited number of industries. The indicator of R&D effort used is the ratio of R&D spending to current price value added; as in the case of investment, the ratio to the industry average is used in the regressions (*RELRDSH*). Data are also available for the 1980s on the level

[5] The Kaldor paradox refers to his finding that the countries with the fastest improvement in export performance were those with the fastest increases in costs (see Kaldor, 1978).

[6] Data on hours worked are not available for the disaggregated industries and so labour productivity can only be calculated on a per worker basis. German hours of work fell by nearly 1% p.a. over the period, whilst those in the United States were roughly constant, thus hourly productivity grew faster than in the United States. Calculations of *RULC* are not affected by differing trends across countries in hours worked,

Table 1

Export Market Shares, Components of RULC and Technology Indicators, Total Manufacturing, 1970–92

	(1) Share of total $ exports of 14 countries (%)	(2) Export market share growth	(3) Nom. exch. rate (– means appreciation)	(4) Nominal wages	(5) Labour productivity	(6) Investment share (% of value added)	(7) R&D share (% of value added)
	(av. 1988–92)	(av. % p.a. trend changes, 1970–92)	(av. % p.a. trend changes, 1970–92)			(av. 1970–92)	(av. 1973–91)
Canada	5.0	−0.5	1.5	7.9	1.8	16.2	2.6
France	9.5	−0.1	1.8	10.1	2.9	14.7	4.8
Germany	19.2	0.1	−2.4	6.0	2.1	12.2	5.0
Italy	7.9	0.6	4.9	14.3	3.3	17.9	2.0
Japan	15.3	1.8	−4.1	7.1	4.8	19.6	5.0
UK	8.1	−1.9	2.4	12.1	3.2	12.3	5.6
USA	16.7	−0.3	0.3	6.6	1.9	11.4	8.0
Australia	0.9	−3.0	3.4	9.8	2.2	12.9	1.6
Belgium	5.4	−0.7	−0.2	8.1	5.0	16.7	N/A
Denmark	1.5	−0.4	0.9	8.5	2.1	15.3	2.9
Finland	1.2	0.4	1.1	10.9	4.0	19.5	3.1
Netherlands	5.7	−0.3	−1.8	6.0	3.0	18.6	5.1
Norway	0.9	−2.1	1.0	9.3	2.0	18.7	N/A
Sweden	2.8	−1.3	2.4	9.3	2.2	15.9	6.4

Note: RULC is Relative Unit Labour Cost

of patenting within the United States by nation of origin. This allows the construction for a number of industries of the patent 'intensity' (the ratio of patents to dollar value added).

The last two columns of Table 1 provide figures for the average investment, and R&D shares for manufacturing in each country over the period. The low levels of investment in the United Kingdom and United States are well known, but the similarly low rate in Germany is more surprising. R&D expenditure is particularly high in the United States and Sweden and particularly low in Italy.

1.4. *Industry and Country Diversity*

The advantage of disaggregated data is that it enables the diversity of industry performance within countries to be exploited. We discuss the raw data in more detail in Carlin *et al.* (1998) and add a few remarks here on the largest exporting countries and industries to highlight the magnitude of the variation in trends across industries and countries.[7]

In each of the three largest exporting countries, West Germany, United States and Japan, (see column (1) Table 1) there is considerable variation in trends in *RULC* across industries implying changes in comparative advantage over time. To take an extreme case, the United States's trend in cost competitiveness improved strongly in textiles yet deteriorated sharply in electrical engineering. Since relative wage trends and relative exchange rate trends vary rather little across industries in the same country, the main explanation is the substantial differences in relative productivity growth.

Investment rates are rather consistently low across industries in Germany and the United States and high in Japan, but R&D effort appears from this data to be much more variable. Patent shares were high but generally declining in the United States (especially in engineering), close to the mean in Germany (but declining over time especially in textiles, instruments and electrical machinery), whilst in Japan, patent intensity moved strongly upward across the range of industries to reach relatively high levels.

Smaller countries can often have a strong presence in particular sectors (e.g. about 12% of OECD exports of chemicals are from the Netherlands). There are really quite large differences in trends in *RULC* across countries at the industry level. For example, there is a difference of over 3% per year in the change in *RULC* in non-electrical machinery between the United States and Germany. Investment shares vary by a factor of two comparing countries at the industry level and R&D shares by even more. There are big differences in measured labour productivity trends (for example a 5% per year differential between Germany and Japan in non-electrical machinery).

To conclude the descriptive section, we have seen in Fig. 1 that there is no clear relationship for the manufacturing sector as a whole between changes in export market share and in cost competitiveness. No country is observed with

[7] The series created from STAN are available from the authors to those who have a licence for the OECD's STAN data-set.

the combination of declining relative costs and increasing export market share. Indeed if Norway is considered an outlier, there appears to be a tendency for countries with rising relative costs to have increased their market shares for manufacturing as a whole. At a disaggregated level, there is considerable heterogeneity in competitiveness and export performance between the industries of a given country both at a point of time and over time. The econometric estimates will exploit this variability to identify the effects of costs on exports.

2. Econometric Modelling Strategy

In order to underpin the empirical work it is necessary to spell out an econometric model more explicitly. Under mark-up pricing an increase in marginal costs is directly translated into an increase in price. In a more general model of imperfect competition such as a Cournot model, increases in domestic relative cost cause both a decline in market share and a decrease in profit mark-ups. The absence of reliable export price data means that it is impossible to identify separately the effects of changes in costs on mark-ups and the effects of changes in price on consumer demand. Appendix 2 sets out a simple model of Cournot competition in export markets, which generates a relationship between a country's export market share and relative costs. This captures both the market share and mark-up effects and also predicts that the degree to which market share falls as relative costs rise will depend on structural characteristics of each industry. In particular, the model suggests that the response of export market share to relative costs will depend on the degree of competition in the product market.

Drawing upon the simple model, a natural empirical specification of the relationship between export market shares (XMS) and relative unit labour costs ($RULC$) is the following:

$$\log(XMS_{ijt}) = \sum_{k=0}^{L} \alpha_k \log(RULC)_{ijt-k} + \nu_{ijt} \tag{1}$$

where $k = 0, \ldots L$, and L is the longest lag length considered. We have assumed that the primary factor that affects relative marginal costs across countries is differing unit labour costs. This seems plausible, as labour is a relatively immobile factor, the price of which will differ systematically across countries. ν_{ijt} captures other influences on export market share.

The elasticity of export market share with respect to $RULC$ is an unfamiliar measure and its relationship to ordinary export price elasticities needs some explanation. If there is complete 'pass through' of relative cost changes into relative export price changes then the market share elasticity is just the export price elasticity plus one (as the change in the dollar value of exports equals the change in volume less the fall in dollar prices). If there is incomplete pass through, so that part of the relative cost change is absorbed by the widening or narrowing of profit margins, then the implied price elasticity of demand is rather larger. Estimates reported by Goldstein and Khan (1985) suggest that perhaps half of labour cost changes are reflected in profits and possibly a similar part of exchange rate changes (although the literature suggests variation over countries, sectors and time – see Knetter (1993) and Menon (1995)). If one half of relative cost changes is reflected in relative price movements, an export market share elasticity of -0.2 implies that the price elasticity of demand is -1.4 (and as such lies towards the lower end of Goldstein and Khan's (1985) consensus estimate). Of course if profitability shifts in the opposite direction from *RULC* (which STAN data for the wage share confirm[8]) then the interpretation of such price elasticities becomes cloudier because changes in profitability can affect export performance through influencing marketing, R&D and investment effort. Our estimates of *XMS* elasticities therefore reflect both the genuine impact of relative price changes and the impact on export volume of such profitability effects.

Delivery lags and long adjustment times between a change in costs, a change in price and then a change in consumer behaviour imply that the reaction of market share to a change in costs will not be immediate. Consequently our baseline specifications allow for a long distributed lag in the effects of relative costs on export market share (our baseline results have $L = 5$).[9]

There are many determinants of export market shares other than *RULC*, which if correlated with *RULC* will bias the coefficients. If these are relatively fixed over time then estimating in first differences will sweep out these correlated fixed effects and so give unbiased estimates of the effect of *RULC*. Even so some countries may still be able to hold on to market shares despite a deteriorating *RULC*. To examine whether this is the case we included a full set of country dummies in the first differences regression and tested for their joint significance at every stage. In other words we allow for country specific trends in the change in export market share even after conditioning on the change in measured relative unit labour costs. Augmenting (1) to allow for these trends gives the following specification:

$$\Delta \log(XMS_{ijt}) = \sum_{k=0}^{5} \alpha_k \Delta \log(RULC)_{ijt-k} + \sum \beta_j COUNTRY_j + u_{ijt} \qquad (2)$$

where Δ is the first-difference operator.

The presence of country trends is problematic, as it is impossible for a country's share of the export market in an industry to grow forever. The country dummies are effectively picking up a model misspecification, which we attempt to resolve in various ways. First, different proxies for technology are included (patents, R&D and investment). Second, we examine whether other country characteristics are correlated with the country dummies. Finally, a series of tests of dynamic misspecification is applied in the analysis of robustness in Section 3.3.

8 The wage share is calculated from STAN by adding an imputed wage element for the self employed to employee compensation and dividing by value added. The imputed wage is taken to be equal to the average wage of employees in the sector concerned. Thus $WAGESH = (W^* N/E)/VA$.

9 We experimented with lags of different length other than five to ensure there was no obvious truncation bias in our estimates.

Equation (2) is estimated in several ways. The first group of results (sub-section 3.1) focuses on pooling the data across all sectors and countries and assuming common coefficients on the determinants of exports. The second sub-section (3.2) allows the coefficients (α_k) to vary across sub-samples. We examine the heterogeneity across industries, across countries and over time periods.

The estimation technique is Ordinary Least Squares. The assumption of exogeneity of *RULC* is not as restrictive as may be at first imagined. Because we are estimating in differences we do allow shocks to *XMS* to have immediate feedback effects on *RULC*. The crucial assumption is that:

$\mathrm{E}(u_{ijt}|\Delta RULC_{ijt}) = 0$ where $\mathrm{E}(\cdot|\cdot)$ denotes the conditional expectations operator. It is quite possible for changes in *XMS* to affect *RULC* in future years, i.e. we allow $\mathrm{E}(u_{ijt+g}|\Delta RULC_{ijt}) \neq 0,\ g > 1$. In Section 4.3 we discuss various ways in which to relax these moment conditions by examining possible instrumental variables for *RULC*.

Even if the original error term in (1) is serially uncorrelated (after taking out individual fixed effects and country trends), first differencing will induce autocorrelation in (2). In all of the econometric results reported the standard errors are robust to arbitrary autocorrelation and heteroscedasticity of unknown form (see White, 1980).[10]

3. Results

3.1. *Determinants of Export Market Share*

3.1.1. *Relative costs*

Table 2 shows the results of implementing (2) for the pooled sample. Industries are weighted by their share in world exports to ensure that due influence is given to the industries that are most important in world trade. Column (1) contains only the *RULC* variables, column (2) only the country dummies and column (3) both sets of variables. In column (2) it is clear that there are substantial country trends. The market shares of Canada, Japan and Finland rose by more than 0.5% per year and those of Australia, Denmark, Norway and Sweden fell by more than 0.5% per year.

The coefficients on *RULC* in columns (1) and (3) allow us to address the question of the average impact of relative unit labour costs on export market shares. In both columns, the RULC terms are jointly highly significant and yield a highly significant long-run elasticity (−0.266 in column (3)). The estimate of the elasticity of *XMS* with respect to *RULC* is not dependent on the exact degree of disaggregation used in the sample, the choice of weights in the regression or the choice of maximum lag length. Estimating (2) with a higher degree of disaggregation using 26 industries (the 'Large Pool', see Appendix 1) yielded a long-run coefficient of −0.264, practically identical to our preferred level of disaggregation. Estimating the baseline equation on the

[10] The estimates are produced from Arellano and Bond's (1991) Dynamic Panel Data (DPD) statistical package written in GAUSS.

Table 2
The Base-Line Equation: Pooled Regression Results

Dependent variable: $\Delta \log(XMS)$	(1)	(2)	(3)
$\Delta \log(RULC(t))$	0.103 (0.034)	–	0.191 (0.034)
$\Delta \log(RULC(t-1))$	−0.153 (0.027)	–	−0.156 (0.027)
$\Delta \log(RULC(t-2))$	−0.069 (0.027)	–	−0.070 (0.027)
$\Delta \log(RULC(t-3))$	−0.068 (0.022)	–	−0.069 (0.023)
$\Delta \log(RULC(t-4))$	−0.047 (0.031)	–	−0.048 (0.031)
$\Delta \log(RULC(t-5))$	−0.112 (0.023)		−0.114 (0.023)
Long-run elasticity of *RULC*	−0.256 (0.069)	–	−0.266 (0.069)
[p-value of joint significance]	[*0.000*]		[*0.000*]
Canada	–	0.007 (0.005)	0.002 (0.007)
France	–	−0.001 (0.003)	0.001 (0.003)
Germany	–	0.003 (0.003)	0.007 (0.003)
Italy	–	−0.002 (0.005)	0.001 (0.006)
Japan	–	0.009 (0.009)	0.011 (0.007)
UK	–	−0.005 (0.003)	−0.001 (0.003)
USA	–	−0.001 (0.003)	−0.005 (0.003)
Australia	–	−0.009 (0.007)	−0.011 (0.007)
Belgium	–	−0.003 (0.005)	−0.006 (0.005)
Denmark	–	−0.006 (0.007)	−0.004 (0.007)
Finland	–	0.006 (0.012)	0.013 (0.011)
Netherlands	–	−0.003 (0.006)	−0.000 (0.006)
Norway	–	−0.026 (0.009)	−0.020 (0.008)
Sweden	–	−0.017 (0.007)	−0.016 (0.007)
Joint significance test of country dummies:		24.41	26.23
$\chi^2(14)$ [p-*value*]		[*0.03*]	[*0.02*]
Observations (*NT*)	2,805	2,805	2,805
LM test of first order serial correlation [p-*value*]	0.948 [*0.343*]	1.483 [*0.138*]	0.776 [*0.438*]
LM test of second order serial correlation [p-*value*]	−1.642 [*0.100*]	−1.876 [*0.061*]	−1.675 [*0.094*]

Note: The sample consists of 12 industries across 14 countries between 1976 and 1992. All regressions are weighted by world-wide industry exports (1980 dollar values). Standard errors in parentheses are robust to heteroscedasticity and arbitrary autocorrelation. LM serial correlation tests are distributed N(0,1). Estimation by Ordinary Least Squares.

original sample without weights gave a long-run coefficient on *RULC* of −0.276. Allowing longer lags of $t-7$, $t-8$ and $t-9$ led to practically identical long-run effects.[11]

As hinted by the simple plot in Fig. 1, the result is very different when the data are aggregated to manufacturing as a whole. When (2) is estimated for total manufacturing, the long-run elasticity between exports and *RULC* is only −0.03 and insignificantly different from zero. Moreover, the initial perverse effects are larger than in the pooled regression, as would be expected if export success induced real exchange rate appreciation. The contrast is very clear

[11] For example including an extra two lags (so allowing *RULC* effects up to $t-8$) led to a long-run effect of −0.298 with a standard error of 0.072 with a sample of 2,463 observations.

between these results and those for the disaggregated data (in the pooled sample), where the exogeneity of the exchange rate is more plausible. This may help to explain why studies that use aggregate data can only find very small elasticities (e.g. Fagerberg (1988) and Amendola *et al.*, (1993)).

The dynamics of adjustment of exports to changes in costs (shown in Table 2 by the coefficients on successive lags on *RULC*) are brought out in Fig. 2. The immediate effect of *RULC* is perverse, in that a decline in competitiveness brings immediate improvement in *XMS*. This is most plausibly interpreted as the well-known J-curve effect often ascribed to long-run contracts being fulfilled after exchange rate movements at predetermined domestic prices. The protracted nature of the response is notable. There are still significant effects of *RULC* coming in after five years. If the perverse effect were left out by omitting the contemporaneous change in *RULC*, the estimate of the long-run elasticity would approximately double.[12] In our view omitting contemporaneous *RULC* is a misspecification as it excludes the important impact effect and includes the 'rebound' effect of the J-curve thereby overestimating the long-run impact of *RULC* on export market shares.

A striking result from column (3) is that the country dummies as a whole are still jointly significant once the change in cost competitiveness (*RULC*) is included. If the change in *RULC* really explained all the systematic variation in

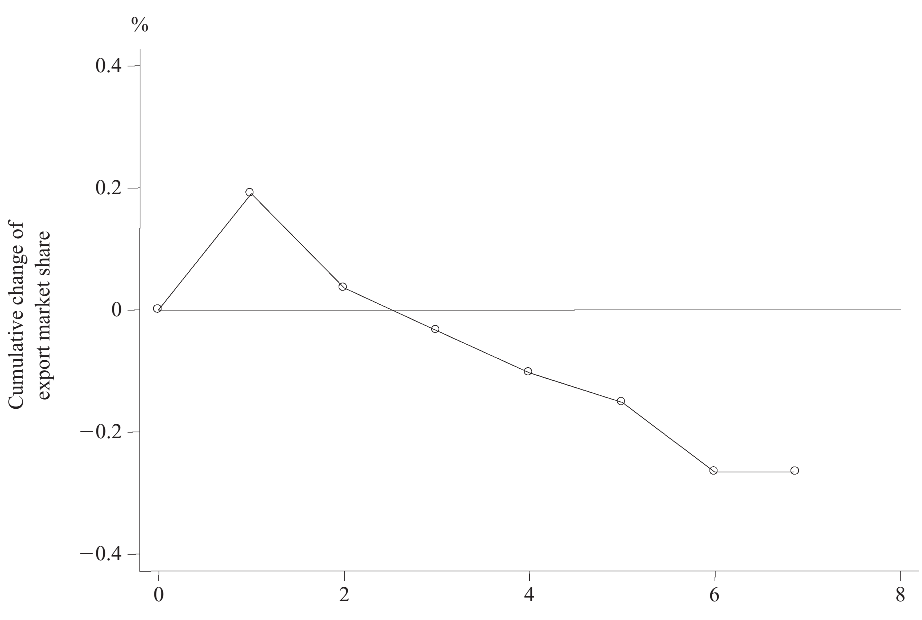


Fig. 2. *The Cumulative Effect of a 1% increase in RULC on Exports Market Share*

[12] This appears to explain the higher estimate obtained by Amable and Verspagen (1995) who use a sub-set of the STAN data.

the change in export market shares, then the country dummies would shrink to irrelevance. Their continued significance testifies to important trends in market shares that cannot be explained purely in terms of *RULC*.[13] For some countries export performance looks distinctly more impressive, and others less so, when set against the trend in cost competitiveness than when viewed in isolation. Thus Germany's dummy increases in size comparing column (3) with column (2) in Table 2 whilst *XMS* trends in the United States, Canada and Denmark weaken. The dummy for Japan becomes slightly larger.

It was noted in Section 1 that the elements of *RULC* need not have the same impact on exports. Earlier work (explicitly in the case of Bank of England (1982)) has generally presumed that the impact of changes in *RULC* is the same whether these changes originate in relative wages, in labour productivity or the exchange rate. Table 3 presents estimates for the export market share equation with *RULC* decomposed into these components. It allows us to discover whether the standard presumption of equal effects is supported by the data.

All three variables take their expected signs in the long run (the exchange rate is defined so that an increase in its value represents depreciation) and all variables are jointly significant and significantly different from zero. The long-run effects are approximately equal and Wald tests confirm that one cannot reject the hypothesis that the long-run effects are equal at conventional levels of significance ($\chi^2(3) = 0.50$ as compared to a critical value at the 5% significance level of 7.8).

Table 3

Decomposition of RULC into Relative Wages, Nominal Exchange Rates and Relative Productivity: Pooled Regression Results

Dependent variable: $\Delta \log(XMS)$	(1)
Long-run elasticity of:	
Relative exchange rate	0.308 (0.131)
	[*0.000*]
Relative productivity	0.217 (0.086)
	[*0.001*]
Relative wages	−0.253 (0.124)
	[*0.037*]
Observations (*NT*)	2,805
Joint significance test of country dummies [p-*value*]	22.48 [*0.033*]
LM test of first order serial correlation [p-*value*]	1.024 [*0.306*]
LM test of second order serial correlation [p-*value*]	−1.447 [*0.148*]

Note: The dynamic specification is the same as for the regressions in Table 2 (with terms from t to $t-5$). Country dummies are included. The number in parentheses to the right of the coefficient is the robust standard error. The number in square brackets below the coefficient is the p-value associated with the Wald test of the joint significance of all terms.

[13] In the baseline model of column (3) in Table 2 R-Squared is 0.075 and in column (1) it is 0.067. This seems low, but is not bad for explaining growth rates of exports (as opposed to levels). The country dummies therefore account for about 11% of the explained variance of the change in export market shares in moving from (1) to (3).

Although the long-run coefficients are very similar, there are major differences in the pattern of coefficients over time.[14] The main difference lies in the existence of the 'perverse' impact coefficient of the relative exchange rate variable due to the 'J-curve' effect (noted earlier) and the absence of any 'perverse' dynamics for the productivity terms. An increase in relative productivity has the expected positive sign even in the first year and in subsequent years (consistent with the results in Wolff 1997).[15] These results suggest that whilst *RULC* is an appropriate variable for analysis of long-run determinants of exports, in short-run analysis, the exchange rate, in particular, should be distinguished from the other components of *RULC*.

3.1.2. *Technology*

In much of the literature on cross-country export determination, authors have stressed the importance of quality differentials arising from different technological capabilities across countries. The view is taken that *RULC* is less important than technology factors. To pursue this question, three measures of technology measured at industry level are used: research and development expenditure, patenting activity and investment in fixed capital as a proxy for embodied technological change. This may be thought of as reflecting successive stages in the cycle of research, innovation and implementation of new technologies.

Those who argue for the importance of quality differentials usually test their hypotheses by entering a proxy for technology into an export equation alongside the relative cost terms.[16] To the extent that technology improves measured productivity it will affect *RULC* directly and it would seem, therefore, that the influence of technology variables has already been included. Nevertheless there may also be some industry or country-specific factor that is not reflected in the industry level price deflators and therefore in measured productivity. For example, higher prices in, say, the German machinery industry could reflect superior design and reliability. When value added is deflated by these higher prices (in the *RULC* formulation) Germany appears less productive than other countries whereas in reality consumer willingness to pay is enhanced by high product quality. Technology variables are therefore added to the baseline model as corrections for measurement error in the (non-quality adjusted) price deflator.[17] Since contemporaneous effects of technology vari-

[14] A Wald test of the restriction that all the coefficients of the exchange rate terms are equal to those of the unit labour cost terms is $\chi^2(6) = 233$, which easily rejects the restriction at conventional levels (the critical value of the Wald test is 12.6).

[15] There is a perverse negative effect of relative wages in the first year but it is insignificant (the coefficient was 0.108 with a standard error of 0.080). Such an effect would be consistent with some part of wage changes being passed rapidly into export prices, but with little immediate effect on export volumes.

[16] See the references listed in note 1 and the survey in Fagerberg (1996).

[17] A similar interpretative question arises in the role of R&D stocks in a production function. Correctly measured physical capital stocks should, in principle, pick up all the R&D effects (see Griliches and Mairesse, 1995, for a more extended discussion).

ables are highly unlikely, they are entered as lags from period $t-1$ and before.[18]

Table 4 reports the results of adding lagged changes in the three technology variables to the basic model. Column (1) refers to the role of relative R&D intensity. In this, and other variants, the R&D term was wrongly signed and insignificant. Even allowing for a much longer lag structure on R&D (by allowing R&D expenditures from up to 12 years previously to enter the

Table 4

Technology Variables in the Baseline Regression: Pooled Regression Results

Dependent variable: $\Delta \log(XMS)$	(1) Relative R&D	(2) Relative patents granted	(3) Relative capital investment
Long-run elasticity of *RULC*	−0.246 (0.085) [*0.000*]	−0.286 (0.115) [*0.000*]	−0.291 (0.062) [*0.000*]
Long-run effect of relative R&D	−0.022 (0.015) [*0.131*]		
Long-run effect of relative patents granted		0.001 (0.003) [*0.188*]	
Long-run effect of relative capital investment			0.0157 (0.0076) [*0.000*]
Canada	0.020 (0.019)	−0.031 (0.020)	−0.070 (0.036)
France	0.006 (0.012)	0.026 (0.014)	−0.068 (0.035)
Germany	0.017 (0.010)	0.016 (0.012)	−0.061 (0.033)
Italy	0.010 (0.016)	0.010 (0.016)	−0.075 (0.037)
Japan	0.018 (0.017)	−0.011 (0.016)	−0.065 (0.036)
UK	0.006 (0.012)	0.015 (0.014)	−0.071 (0.034)
USA	0.014 (0.012)	0.017 (0.015)	−0.073 (0.033)
Australia	−0.015 (0.013)	0.070 (0.022)	−0.092 (0.035)
Belgium	–	0.020 (0.017)	−0.077 (0.035)
Denmark	0.015 (0.012)	−0.003 (0.022)	−0.078 (0.036)
Finland	0.008 (0.019)	0.037 (0.017)	−0.057 (0.036)
Netherlands	0.008 (0.015)	0.004 (0.017)	−0.074 (0.035)
Norway	–	0.004 (0.013)	−0.094 (0.036)
Sweden	0.006 (0.014)	−0.022 (0.012)	−0.088 (0.036)
Joint significance test of country dummies [p-*value*]	27.02 [*0.01*]	44.30 [*0.00*]	38.15 [*0.00*]
Observations	1,454	774	2,717
sample period	1980–1991	1987–1992	1976–1992
lags of technology variable	$(t-1)$ to $(t-8)$	$(t-1)$ to $(t-6)$	$(t-1)$ to $(t-6)$
LM test of first order serial correlation [p-*value*]	−0.619 [*0.536*]	−1.014 [*0.310*]	0.236 [*0.813*]
LM test of second order serial correlation [p-*value*]	0.454 [*0.650*]	−0.592 [*0.238*]	−1.661 [*0.097*]

Notes: The number in parentheses to the right of the coefficient is the robust standard error. The number in square brackets below the coefficient is the p-value associated with the Wald test of the joint significance of all terms.

[18] The (log) levels of these variables are used rather than the (log) differences as the levels themselves represent changes in an industry's technology. R&D flows are approximately equal to changes in the R&D stock for very high levels of depreciation (very fast diffusion). The technology variables were all insignificant when included as growth rates rather than as levels.

equation) did not shift the results. The failure of the R&D variable may be because what matters for product quality is not the inputs to innovation, but whether past research is successful. Measures of innovative output such as patents have been suggested as superior and have been found quite frequently to be significant at the industry level in earlier work (e.g. Greenhalgh *et al.*, 1994, Amable and Verspagen, 1995).

Column (2) of Table 4 shows the effect of adding lagged relative patent intensity to the baseline model. The patents are those granted in the United States in order to ensure a common basis for cross-country comparisons. Although the coefficient on the technology variable is positive in this case, it is not significant at conventional levels.[19] Experiments with different functional forms of these innovation variables failed to change the results. Technology effects are not being masked by the inclusion of the country dummies. Even after excluding the country dummies from the regression, the technology variables were still insignificantly different from zero.[20] The slight variation in the estimated long-run cost elasticities arises because the equations are estimated on smaller samples because of missing values of R&D and patents for some industries/countries in some years. The long-run coefficient on *RULC* when the R&D variables in column (1) are dropped is -0.249 (0.083) and when the patent variables in column (2) are dropped is -0.282 (0.116).

A variant of the technology argument is that it is embodied technological change in new capital goods that will have the greatest effect on product quality. In the spirit of the endogenous growth literature, investment intensity is a proxy for embodied technological change. When lagged *RELINVSH* was added to the baseline model including *RULC*, the long-run effect in the pooled regression was positive and statistically significant (column (3) Table 4).[21] Unlike Delong and Summers (1991) it was not possible to disaggregate investment further into equipment and other forms, but the results are strongly suggestive of the importance of higher investment rates in improving export performance.[22]

We conclude that policies to foster higher spending on R&D or greater patenting activity are, by themselves, unlikely to have much effect on trade performance over and above their effect on measured relative unit labour costs. Despite the importance of investment, the country dummies remained significant ($\chi^2(14) = 38.15$ compared to a critical value of 23.7). Thus

[19] Obviously the presence of the United States may bias these results given that US firms are intrinsically more likely to patent in their own country. Dropping the United States from the analysis rendered a larger but still insignificant long-run coefficient on the patent variable (coefficient of 0.003 with a standard error of 0.002).

[20] The long run effect of R&D was -0.006 with a standard error of 0.004 and the long run effect of patents was -0.0020 with a standard error of 0.0011.

[21] One may be concerned that even lagged investment may be endogenous. Note, however, that the effect of investment $(t-1)$ is actually negative and dropping the suspected endogenous first lag leads to a stronger implied long-run effect (0.021 with a standard error of 0.009).

[22] Anderton's (1996) analysis of UK export volumes also found investment to be more frequently significant than patenting or R&D spending. Greenhalgh *et al.* (1996) report that measures of the commercial adoptions of innovations were more robust in explaining trade performance of British high tech industries than were measures of patenting.

technology-related factors did not appear to account for the residual trends in export performance after controlling for costs. Examination of the country trends (Table 4, column (3)) reveals a similar ranking to those in Table 2.

3.1.3. *Institutional factors*

What could explain the trends in country export performance apart from labour costs and technology? The case of West German performance serves to exemplify the failure of these variables to fully capture the trends. The trend in German market share is positive but becomes larger once relative costs are included. Germany's cost competitiveness deteriorates not only because of exchange rate appreciation but because of feeble measured labour productivity growth (see Table 1). Since German investment is below average (see Table 1) the inclusion of investment in the regression still leaves Germany with unexplained strength in export performance. Single country studies and bilateral comparative studies (e.g. Oulton, 1996) suggest that across industries, German goods are located in the high quality product segments. It has been suggested that the system of human capital formation, patterns of diffusion of incremental innovation within and between industries and the role of committed owners in fostering long-term relationships within and between companies could account for success in high quality manufacturing (e.g. Porter, 1990, Carlin and Soskice, 1997).

To examine whether these institutional factors have any explanatory power across OECD countries we ran regressions of the coefficients on the country dummies from the pooled regression, which included the *RULC* and *RELINV* terms, against a series of country-specific indicators. The three factors that turned out to be important were human capital formation (*SCHOOL*), disembodied technical progress across the business sector (as proxied by average TFP growth 1973–91) and the structure of corporate ownership (*OWNCONC* defined by the mean shareholding of the largest three shareholders in the 10 largest private sector non-financial companies (La Porta *et al.* 1998)).

The regression results (with the standard errors in parentheses) are:

Dependent variable: coefficients of the country dummies from the regression in column (3) Table 4.

$$b_{COUNTRY} = -\underset{(0.026)}{0.16} + \underset{(0.002)}{0.007}\ SCHOOL + \underset{(0.002)}{0.012}\ TFP + \underset{(0.016)}{0.03}\ OWNCONC$$

Number of observations = 14

Adjusted R-squared = 0.545

Each variable has its predicted sign and the schooling and total factor productivity variables are significant at the 1% level, with ownership concentration significant at the 10% level. More than half of the variation in the underlying country trends in export market shares is accounted for by these three variables. The variable 'business sector total factor productivity growth' (OECD, 1993, Table A65) is not entirely satisfactory since it is a residual from a growth accounting equation. However, its significance supports the notion that disembodied technical progress – including organisational change across the business sector as a whole – plays a role in export performance over and above its impact on *RULC*. When other direct measures of economy-wide innovation were added to the regression, each was insignificant. These included the ratio of R&D expenditure to GDP (p-value: 0.449) (OECD, 1996), patent applications in the United States per thousand workers (p-value: 0.610), patent applications in Germany (p-value: 0.877), and research intensity measured by R&D scientists and engineers working in business per worker (p-value: 0.174) (Eaton *et al.*, 1998).[23] It should be noted that industry-specific labour productivity growth and the additional direct impact of investment have already been included in the original export market share regression.

The association of schooling (which measures mean years of schooling (OECD, 1992)) with country trends may operate through the contribution of education to quality-adjusted productivity as shown in the matched plant comparisons of Prais and colleagues (e.g. Prais, 1995). The role of concentrated ownership in sustaining long-term relationships between skilled workers and management, and between related companies (e.g. final goods producers and suppliers) has been discussed in the corporate finance literature and in studies of national systems of innovation (e.g. Franks and Mayer, 1990; Porter, 1990). However, there is little systematic cross-country empirical evidence of its significance for economic performance (e.g. Shleifer and Vishny, 1997; Berglöf, 1997). Its role in helping to account for trends in export market shares suggests that the theoretical arguments and anecdotal evidence may reflect an aspect of the broader experience of OECD economies. Although only speculative, these results suggest that the factors associated with successful export performance might be relatively deep-seated features of a nation's institutions.[24] We interpret the results as identifying directions for future research.

3.2. *The Heterogeneity of the Elasticity of Exports to Costs*

In this Section we address the second question of what lies behind the variation in the cost-sensitivity of export market shares. It is also possible to test the hypothesis coming from most models that relative costs may be less important for export performance in industries that are more R&D-intensive. The model in Appendix 2, for example, points to the fewer competitors in

[23] Inclusion of the direct measures of R&D and patenting had virtually no effect on the size or significance of total factor productivity. However, they tended to reduce the impact of the schooling variable. This was clearest in the case of the measure of R&D workers and highlights the difficulties of identifying a human capital from an R&D capital effect, at least when R&D is measured in terms of scientists and engineers.

[24] Other variables used to capture institutional differences between countries such as proxies for the characteristics of the wage bargaining system (or of 'corporatism'), of labour market regulation and of the infrastructure capital stock proved insignificant. This implies that any impact they have on exports operates through *RULC*.

R&D intensive industries as a factor that may reduce the sensitivity of exports to costs. In order to explore this issue, it is necessary to allow the coefficient on changes in relative costs to vary across industries.

We re-ran the baseline equation separately for each of the 12 industries. Table 5 provides a summary of the results. Apart from chemicals, all of the industries had the expected negative effects of costs on export market share in the long run. From the perspective of robustness, the most important feature of these results is that the mean of the industry specific coefficients is −0.24, very close to the long-run coefficient in the pooled sample of −0.27. Thus, pooling across industries is not causing a gross misrepresentation of the average long-run elasticity of export market share with respect to costs (cf. Pesaran and Smith, 1995). In addition, we estimated a very general model in which we allowed the coefficients on *RULC* to be different in every country-

Table 5

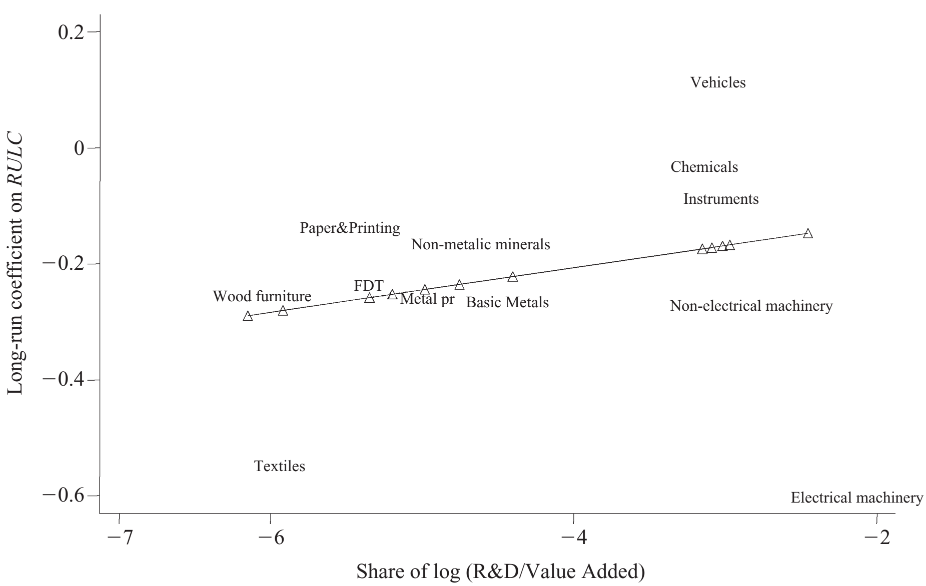
RULC and Export Market Shares by Industry

	Industry regressions pooled across countries		Industry-country regressions
	(1) *RULC* long-run	(2) Joint significance of country dummies (p value)	(3) *RULC* long-run: mean by industry from individual industry-country regressions
Food, drink, tobacco	−0.257 (0.111) [*0.000*]	0.000	−0.170
Textiles & clothing	−0.521 (0.257) [*0.000*]	0.000	−0.534
Wood & furniture	−0.260 (0.281) [*0.002*]	0.000	−0.393
Paper & printing	−0.124 (0.119) [*0.000*]	0.000	−0.013
Chemicals	0.008 (0.165) [*0.007*]	0.000	0.052
Non-metallic minerals	−0.142 (0.217) [*0.008*]	0.000	0.007
Basic metals	−0.272 (0.216) [*0.000*]	0.000	−0.412
Metal products	−0.258 (0.231) [*0.000*]	0.000	−0.154
Non-electrical machinery	−0.281 (0.242) [*0.000*]	0.000	−0.204
Electrical machinery	−0.597 (0.220) [*0.000*]	0.000	−0.389
Transport equipment	−0.159 (0.214) [*0.000*]	0.000	−0.318
Instruments	−0.015 (0.122) [*0.000*]	0.000	−0.058

Notes: The coefficients in column (1) are from industry-specific regressions identical in form to those presented in Table 2. The p values from a χ^2 test of the joint significance of the *RULC* terms are in square brackets. Column (2) gives the p-value for the χ^2 test of the joint significance of the country dummies. Column (3) reports the means for each industry from the 166 individual industry-country regressions.

industry pair. Running (2) on each of these 166 samples gave a distribution of long run elasticities of export market share with respect to *RULC*. The mean of these elasticities within each industry across countries is reported in column (3) of Table 5. The raw correlation of these industry averages with those in column (1) is 0.79 and the Spearman rank correlation is 0.83, which is significant at the 1% level.

We use the coefficients on *RULC* from the industry equations to examine whether higher R&D intensity is associated with less sensitivity of exports to costs.[25] The scatter plot in Fig. 3 shows that there is one outlier. Removal of this outlier reveals that industries with high R&D intensity are less sensitive to costs as our simple model would predict.[26] The outlier is the electrical machinery industry, which is very high-tech and is also very cost-sensitive. This industry has had substantial increases in the competition arising from more open government procurement policies in recent years, especially associated with defence purchases (see Davies and Lyons, 1997).[27]



Note: The regression line as shown excludes the electrical machinery industry.

Fig. 3. *Lower Sensitivity of Exports to Costs in High Tech Industries*

[25] We also tried including the R&D variables in the industry-specific regressions. The long-run effect was never significant at conventional levels. For example, using R&D shares $(t-1)$ to $(t-6)$ there was only one industry where the effect was quantitatively large and even here the coefficient was insignificant (R&D in the vehicles had a long-run effect of 0.347 but the p-value was 0.108).

[26] It might be imagined that *RULC* would have a larger effect in sectors where labour costs comprised a larger share of total costs. However, when the long-run elasticities are regressed on sample average shares of labour cost by industry there is no relation at all. This is not so surprising since one industry's intermediate input is another industry's output, the cost of which will be strongly influenced by common labour cost trends. Thus *RULC* will pick up more than just cost increases emanating from labour employed in the sector itself.

[27] International outsourcing may also be a bigger issue in this industry than elsewhere (e.g. TV sets).

Going one step further and allowing the industry specific regressions to be different in the later years from earlier years produced some interesting results. Across 10 of the 12 industries, the *RULC* elasticity was more negative in the post-1984 period than the pre-1984 period. Cost competition in the majority of industries became more important in the 1980s than it was in the 1970s.[28] The most obvious explanation and one that is consistent with the model is increased competition. As a proxy for changes in competition in an industry we use the average change in import penetration in the industry across the OECD. A simple regression of the change in elasticities against the change in global import penetration resulted in a significant negative correlation ($t = 2.15$). Fig. 4 illustrates that the industries that opened up the most to trade were also those in which cost competition became more important (such as the textile industry).

Both the pooled and industry regressions presume that the coefficients apply equally across countries. In order to examine whether the exports of some countries were more cost sensitive than those of others the regressions were also run for countries separately (Table 6). Since all regressions are weighted by the world share of industry exports in total world exports, differences in country coefficients do not reflect differences across countries

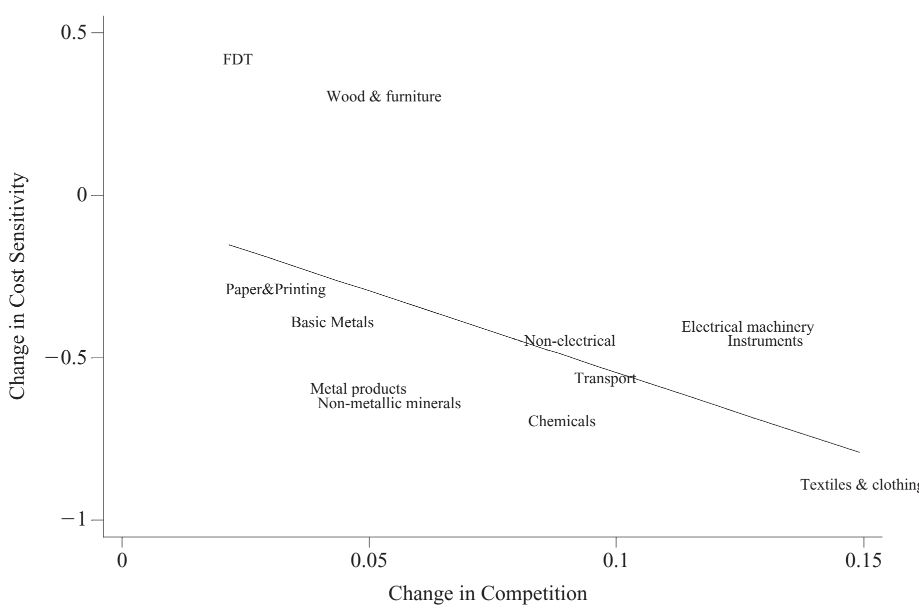


Fig. 4. *Sensitivity of Exports to Costs Increased more after 1984 in Industries with the Largest Rise in Import Competition*

[28] This was robust to the exact year chosen.

Table 6

RULC and Export Market Shares by Country

	Country regressions pooled across industries		Industry-country regressions
	(1) *RULC* long-run	(2) Joint significance of industry dummies (p value)	(3) *RULC* long-run: mean by country from individual industry-country regressions
Canada	0.307 (0.304) [*0.000*]	0.000	0.600
France	0.172 (0.098) [*0.000*]	0.000	0.340
Germany	−0.124 (0.162) [*0.000*]	0.000	−0.238
Italy	−0.033 (0.232) [*0.000*]	0.000	0.032
Japan	−0.400 (0.204) [*0.000*]	0.000	−0.356
UK	−0.246 (0.101) [*0.000*]	0.000	−0.227
USA	−0.287 (0.133) [*0.000*]	0.000	−0.361
Australia	−1.197 (0.736) [*0.000*]	0.000	−1.029
Belgium	0.041 (0.089) [*0.000*]	0.000	−0.027
Denmark	0.224 (0.108) [*0.000*]	0.000	0.051
Finland	−0.356 (0.221) [*0.463*]	0.000	−0.167
Netherlands	0.164 (0.125) [*0.000*]	0.000	−0.122
Norway	−0.907 (0.124) [*0.000*]	0.000	−0.826
Sweden	−0.670 (0.047) [*0.000*]	0.000	−0.628

Notes: The coefficients in column (1) are from country-specific regressions identical in form to those presented in Table 2 (i.e. all regressions include $RULC(t)$ to $RULC(t-5)$ and a full set of industry dummies). Robust standard errors are in parentheses. The p values from a χ^2 test of the joint significance of the *RULC* terms are in square brackets. Column (2) gives the p-value for the χ^2 test of the joint significance of the industry dummies. Column (3) reports the mean for each country from the 166 individual industry-country regressions.

in industrial composition. Overall the results were consistent with prior expectations. One country (Denmark) has a significantly positive cost elasticity suggesting very low price sensitivity. However, a majority of the long-run coefficients on *RULC* are negative, and despite the smaller sample size, five are significant (Japan, United States, United Kingdom, Norway and Sweden). As was the case with the industry-specific regressions, the mean of the country-specific elasticities is −0.24, which is very close to the elasticity in the pooled sample. Assuming a common coefficient seems to pick up the average effect reasonably well. The mean across industries within each country is given in column (3) of Table 6. (The raw correlation of these country averages with those in column (1) is 0.827 and the rank correlation is 0.80, which is significant at the 1% level).

The country specific results are consistent with those of Magnier and Toujas-Bernate (1994) and Amable and Verspagen (1995) who found German exports less sensitive (to prices and labour costs respectively) than were the exports of Japan, the United States and United Kingdom. But Germany does not seem out of line with the majority of countries in the core ERM group. Exports appear to be most cost-sensitive amongst the countries that remained outside the ERM or joined only shortly before its collapse (United Kingdom, Sweden, also Norway). The sensitivity of export market shares to costs seems to be related to two of the institutional variables that appeared to play a role in accounting for underlying country trends in exports. Countries where exports are less sensitive to costs are those with higher levels of ownership concentration and with higher rates of business-sector total factor productivity growth.[29]

We also estimated the most general model in which elasticities can vary by industry and country. Although there is a lot of variation (standard deviation 0.737) in the estimated distribution, the mean of the 166 elasticities was −0.214. This is slightly lower but still quite close to the estimate from the pooled sample.

3.3. *Econometric Robustness*

3.3.1. *Endogeneity*

The empirical strategy in this paper has been to keep to simple estimation by OLS. Clearly, there are potential problems with this. In order to check the robustness of our results, several experiments with the baseline specification were undertaken.

The most worrisome aspect of the analysis is the assumption that *RULC* can be treated as an exogenous variable. We argue that this is a reasonable assumption. On formal econometric grounds we are not assuming that there is never any feedback from changes in export market share to changes in *RULC*. The estimation procedure is in growth rates, so we are assuming that shocks to exports take at least two periods to feed back to relative unit labour costs. We feel comfortable about assuming this in relation to the nominal exchange rate. Our industries are not large, so shocks to a specific industry's exports will not

[29] Dependent variable: long-run elasticity of *XMS* with respect to *RULC* in the country equations (Table 5):

$$a_{COUNTRY} = -\underset{(0.276)}{1.007} + \underset{(0.095)}{0.231}\ TFP + \underset{(0.548)}{1.517}\ OWNCONC$$

Number of observations = 14

Adjusted R-squared = 0.2403

have much effect on the country's exchange rate (and the country dummies will control for national trends in *RULC* and *XMS*).

We find the assumption that an industry's unit labour costs are exogenous in the face of an export shock less acceptable. Reductions in trade barriers in a large foreign market for a specific industry could boost exports and give a spur to productivity growth. Alternatively, if export shocks generate abnormally high profits, workers may take some of these rents in the form of higher wages (see Van Reenen, 1996, for such a rent-sharing model). This would render OLS inconsistent. To deal with this we take several approaches. We begin by noting that endogeneity bias is most likely to affect contemporaneous *RULC*. Dropping the first two lags of *RULC* in column (3) of the baseline model of Table 2 did not change the main results[30]: the *RULC* terms were jointly significant (p-value < 0.00) with a long-run effect estimated to be -0.343 with a standard error of 0.044.

A second approach is to utilise the decomposition exercise of Table 3. We first note that the endogeneity biases for the wage and productivity components of unit labour costs are likely to be in opposite directions (towards zero for wages and away from zero for productivity). Yet as shown in Table 3, we could not reject the hypothesis that the long-run coefficients were equal for all three components of *RULC*. The finding that the OLS estimates of the decomposed *RULC* elasticities exhibit this theoretically appealing property also persuades us against the view that substantial endogeneity bias is present.

The most compelling test of endogeneity requires an instrumental variable approach. We have argued above that R&D does not have a direct effect on exports (see the evidence in Table 4). It is likely, however, to have an indirect effect through lowering unit labour costs. There is a voluminous literature on the effects of R&D on productivity suggesting that such an effect exists (see Griliches, 1998, for example).[31] In Table 7 column (1) we estimate the preferred specification (i.e. column (3) Table (4)) allowing different coefficients on the two components of *RULC*: nominal exchange rates (which we maintain are exogenous) and unit labour costs (which could be endogenous). Column (2) then instruments contemporaneous unit labour costs (*ULC*) with lags of relative R&D intensity (the same variable as in Table 4 column (1)). Although the coefficient on *ULC*(t) falls and the standard error rises, the change is minute. The long run effects are practically identical. One may be concerned that the instruments are weak in the sense they do not predict future costs. Column (3) reports the reduced form for *ULC* and shows that the lagged terms in R&D are jointly significant (p-value $= 0.01$).

Taken as a whole, we do not think there is significant endogeneity bias corrupting our results.

[30] Since there is a 'perverse' coefficient on *RULC* in period one associated with the J-curve effect, we need also to drop period two when this perverse effect unravels.

[31] The significant effects for R&D spending or patents on export performance reported in a number of other studies using STAN data (Wakelin, 1997; Fagerberg, 1997; Ionnidis and Schreyer, 1997) may reflect their not having fully accounted for the indirect effects of R&D on exports via costs.

Table 7

Possible Endogeneity of RULC: Using Lagged R&D as an Instrumental Variable

Dependent variable:	$\Delta \log(XMS)$		$\Delta \log(ULC)$
	(1) OLS	(2) IV	(3) Reduced form
$\Delta \log(ULC(t))$	−0.064 (0.061)	−0.063 (0.062)	
$\Delta \log(ULC(t-1))$	−0.057 (0.043)	−0.065 (0.043)	0.074 (0.052)
$\Delta \log(ULC(t-2))$	−0.078 (0.055)	−0.075 (0.055)	−0.006 (0.042)
$\Delta \log(ULC(t-3))$	−0.137 (0.047)	−0.130 (0.046)	0.054 (0.040)
$\Delta \log(ULC(t-4))$	0.058 (0.043)	0.062 (0.043)	−0.050 (0.300)
$\Delta \log(ULC(t-5))$	0.053 (0.043)	0.051 (0.043)	0.032 (0.038)
long-run effect of unit labour costs	−0.223 (0.091)	−0.219 (0.091)	
	[*0.002*]	[*0.002*]	
Δ Relative Exchange Rate (t)	−0.549 (0.049)	−0.528 (0.037)	−0.027 (0.038)
Δ Relative Exchange Rate $(t-1)$	0.350 (0.056)	0.345 (0.041)	0.015 (0.028)
Δ Relative Exchange Rate $(t-2)$	0.098 (0.060)	0.111 (0.046)	0.051 (0.043)
Δ Relative Exchange Rate $(t-3)$	−0.028 (0.050)	0.032 (0.044)	0.102 (0.031)
Δ Relative Exchange Rate $(t-4)$	0.121 (0.057)	0.121 (0.041)	0.033 (0.034)
Δ Relative Exchange Rate $(t-5)$	0.102 (0.056)	0.131 (0.039)	0.011 (0.040)
R&D share $(t-1)$			−0.027 (0.010)
R&D share $(t-2)$			0.012 (0.016)
R&D share $(t-3)$			0.013 (0.013)
Joint significance test of R&D terms			10.60
[p-*value*]			[*0.014*]
Joint significance test of investment terms $(t-1)$ to $(t-6)$ [p-*value*]	36.88 [*0.000*]	41.42 [*0.000*]	36.22 [*0.000*]
Joint significance test of country dummies [p-*value*]	31.35 [*0.002*]	33.77 [*0.001*]	58.64 [*0.000*]
Observations	1,728	1,728	1,728
Sample period	1978–1991	1978–1991	1978–1991
LM test of first order serial correlation	−0.114	−0.050	−1.612
[p-*value*]	[*0.909*]	[*0.960*]	[*0.107*]
LM test of second order serial correlation [p-*value*]	1.207 [*0.228*]	−0.057 [*0.954*]	−1.256 [*0.209*]

Notes: The number in parentheses to the right of the coefficient is the robust standard error. The number in square brackets below the coefficient is the p-value associated with the Wald test of the joint significance of all terms. In column (2) *ULC(t)* is treated as endogenous; the instruments are R+D share $(t-1)$ to $(t-3)$.

3.3.2. *Dynamics*

Although we have allowed a fairly unrestricted lag structure to capture the effects of *RULC* over time, the baseline equation does not allow for dynamics in the export market share variable. Yet many recent contributions to the trade literature have suggested that there is considerable persistence in countries' export market shares (e.g. Dixit, 1989). This may be related to the costs of losing market share when there are significant switching costs to consumers. One might expect to see a very sluggish response to cost changes due to this fact, as companies are reluctant to lose market share (and this is partly borne out in Fig. 2).

One simple way of testing for this effect is to include lags of the dependent variable in our specifications.[32] A well-known problem with this procedure is the fact that the differenced error term will be correlated with the lagged dependent variable by construction. This will lead to downward bias on the lag. We chose to instrument it with longer lags of market share (in periods $t-3$ and before) using a GMM procedure. This procedure (suggested by Anderson and Hsaio (1982) and refined by Arellano and Bond (1991)) is valid in the absence of autocorrelation of greater than order 2 in the transformed first differences error term (a condition which was satisfied).

The lagged dependent variables were insignificant in the pooled results when estimated by OLS. By contrast, the GMM results revealed that the lag coefficient is in fact highly significant suggesting considerable persistence in market shares. This is consistent with the more aggregate results offered by Amendola *et al.* (1993). Despite the fact that this implies the responsiveness in the medium run to changes in cost competitiveness may be somewhat slower than in the baseline results, the size of the long run coefficient on *RULC* is very similar (−0.283, with a standard error of 0.049).[33]

A further issue in relation to the dynamic specification of the model is whether a more explicit cointegration framework should be adopted. Could the presence of country trends reflect a dynamic misspecification that could be remedied by the use of information on cost levels? A popular methodology in the time series literature is the two-step approach of Engle and Granger (1987). A practical difficulty with implementing their procedure is that, as discussed in Section 1.2, there is no way to obtain reliable information on productivity levels across all the industries used. However, to the extent that the superconsistency of the estimates from the regression in levels holds even in the presence of measurement error and endogeneity, this may not be a problem. Recent Monte-Carlo evidence has cast some doubts on the super-consistency result, however, even for the time length of the data we are considering here (about 20 years).

Despite these concerns, we estimated the model in levels regressing market shares against the level of *RULC* (calculated using PPP exchange rates for GDP). The long run coefficient on *RULC* was −0.217 with a standard error of 0.046. These estimates were used to construct the 'error correction term' in $(t-6)$ which was included in the baseline specification of (2). As expected the variable took a significantly negative coefficient. The possibility that this procedure would push the country dummies into insignificance was rejected – they remained jointly significant ($\chi^2(14) = 28.5$).

[32] We also tested for asymmetric responses to exchange rate shocks by allowing a different coefficient on positive changes in *RULC* compared to negative changes. The null of symmetrical responses could not be rejected.

[33] The coefficients (standard errors) on *RULC* (t) to $(t-5)$ were 0.157(0.037), −0.257(0.045), 0.094(0.045), −0.060(0.031), −0.045(0.041), −0.116(0.042) respectively. Those on market share $(t-1)$ to $(t-3)$ were 0.587(0.111), −0.333(0.071) and −0.050(0.064) respectively.

4. Conclusions

This paper has made use of a recently compiled data set to confirm and clarify some long-held hypotheses as to the determinants of export performance and to throw light on a number of more recent conjectures. From the perspective of Ricardian trade theory, the use of industry level panel data for the exports of 14 OECD countries has produced some reassuring results. There appear to be important effects of relative costs on export market shares and the coefficients accord with a sensible adjustment path over time. The elasticity between relative costs and export market shares is approximately −0.27. This estimate is very robust to various experiments of disaggregating the sample by industry and country or allowing for more flexible dynamic specifications. We have also been able to confirm that in the long-run proportionate changes in the components of relative unit labour costs (exchange rate, wages and labour productivity) have approximately the same effect on export market shares, although their short-run dynamics differ. Thus as an index of cost competitiveness, *RULC* has much to commend it.

It is also clear, however, that there are important influences on export market shares other than relative costs. The first indicator of such influences is the fact that the country dummies remain jointly significant after relative costs are included in the change in export market share equation. Secondly, the proposition that ''technology'' factors have an effect on export performance was confirmed. Controlling for cost changes, we find that relative investment shares have a marked effect on export market shares, which supports the idea that technological improvements embodied in new capital goods promote export performance in ways that are not picked up by the productivity trends. However, there was no robust evidence that R&D or patenting intensities have an impact on trade over and above their effects on measured productivity. Nevertheless, there was evidence that the R&D intensity of an industry serves to dampen the responsiveness of export market shares to changes in relative costs. The examination of the separate industry equations suggested that both quality upgrading (and the associated reduced cost sensitivity of exports) and globalisation (and the associated increased cost sensitivity of exports) are both present. Thus two much discussed features of contemporary manufacturing trade have identifiable and conflicting effects on cost-sensitivity.

Finally, we were able to find some support for the role of institutional factors underlying the persistent trends in export market shares (once relative costs and fixed investment had been taken into account). Simple regressions of the residual country trends on a series of institutional variables suggested a role for country differences in human capital accumulation, disembodied technical progress (as reflected in aggregate business-sector total factor productivity growth) and ownership concentration. If the role of these factors is confirmed in subsequent work, implications for policy would follow. For example, the significant role of business sector TFP growth would suggest that policy-makers should focus on improving the conditions for innovation across the economy rather than taking a narrow view of promoting R&D activities *per se* or of promoting specific industries.[34] The indication from our results that ownership concentration may make a positive contribution to export market performance in this sample of countries highlights the potential hazards of policy prescription in the field of corporate governance.

The existence of underlying trends in export performance combined with an important role for cost competitiveness has implications for the debate about exchange rate arrangements in Europe. Within EMU, there will be a common inflation rate. With constant average profit margins, this implies a common growth rate of unit labour costs. Much of the debate about the functioning of EMU has focused on the level of unemployment required in different countries to achieve and maintain the convergence of their unit labour cost growth rate to the rate of inflation set by the European Central Bank. It is normally assumed that, although achieving and sustaining such nominal convergence may be costly, it will maintain unchanged trade performance. Our results cast doubt on this presumption. Investment (and possibly a set of institutional variables) influence export market shares even if relative costs remain unchanged. It is not clear how monetary union would produce the necessary convergence in investment, or in institutional structures. Without such 'deep convergence' countries with poor underlying trends will have to maintain lower rates of labour cost increase than the EMU inflation rate if they are to maintain their shares of export markets. This may prove very difficult to achieve.

The evidence presented here also suggests that where the competitiveness benefits of exchange rate depreciation are maintained, export market shares will be affected. But as we have seen, the extent to which a country's market share responds to changes in *RULC* varies. Indeed a rather striking partition of the countries suggests itself – those countries most closely associated with the European Exchange Rate Mechanism appear to have export market shares that are relatively insensitive to *RULC* (as does Canada with its very close association with the US economy).

By contrast, the exports of those European countries in the sample that are most sceptical about monetary integration (United Kingdom, Norway and Sweden) appear to be more sensitive to relative costs. Since the latter countries are also characterised by negative underlying trends in export market shares, repeated devaluations remain a temptation in order to gain offsetting improvements in cost competitiveness. These results help to provide an economic explanation for scepticism in the United Kingdom, Sweden and Norway regarding the merits of membership of a single currency area. They also help to explain why membership was supported in France, Italy and Germany and the other smaller EU countries in our sample where exports appear to exhibit less sensitivity to costs.

[34] The Swedish experience of very high levels of R&D expenditures combined with poor business sector TFP performance (and, as we have shown, a poor underlying trend in export market shares) may be due to the poor incentives to exploit innovations within the domestic economy (Henrekson *et al.* 1996).

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Appendix 1. Data Appendix

The full OECD STAN data set covers 20 countries. Mexico and Korea were omitted because of their relatively low levels of development at the beginning of the period. Austria's data contained no series for real output, and there were extensive sections of missing data for New Zealand, Portugal and Spain which necessitated their exclusion since a constant set of countries is required for generating a consistent set of relative variables (e.g. *RULC*). Whilst the version used (1995) covered the years 1970–93, there were too many missing values for 1993, so that the analysis was restricted to 1970–92. The STAN database covers total manufacturing with 48 subdivisions at various different levels of aggregation.

Table A1 shows which industries comprise the basic pool (the 12 main industry divisions covering the whole of manufacturing except the residual category 'other manufacturing' which, inspection of the data suggested, varies in definition not only across countries, but also across variables for a given country). The table also shows the maximum degree of disaggregation available within STAN and indicates which sub-industries were omitted from the 'large pool' (26 industries).

The ANBERD data set on R&D spending provides data corresponding to the basic pool (after aggregation of some smaller sub-divisions for the machinery and transport equipment sectors). The only mismatch is that aerospace is included with aircraft and

Table A1
Industry Coverage and Aggregation

Basic Pool	Maximum Disaggregation
food, beverages and tobacco	food; beverages; tobacco
textiles, apparel and footwear	textiles; wearing apparel; leather and products; footwear
wood products and furniture	wood products; furniture
paper products and printing	paper products; printing and publishing
chemical products	industrial chemicals; other chemicals (drugs and medicines*; chemical products nec*); petroleum refineries†; petroleum and coal products†; rubber products; plastic products nec.
non-metallic mineral products	pottery and china; glass and products; non-metallic mineral products
basic metal industries	iron and steel; non-ferrous metals
metal products	metal products
non-electrical machinery	office and computing machinery*; machinery and equipment nec*
electrical machinery	radio, TV and communication equipment*, electrical apparatus*
transport equipment	shipbuilding and repairing; railroad equipment†; motor vehicles; motorcycles and bicycles†; aircraft†, transport equipment nec†
instruments	instruments

Note: Subindustries marked * could not be used because STAN provided no real output data; in addition, subindustries marked † were omitted from the Large Pool because of missing data and/or excessive variability in the series. nec means not elsewhere classified.

thus transport equipment in the R&D series, whereas it is included in non-electrical machinery in the STAN data. Given the possibility of serious distortion of the R&D data for transport equipment this industry was replaced in the basic pool by motor vehicles when R&D was a variable. ANBERD does not provide data for Belgium and Norway and starts in 1973 and ends in 1991 which correspondingly restricts the data set when R&D data are used.

Patent Data for US patents by country of origin from the International Technology Indicators Database can be matched into the basic pool except that no data are available for Wood Products and Paper Products, and there are data for food and beverages and textiles, rather than the more aggregated groups. These were matched with the appropriate STAN sub-divisions and analysis conducted on this slightly amended version of the basic pool. The data are available for 1980–91.

Definitions of Variables

WAGES Wages per worker. Calculated by dividing employee compensation, which includes non-wage labour costs (from STAN) by number of employees. The latter was calculated by multiplying total employment (from STAN) by the share of employees in total employment; the latter was interpolated from beginning and end period values derived from the OECD International Sectoral Data Base, supplemented from OECD National Accounts. Where data on self-employment were missing the share of dependent employment was assumed to be equal to that of the industry grouping at one higher level of aggregation. In a few cases (generally at the beginning of the period), missing values for wages per worker were filled in for sub-industries (in the larger pool) by linking to changes in the series for larger industry aggregates (in the basic pool).

PROD Labour Productivity. Value Added at constant (1985) prices (from STAN) divided by total employment (from STAN). In a few cases (generally at the beginning of the period), missing values were filled in for sub-industries (in the larger pool) by linking to changes in the series for the larger industry aggregates (in the basic pool).

INVSH Investment Share. Gross fixed capital formation at current prices divided by value added at current prices (both from STAN)

RDSH R&D Share. Business enterprise intramural expenditure on R&D at current prices (from ANBERD) divided by value added at current prices (from STAN).

PATSH Patent Share. Patents in the United States divided by value added converted to dollars at the PPP exchange rate.

WAGESH Wage Share. Wages per employee divided by value added at current prices per person employed (i.e. employee compensation, adjusted for self employment by attributing to the self-employed in a sector a wage equal to the average wage in the sector, divided by current price value added).

$ULC Labour Cost in Dollars per unit of Output. Employee compensation divided by the average value of the exchange rate divided by value added at constant prices (all from STAN). Note that this series is not comparable in level terms across countries (since real output is expressed in terms of national currencies), but changes in *$ULC* are comparable (changes in dollar labour costs per unit of output).

Relative Series

XMS Export Market Share is calculated by taking exports in national currencies, current prices from STAN and converting them to US dollars using the average value of the US dollar exchange rate (from STAN) and dividing by the sum of exports for that industry and year for the 14 countries.

Most of the basic variables described above are used in the analysis in 'relative form' that is the value for the ith industry of the jth country in the tth year is expressed relative to the average value for the ith industry over all the countries in the tth year. This is done by constructing a weighted average of the individual country values, using *XMS* of the ith industry in the jth country in 1980 as weights. For example *RELINVSH* is the investment share relative to the average (i.e. with values above or below one depending on whether the country concerned is above or below the average). Exactly the same procedure was used for calculating *RELRDSH* and *RELPATSH*.

Missing values for individual years (for example at the beginning or end of the series) pose problems because a consistent series of relative values must be constructed for a consistent sample of countries (or otherwise relative values would jump about as countries entered or left the reference group). Accordingly, where there were missing values we used interpolation (usually with reference to the behaviour of the variable for total manufacturing, or its recent average value for the industry concerned) to derive a 'shadow' value of the variable for use in constructing the weighted average for all countries. We did not insert this shadow value into the basic data set.

In the case of $*ULC* and its components – relative wages per head, relative productivity and the relative exchange rate – relative levels cannot be constructed. This is because an average cannot be taken where the variables concerned are expressed in different national currencies (wages per head, real output per head or units of national currency per US dollar). Accordingly indices of these variables were constructed (with $1970 = 100$) and relative values of these indices calculated in the normal way. This allows calculation of the proportionate change in *RULC* (and similarly for relative wages per head, relatively productivity and the relative exchange rate).

Appendix 2. A Simple Model of Export Market Shares

To motivate the empirical specification we present a simple model to capture the main ideas. Consider a segmented product market where p_i is the price in country i (reflecting market segmentation). To keep things simple consider the case where there are two countries and there is Cournot competition in the product market. Demand in country i is assumed to be:

$$p_i = a - b_i Q_i$$

where $a > 0$ is the choke price (consumer preferences assumed to be identical); Q_i is aggregate demand in country i and $b_i = m_i^{-1}$, where $m_i > 0$ is the size of the market in country i, so we allow the size of the market to be different in the two countries. There are n_i firms producing this good in country i each with constant unit operating costs, c_i, $a > c_1 \geqslant c_2 > 0$. We abstract from trade and transport costs.

Assume that the cost differences are sufficiently small that firms from each country sell in each market. A one-shot Nash equilibrium in quantities tells us that

$$p_1 = p_2 = \frac{a + n_1 c_1 + n_2 c_2}{n_1 + n_2 + 1}$$

Total exports from country 1 to country 2 (X_1) and from country 2 to country 1 (X_2) are then

$$X_1 = m_2[n_1(a - c_1) + n_1 n_2(c_2 - c_1)]$$
$$X_2 = m_1[n_2(a - c_2) + n_1 n_2(c_1 - c_2)].$$

Export market share of country 1 ($XMS_1 = X_1/X$; $X = X_1 + X_2$) is straightforward to calculate given these expressions. To see the comparative statics note that for any variable z,

$$\frac{\partial XMS_1}{\partial z} = \frac{X \dfrac{\partial X_1}{\partial z} - X_1 \dfrac{\partial X}{\partial z}}{X^2} = \frac{X_2 \dfrac{\partial X_1}{\partial z} - X_1 \dfrac{\partial X_2}{\partial z}}{X^2}.$$

For an increase in *RULC* (country 1's costs increase and country 2's costs remain the same

$$\frac{\partial XMS_1}{\partial c_1} = -\frac{n_1}{X}[(1 - XMS_1)\, m_2 (1 + n_2) + XMS_1\, m_1\, n_2].$$

This expression is clearly negative. More interestingly the magnitude of the sensitivity of export market share to *RULC* will depend on the other parameters of the model. In particular the sensitivity will be higher the greater is the degree of competition in the market (which is indexed by the number of firms in this model). Even an increase in competition outside the home country should have an effect on the sensitivity of *XMS* to changes in *RULC*.

It is more difficult to get unambiguous comparative static results from the other parameters of the model. An increase in competition in the domestic market will have ambiguous effects on export market share as will an increase in market size. For example, consider an exogenous increase in the number of firms in country 1 on its own market share

$$\frac{\partial XMS_1}{\partial n_1} = \frac{1}{X^2}[(a - c_1) X_2 + (c_2 - c_1)\, n_2 (X_2 + m_1 X_1)].$$

This expression will clearly be positive if country two has equal or higher costs than country 1, but is ambiguous in the more general case.

For any given industry we assume that the market size and competition parameters are captured by fixed effects and common time effects (we have no reliable measures of country-industry-time specific increases in competition). In the second part of the results section we allow the coefficient on *RULC* to vary with industry characteristics (such as R&D intensity).

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