PRODUCTIVITY PERFORMANCE AND EXPORT PERFORMANCE:

A TIME-SERIES PERSPECTIVE

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INTRODUCTION

Since the work of Solow [1957], it has been accepted that technological change accounts for a significant portion of GNP growth in industrialized economies. Technological change has been defined either by the estimated time trend in regressions of aggregate output on inputs or by indexes of total factor productivity. Although there have been various refinements to the measurement of total factor productivity, there still is no satisfactory explanation for its source [Solow, 1988; Feenstra and Markusen, 1991].

International trade theory has suggested a potential source of productivity gains: an outward-oriented trade regime and fairly uniform incentives for production across export- and import-competing goods [Helpman and Krugman, 1985; Pack, 1988; Rodrik, 1992; Edwards, 1993; World Bank, 1993; Krueger, 1997]. Thus, international trade theory sees the growth of exports as stimulating production across the economy through technological spillovers and other externalities. Exports might create these externalities for the following reasons: (i) exposure to international markets calls for increased efficiency and provides incentives for product and process innovation, (ii) the increase in specialization allows the exploitation of economies of scale, and finally, (iii) larger exports will contribute to the stock of knowledge and human capital in the economy, thereby benefiting all firms. Thus, the rate of export growth will cause economy-wide productivity gains.

One of the important implications of the neoclassical growth theory is that all countries eventually would converge towards the same level of productivity. The lack of evidence that this would happen prompted the development of "new growth" theories [Helpman and Krugman, 1985; Romer, 1986; 1990; Grossman and Helpman, 1991a; Grossman and Helpman, 1995; Durlauf and Quah, 1999]. These new theories are characterized by the endogenization of technology. A justification of causality from

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productivity to exports may be found in "New trade" theories, which argue that productivity leads to greater exports by pointing out that differences in technology are important motivating factors for trade. In other words, international technological differences are important determinants of international competitiveness and trade performance of developed countries.

Although the "new" trade theory considers the relationship between productivity gains and trade, the effect of trade on productivity gains is fundamentally ambiguous and inconclusive in models of imperfect competition and increasing returns to scale [Grossman and Helpman, 1991a]. Exports are assumed to increase technical efficiency to a greater degree in smaller economies and those with fewer new firms entering markets. The reason is that in small economies, the minimum efficient scale is likely to be relatively large compared to the domestic market size, which implies that exports have a greater potential to exploit economies of scale. Furthermore, productivity improvements are more likely to result from an increase in exports if (i) tougher competition is induced by entry of new firms, leading to the exit of inefficient firms and to an increase in X-efficiency, or (ii) incentives are created to invest in R&D. Openness to trade also means fiercer foreign competition that may choke off domestic investment opportunities, thereby lowering productivity. Whether exports will create productivity gains and losses can only be determined empirically.

However, casual inspection of productivity and exports in industrialized countries shows that these two time series are co-trending. Countries that are successful in their export performance seem also to be successful in their productivity performance and vice versa. A number of studies have found a positive relationship between exports and productivity growth. This relationship often appears to hold regardless of country studied, technique used, level of disaggregation of the data, and time span. The more difficult question to answer is whether the relationship is causal and if so, in what direction. At the macro-level, Marin [1992] finds uni-directional causality, running from exports (of manufacturing goods) to labor productivity (defined as manufacturing output per employee), for Germany, Japan, the UK, and the United States. At the micro-level, plants or firms with higher productivity growth are the ones that are more likely to sell in the export market, not the other way around. Examples of these studies are Clerides, et al. [1998] on a few developing countries, and Bernard and Jensen [1997] on the United States.

This paper addresses the following questions: Does a long-run steady-state relationship exist between productivity and exports? Is there any comovement or causality between productivity and exports? What is the direction of causality between these variables? It addresses these questions by looking at aggregate country-wide data from France, Germany, Italy, Sweden, and the UK. We chose this set because Germany and France represent cases of relatively favorable productivity and export growth rates and Italy, Sweden and the UK represent countries with relatively less favorable records in export and productivity. The countries as well as the econometric technique used in this paper differ from the studies mentioned above.

The purpose of this paper is to examine the causal nexus of exports and productivity for five industrialized countries and to explore the long-run and short-run dynamics between these variables by examining unit root properties, the Johansen cointegration technique, and the augmented Granger causality tests. Cointegration techniques are used to establish the long-run steady-state relations between or among economic time series. We also use variance decompositions to trace out the effect of one-time shocks to the system. Finally, a series of diagnostic tests is performed to check that the underlying assumptions are fulfilled.

This paper is organized as follows: The next section briefly lays out the possible relationships which may exist between exports and productivity. We then discuss data and methodology used in this study, present and interpret the results, and finally conclude the paper.

EXPORT-LED PRODUCTIVITY; PRODUCTIVITY-LED EXPORTS OR FEEDBACK?

It is argued that output growth can lead to higher productivity growth because it allows economies of scale to be exploited. As output grows, capacity utilization expands, leading to a decrease in average cost. Thus, output growth is expected to be positively related to productivity growth, known as "Verdoorn's Law." An outward-oriented policy facilitates large-scale production by increasing access to imported intermediate inputs; by eliminating policy induced biases against exports it encourages export growth, which enables firms to overcome the constraints of a small domestic market. Thus, one possible link between export growth and productivity growth takes place through output growth.

Export growth can lead to higher productivity growth also as a result of (i) greater capacity utilization in industries in which the minimum efficient size of plant is large relative to the domestic market, (ii) greater horizontal specialization as each firm concentrates on a narrower range of products, and (iii) absorption of new technologies or spill-over effects [Krueger and Tuncer, 1982; Pack, 1988; Eaton and Kortum, 1994; Coe and Helpman, 1995; Krueger, 1997]. Furthermore, with more foreign exchange resulting from export growth, firms would have better access to imported inputs and new technology. The outward-oriented trade policy may bring local firms closer to foreign firms, and provide them with opportunities to learn better management practices. Export orientation also encourages domestic firms to train their workers better, may give access to advanced technologies, learning by doing, and increases the number of skill-intensive jobs, leading to productivity growth which takes place through more efficient use of technology [Grossman and Helpman, 1991b; Ben-David and Loewy, 1998]. This implies that as exports grow productivity improvement occurs and, thus, the hypothesis predicts that the rate of export growth will cause economy-wide productivity gains. Therefore, there is expected to be a positive link between export expansion and productivity growth.

The lack of evidence that all countries eventually would converge towards the same level of productivity prompted the development of "new growth" theories [Helpman and Krugman, 1985; Romer, 1986, 1990; Grossman and Helpman, 1991a; Grossman and Helpman, 1995; Durlauf and Quah, 1999]. These new theories focus on the endogenization of technology. "New trade" theories, which take into account differences in technology as an important motivating factor for trade, justify the causality from productivity to exports. That is, many have studied how international technological differences contribute to international competitiveness and trade performance of developed countries.

However, a feedback relationship between exports and productivity is an interesting prospect. Exports may rise from the realization of economies of scale due to productivity gains; the rise in exports may further create cost reductions which may result in further productivity gains [Helpman and Krugman, 1985]. In other words, export expansion leads to improved skills and technology. This increased efficiency creates a comparative advantage for a given country, which facilitates exports.

Although in the "new trade" theory, productivity (technical efficiency) and trade are central links, the effect of trade on productivity is not conclusive in models of imperfect competition and increasing returns to scale [Helpman and Krugman, 1985; Romer, 1990; Grossman and Helpman, 1991a]. Whether a trade orientation enhances or retards productivity growth depends on the competitive conditions on the domestic market and the market structure. For example, an export expansion might encourage too many firms producing at too-low levels of output, which might dampen or reverse the original export-induced productivity increase [Baldwin and Krugman, 1986; Flam and Helpman, 1987]. Alternatively, openness to trade means that the monopoly profits of domestic firms are extended over a larger market, creating an incentive to invest in R&D and thereby increasing productivity. It also means fiercer foreign competition that may choke off domestic investment opportunities, thereby lowering productivity [Grossman and Helpman, 1991a; Cohen, 1995]. These factors imply that whether exports will cause productivity gains or losses can only be decided empirically.

Do exports and productivity share a common trend so that they can be considered to have a long-run equilibrium relationship? Does a causal link exist between exports and productivity? Do movements in exports predict movements in productivity? This paper attempts to answer these questions for our sample countries based on the cointegration and causality approach outlined in the next section.

DATA AND METHODOLOGY

The data used in this study is real exports, labor productivity, and total factor productivity. The labor productivity (LP) is constructed as real GDP (in terms of national currency) per total employment. The real export series is defined as nominal exports (in terms of national currencies) deflated by the export price indexes (1990 = 100). The real GDP series is derived from the *OECD Economic Outlook* (various issues) and the *IMF International Financial Statistics* (various issues). The total employment is taken from the *OECD Economic Outlook* (various issues). The export series and export price indices are obtained from the *OECD Economic Outlook* (various issues) and the *IMF International Financial Statistics* (various issues). The data on total factor productivity (TFP) is derived from the *International Sectoral Database, OECD*, Paris. In the case of LP, the data is yearly and covers 1960 to 1997 for Germany, Italy, Sweden, and the UK.[1] For France, the data covers 1960 to 1994. The reason for the choice of different time periods was the availability of the data. In the

case of TFP, the data is yearly and covers the period 1970 to 1998 for each country in the sample.[2] All the variables are transformed to the natural logarithm. The real export, TFP, and the importance of export sector (as a percent of GDP), for each country, are illustrated in Figures 1-3 in Appendix A.

The empirical approach based on correlations between exports and LP involves the problem that the correlation is not very informative since it is not clear whether the result reflects primarily business cycles patterns or real causal links, as is suggested by the hypothesis. Thus, using TFP, as a sensitivity test, is justified on these grounds.

To ensure correct model specification and to avoid the possibility of obtaining misleading results, it is important first to check the time series characteristics of the data by testing for unit root and cointegration. We test first for the integration order of each variable. A variable is integrated of order d, denoted I(d), if it must be differenced d times to achieve stationarity. In addition to the augmented Dickey-Fuller (ADF) test for deciding the integration order of each variable, we use the Johansen [1991] multivariate test. The test for cointegration reported here follows the Johansen [1988; 1991] and Johansen and Juselius [1990] maximum likelihood estimator. The Johansen procedure is based on the error-correction representation of the vector autoregression VAR (k) model with Gaussian errors. Johansen and Juselius [1990] introduce two likelihood-ratio tests known as the λ-max and trace tests to determine the number of cointegrating vectors using the maximum likelihood estimates of cointegrating vectors. The lag order, k, is chosen carefully by a combination of multivariate Schwarz [1978] Bayesian criterion (SBC), multivariate Hannan and Quinn [1979] criterion (HQC), and a series of multivariate diagnostic tests.

Let x_t be real exports and y_t be either LP or TFP, where x_t and y_t can be defined either in levels or growth rates. The export variable is said to cause the productivity variable in Granger's [1969] sense if the inclusion of lagged values of x_t improves the forecast of y_t. Similarly, the productivity variable is said to cause the export variable in Granger's sense if the forecast for x_t has a smaller mean square error when the past values of the productivity variable are included.

Causality tests require that the time series be stationary.[3] Otherwise, the F-statistics from the tests will indicate non-standard distributions, and the empirical results can be misleading [Sims, et al., 1990]. If the original series are non-stationary, they must be transformed into stationary variables by differencing the variables until they are stationary. When two series are cointegrated, however, there is a long-run equilibrium between the two variables. Hence, in the presence of cointegration, the simple Granger causality tests can become inappropriate and should be modified because when all the variables are in first difference, only short-run effects will be picked up. Thus, standard Granger causality tests, augmented with error-correction terms (derived from the long-run cointegrating relationships), are used to examine the long-run effects. Such tests are carried out on I(0) variables to assure that valid inferences may be made from the tests [Engle and Granger, 1987]. The augmented Granger causality test is usually formulated as:

$$(1) \qquad \Delta \ln x_t = \alpha_0 + \sum_{i=1}^{k-1} \beta_i \Delta \ln x_{t-i} + \sum_{i=1}^{k-1} \lambda_i \Delta \ln y_{t-i} + \delta \eta_{t-1} + \varepsilon_t ,$$

TABLE 1
Choosing the Optimal Lag of the VAR Model for x and y (TFP)

Country	Lag	Multivariate Statistics		Information Criteria	
		LM(4)	Norm(4)	SBC	HQC
France	2	**0.94**	**0.93**	**−12.606**	−12.374
	3	0.38	0.77	−12.443	−13.357
	4	0.16	0.42	−12.491	**−13.491**
Germany					
	2	0.07	**0.95**	−8.319	**−9.017**
	3	**0.91**	0.06	**−8.373**	−8.937
	4	0.83	0.62	−8.052	−8.831
Italy					
	2	0.72	0.09	−9.780	−10.414
	3	**0.96**	**0.45**	**−10.480**	**−11.255**
	4	0.01	0.26	−9.968	−10.827
Sweden					
	2	0.40	0.39	**−11.666**	**−13.402**
	3	**0.96**	**0.87**	−11.593	−12. 960
	4	0.66	0.84	−11.420	−12.141
UK					
	2	0.84	0.08	−7.874	−8.436
	3	0.16	**0.26**	**−7.925**	**−10.687**
	4	**0.90**	0.04	−7.797	−8.622

All the test statistics are χ^2 distributed. LM(ρ) is the Breusch-Godfrey Lagrange multiplier test for residual autocorrelation of order ρ. The test for normality (Norm(4)) is based on a multivariate version of the Shenton and Bowman [1977] test developed by Doornik and Hansen [1994]. The p-values of the multivariate tests are reported here. SBC and HQC are the multivariate Schwarz [1978] Bayesian criterion and the multivariate Hannan and Quinn [1979] criterion, respectively.

(2)
$$\Delta \ln y_t = \gamma_0 + \sum_{i=1}^{k-1} \phi_i \Delta \ln x_{t-i} + \sum_{i=1}^{k-1} \varphi_i \Delta \ln y_{t-i} + \sigma\tau_{t-1} + \mu_t ,$$

where ϵ_t and μ_t are error terms which are assumed to be white noise with zero mean, constant variance and no autocorrelation, Δ denotes the first difference, and η_{t-1} and τ_{t-1} are the error correction terms that are found from the long-run cointegrating regressions. In equation (1) causality implies that $\Delta \ln y$ "Granger-causes" $\Delta \ln x$, provided that either some λ_i or δ is not zero. Similarly, in equation (2) $\Delta \ln x$ "Granger-causes" $\Delta \ln y$ if either some ϕ_i or σ is not zero. Granger-causality is shown in two ways. First, the F-statistics are calculated under the null hypothesis that in equations (1) and (2) all the coefficients of λ and ϕ equal zero. Second, the independent variables "cause" the dependent variable if the error correction term in equation (1) and (2) is statistically significant [Granger, 1988]. It should be mentioned that lagged coefficients on the independent variables represent short-run causal effects, while the coefficient of the error correction term reflects long-run causality.

TABLE 2
Testing Cointegration Between x and y (TFP) by Using the Johansen Maximum Likelihood Procedure

	Eigen-Value	Null Hypothesis	Alternative Hypotheses		95% Critical Value	90% Critical Value	Homogeneity P-Value
France		Trace tests:		Trace Value			0.02
	0.6798	r = 0	r > 0	33.33	20.18	17.88	
	0.2835	r ≤ 1	r > 1	8.00	9.16	7.53	
		λ_{max} tests:		λ_{max} value			
	0.6798	r = 0	r = 1	27.33	15.83	13.81	
	0.2835	r = 1	r = 2	8.00	9.16	7.53	
Germany		Trace tests:		Trace Value			0.01
	0.6512	r = 0	r > 0	23.19	20.18	17.88	
	0.2472	r ≤ 1	r > 1	2.29	9.16	7.53	
		λ_{max} tests:		λ_{max} Value			
	0.6512	r = 0	r = 1	20.90	15.83	13.81	
	0.2472	r = 1	r = 2	2.29	9.16	7.53	
Italy		Trace tests:		Trace Value			0.04
	0.4975	r = 0	r > 0	28.08	20.18	17.88	
	0.1460	r ≤ 1	r > 1	5.96	9.16	7.53	
		λ_{max} tests:		λ_{max} Value			
	0.4975	r = 0	r = 1	22.12	15.83	13.81	
	0.1460	r = 1	r = 2	5.96	9.16	7.53	
Sweden		Trace tests:		Trace Value			0.00
	0.6243	r = 0	r > 0	29.84	20.18	17.88	
	0.1186	r ≤ 1	r > 1	3.41	9.16	7.53	
		λ_{max} tests:		λ_{max} Value			
	0.6243	r = 0	r = 1	26.44	15.83	13.81	
	0.1186	r = 1	r = 2	3.41	9.16	7.53	
UK		Trace tests:		Trace Value			0.01
	0.5724	r = 0	r > 0	23.55	20.18	17.88	
	0.2796	r ≤ 1	r > 1	6.56	9.16	7.53	
		λ_{max} tests:		λ_{max} Value			
	0.5724	r = 0	r = 1	16.99	15.83	13.81	
	0.2796	r = 1	r = 2	6.56	9.16	7.53	

λ_{max} is the maximal eigen-value test statistic for at the most r cointegrating vectors(s) against the alternative of $r + 1$ cointegrating vector(s); Trace is the stochastic matrix trace test for at the most r cointegrating vectors(s). The long-run homogeneity test also restricts the constant term to be zero, i.e., b'_R = (-1.0, 1.0, 0.0).

ESTIMATION RESULTS

The methodology discussed earlier to infer the relationship between exports and two alternative measures of rates of productivity implies three steps. The first step is to test the variables for stationarity.[4] The estimated results, not presented but available on request, showed that each variable is integrated of the first order.[5] That is, these variables should be differenced once to become stationary. Since the variables are found to be non-stationary, it is of interest to investigate if these variables, for the

TABLE 3
The Estimated Cointegrating Vector Applying the Johansen Procedure

	ln x	ln y (TFP)	Constant
France	-1.000	5.350	-18.752
	0.187	-1.000	3.504
Germany	-1.000	4.596	-14.371
	0.218	-1.000	3.127
Italy	-1.000	3.468	-9.719
	0.288	-1.000	2.803
Sweden	-1.000	5.769	-18.455
	0.173	-1.000	3.199
UK	-1.000	8.719	42.788
	0.115	-1.000	-4.907

−1.000 implies that the cointegrating vector is normalized with respect to the variable.

country in question, to establish any long-run equilibrium. Thus, the second step is to test for cointegration between exports and productivity in each country using the Johansen procedure. The presentation is focused on the estimations using TFP measures and the results for LP are not reported here but are available from the authors on request. Based on the information presented in Table 1, we choose VAR(3) for Germany, Italy, and the UK, and VAR(2) for other countries in the sample.[6] The cointegration test results are presented in Table 2. The results from both of the tests (lambda max and trace statistics) indicate that there is one cointegrating vector between the variables,(i.e., exports and productivity (both measures) in each economy establish a long-run equilibrium). We also test for long-run homogeneity. The results reported in Table 2 show that the assumption of long-run homogeneity is rejected for each country at the 5 percent significance level. These results imply that co-movement between the variables is not one by one in the long run. The cointegrating vector, which is normalized with respect to both variables for each country, is presented in Table 3. On the basis of the results, we conclude that productivity (both measures) and exports are cointegrated, and are therefore causally related in each economy.[7] It should be mentioned that TFP and real exports cointegrate at the 5 percent significance level for each country.[8]

We checked for parameter stability by using the recursive coefficients. The recursive coefficients are estimated repeatedly, using ever larger subsets of the sample data. If there are s coefficients to be estimated in the coefficient vector **v**, then the first s observations are used to form the first estimate of v. This process is repeated until all the T sample points (where T is the sample size) have been used, yielding T- s estimates of the **v** vector. The plots of these recursive coefficients enable us to trace the evolution of any coefficient as more and more of the sample data are used in the estimation. If the coefficient displays significant variation as more data is added to the estimating equation it is a strong indication of instability. By studying the behavior of the recursive coefficients, it appears that the parameters are almost time invariant.[9]

TABLE 4
Test for Granger Causality Between x and y (TFP)

	H_0	δ (σ)	λ_i (ϕ_i)
France	ln y does not Granger cause ln x	0.000	0.434
	ln x does not Granger cause ln y	0.422	0.196
Germany	ln y does not Granger cause ln x	0.003	0.034
	ln x does not Granger cause ln y	0.005	0.503
Italy	ln y does not Granger cause ln x	0.031	0.445
	ln x does not Granger cause ln y	0.029	0.214
Sweden	ln y does not Granger cause ln x	0.850	0.462
	ln x does not Granger cause ln y	0.001	0.734
UK	ln y does not Granger cause ln x	0.021	0.026
	ln x does not Granger cause ln y	0.003	0.995

p-values are presented here.

The third step is to perform a standard Granger causality test augmented with an appropriate error-correction term taken from the appropriate cointegration relationship in each country in the sample, as shown by equations (1) and (2). A causal link between export growth and productivity growth is found based on the values of the F-statistics on chosen lag orders of the independent variable, and the t-statistics on the error correction term, as shown by Table 4. In the case of LP, one can conclude that causality is bi-directional in the case of the UK. For France, Italy, Germany and Sweden, causality is uni-directional and runs from exports to LP. The short-run causality exists only in the UK and it runs unidirectionally from exports to LP. When TFP is used, as shown by Table 4, the flow of causality is bi-directional in Germany, Italy, and the UK. In France the flow of causality runs in only one direction—from productivity growth to export growth—while in Sweden causality runs from export to productivity growth. The short-run causality exists only in the case of Germany and the UK, and it runs unidirectionally from TFP to exports in both countries.

We also used variance decompositions to trace out the effect of one-time shocks to the system. The variance decomposition measures the contribution of each innovation in the vector error correction model (VECM) to the k-step ahead forecast error variance of the dependent variables. It is a useful tool for determining the relative quantitative importance of shocks to the variables in the system. The variance decompositions between TFP and real exports were estimated for each country. On the basis of the results that we have obtained we can conclude that about 35, 21, 13, 1, and 20 percent of the 4-step forecast error variance of exports is accounted for by innovations in TFP for France, Germany, Italy, Sweden, and the UK, respectively. For a four-forecast horizon, export innovations contribute about 3, 48, 42, 80, and 86 percent for the forecast error variance of productivity for France, Germany, Italy, Sweden, and the UK, respectively. The chosen order for estimating the variance decompositions is real exports and productivity, which allows for real exports to be affected by the simultaneous and past innovations in productivity while productivity is only affected by the past innovations in real exports. However, these variance decompositions are, more or less, in line with the previous causality nexus achieved for each country.[10]

SUMMARY AND CONCLUSIONS

Recent trade theory suggests that the relationship between trade and productivity is fundamentally ambiguous. This paper investigates the cointegration and causal relationship between exports and two alternative measures of rates of productivity growth for France, Germany, Italy, Sweden, and the UK. On the basis of Johansen's maximum likelihood procedure and the augmented Granger causality tests, we conclude that exports and productivity are causally related in the long run. A combination of multivariate information criteria and a series of diagnostic tests are used to choose the optimal lag length in each case. In the case of labor productivity, we conclude that exports Granger-cause productivity growth in the case of France, Italy, Germany and Sweden. For the UK, causality runs in both directions. When total factor productivity is used, the estimated results reveal that the flow of causality is bi-directional in Germany, Italy, and the UK. In France the flow of causality runs in only one direction from productivity growth to export growth, while in Sweden causality runs from export to productivity growth.[11] These causality directions are also confirmed by conducting variance decompositions (except for Italy in the case of labor productivity). The reasons for the differences in the causality directions between exports and two alternative measures of rates of productivity may be due to the fact that labor productivity is not a complete measure of productivity, and more important, it is a very noisy measure of productivity that may just pick up business cycle results. Furthermore, all national VAR-models with TFP perform better than those with LP with respect to the normalized cointegrating vectors and the variance decompositions as discussed earlier. Thus, we rely more on the results obtained by TFP than those for LP.

Our findings, however, indicate that there is a systematic relationship between exports and productivity in these countries. The results suggest that export growth contributes to productivity growth and, thus, the expansion of exports is an integral part of productivity growth. The established bi-directional causality implies that export promotion is an instrument in the stimulation of productivity growth and vice-versa. In other words, export expansion leads to improved skills and technology, and this increased efficiency creates a comparative advantage for a given country, which facilitates exports. We interpret these results as strongly supportive of the role of endogenous growth models in explaining continuous growth. By assuming TFP as a proxy for output, the results also lend support to the export-led growth hypothesis (except for France) which has been supported in recent time-series studies concerning both developed and less developed countries [Giles, et al., 1992; Thornton, 1997; Doyle, 1998; Xu, 1998; Giles and Williams, 1999]. Our findings may also justify the reduction of international trade barriers in order to facilitate exports as a potential source of productivity gains.

APPENDIX A

FIGURE 1
Time Plot of Real Export

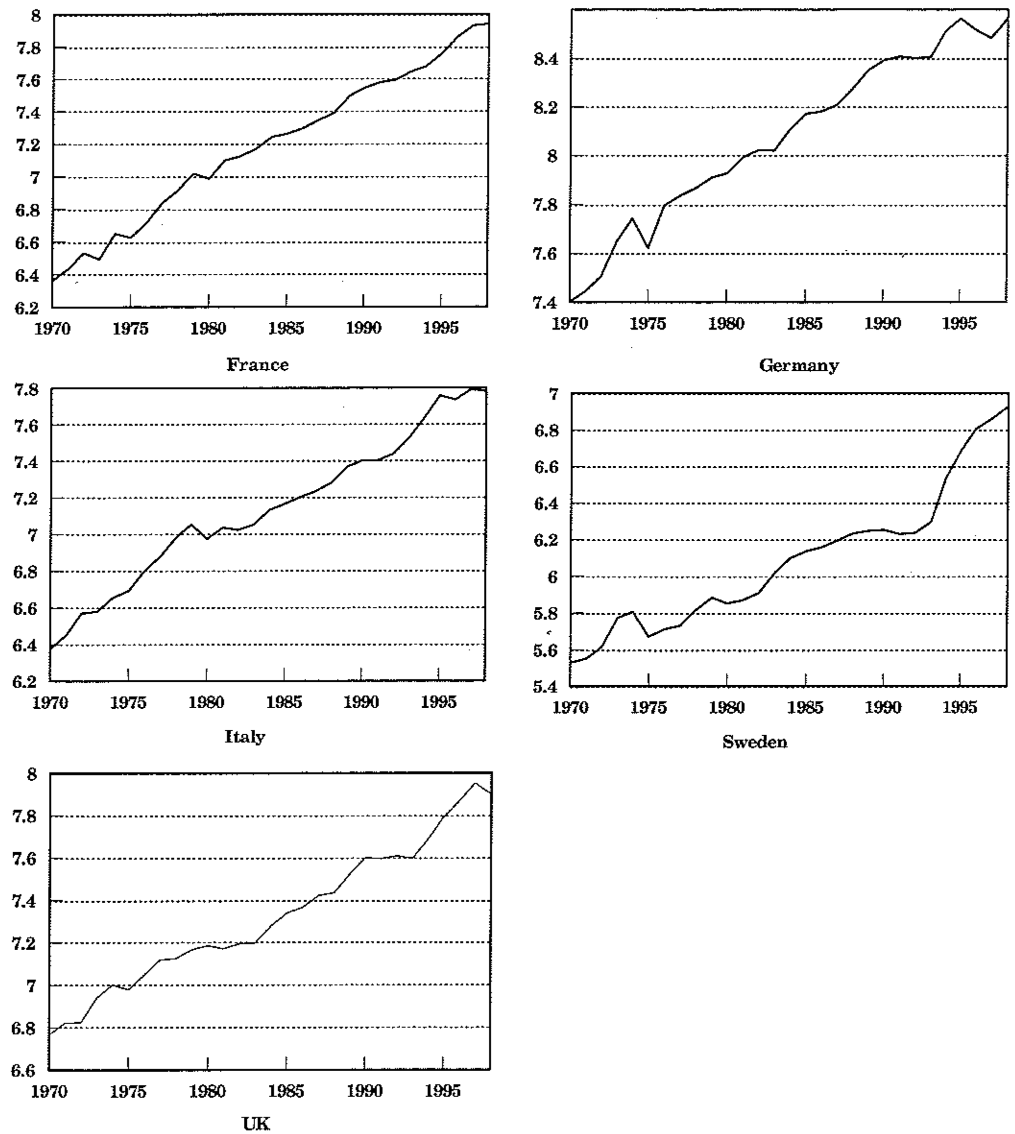


FIGURE 2
Time Plot of TFP (Base Year = 1990)

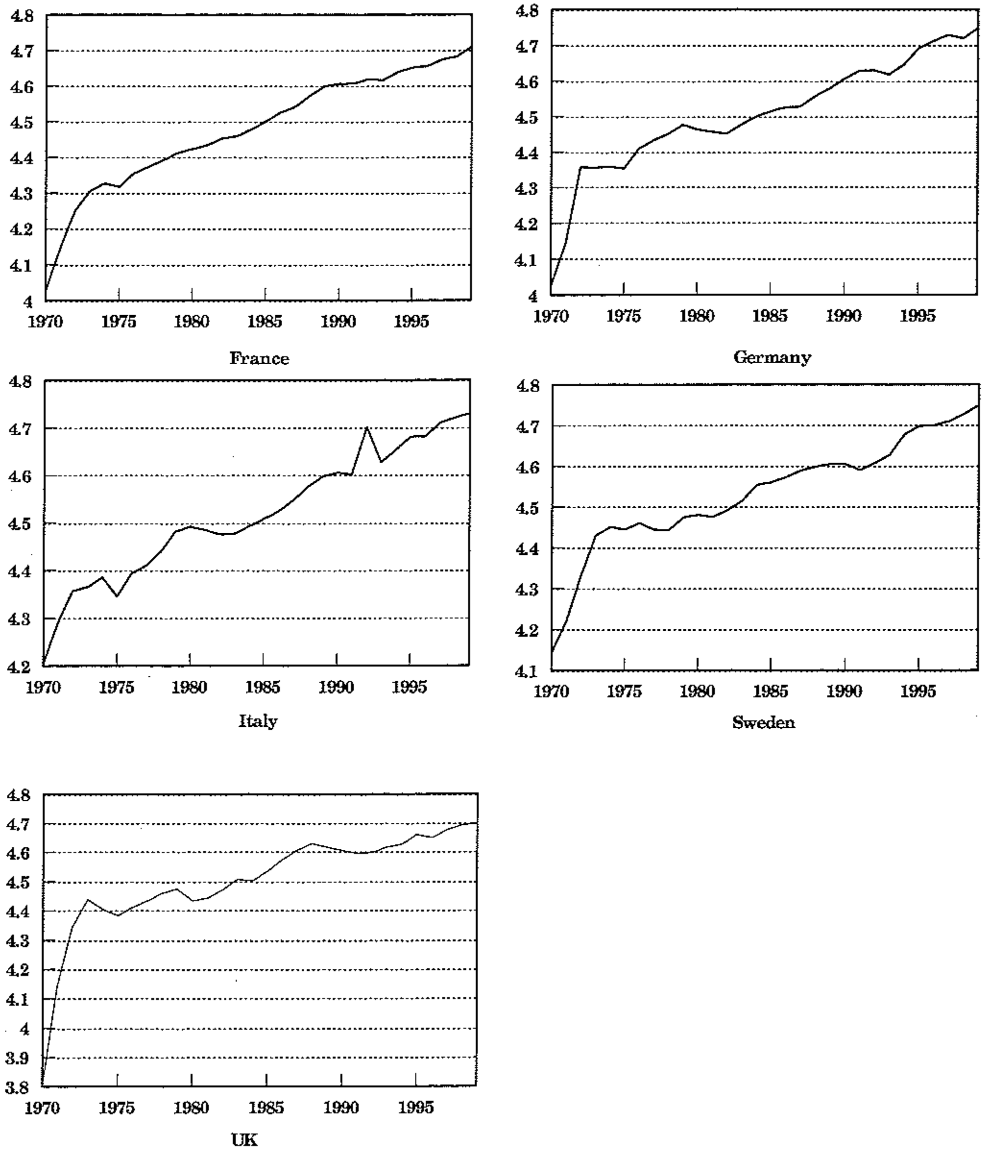
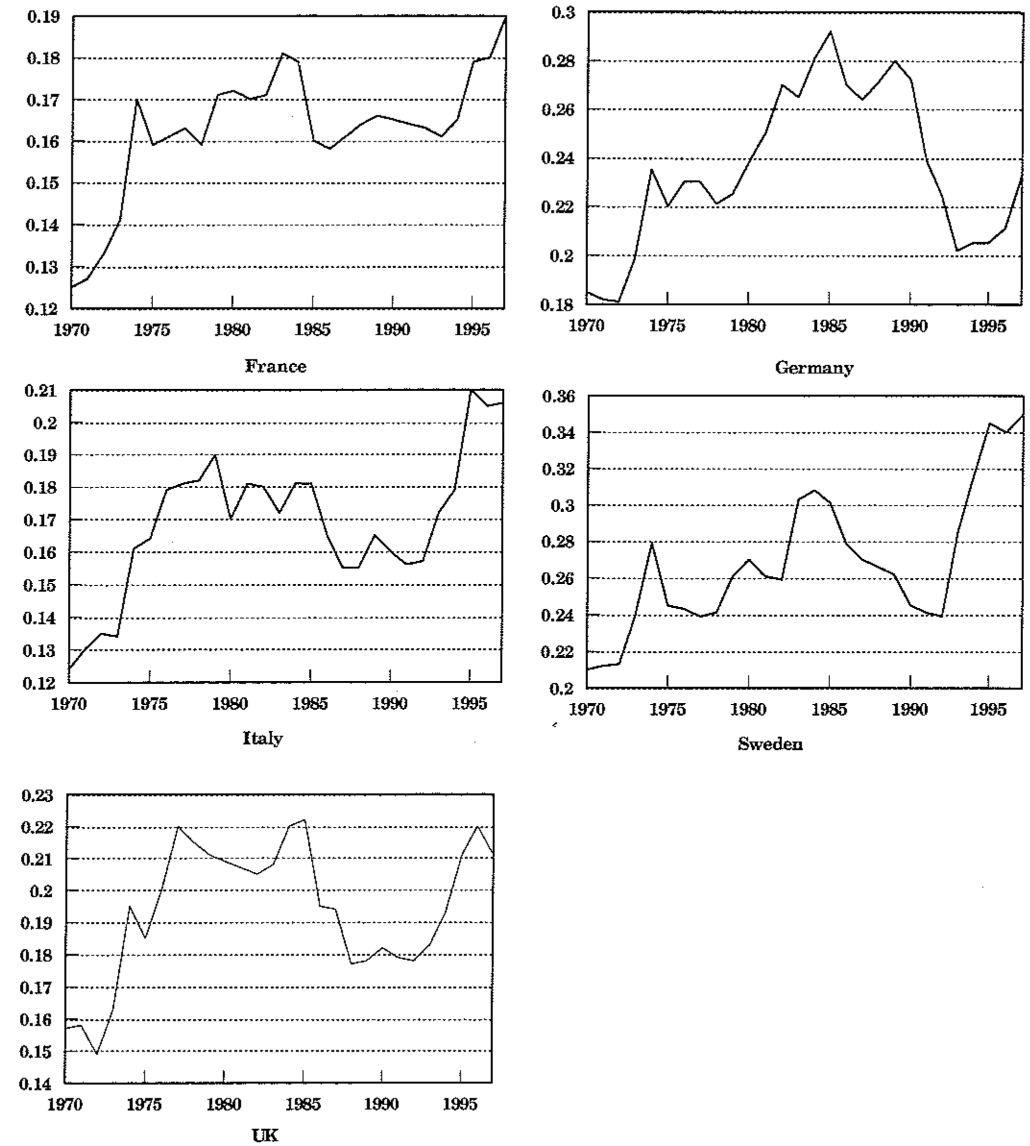


FIGURE 3
Time Plot of Export per GDP



NOTES

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1. Note that German data covers the reunification of Germany.
2. Although most cointegration studies use quarterly data in order to increase the degrees of freedom, the main problem in identifying a cointegrating vector is the span of the period. This is because the method actually attempts to identify a parameter supposed to be constant over an infinite period [Juselius, 1999].
3. It should be mentioned that differencing is one possible (and customary) option to transform the series, but there are certainly other ways to deal with non-stationarity. In fact, differencing is equivalent to applying one of several available filters in the frequency domain. Whether it is the best depends on the nature of the non-stationarity.
4. It should also be pointed out that a trend term was also included in the ADF test for each variable. However, it did not alter the conclusion that each variable is integrated of the first degree.
5. According to Hendry and Juselius [2000], it is a good idea to treat the variables as non-stationary if the roots are very close to unity. As the null hypothesis in the Johansen procedure is stationarity we have applied the 10 percent significance level for this test. Furthermore, the graphs presented in Appendix A support the view that the data generating process for each variable is characterized by non-stationary behavior.
6. We also tested for singlewise ARCH effects. The estimated results show that the null hypothesis of no ARCH effects could not be rejected in any case at the conventional significance levels.
7. It should be mentioned that a dummy variable was included in the VAR model for Germany to capture the effect of reunification.
8. It is necessary to point out that the cointegrating vectors in the case of LP are radically different across countries. This may lead us to question whether a long-run equilibrium has actually been found in the case of LP.
9. The plots of the recursive coefficients are available from the authors on request.
10. The variance decompositions between LP and real exports, for each country, show that about 2, 2, 12, 1, and 27 percent of the 4-step forecast error variance of exports is explained by innovations in LP for France, Germany, Italy, Sweden, and the UK, respectively. For the same forecast horizon export innovations contribute about 9, 50, 1, 3, and 25 percent for the forecast error variance of LP for France, Germany, Italy, Sweden, and the UK, respectively. These variance decompositions are also, more or less, in line with the previous causality nexus achieved for each country, except for Italy. The variance decompositions in the case of LP are problematic since export innovations show much less effect in a small open economy like that of Sweden than in the substantially lager economies of Germany and the UK. This may be due to the fact that LP is a very noisy measure of productivity especially on the business cycle frequencies. That is, it may simply reflect business cycle variation in employment.
11. The lack of causality from TFP to exports in the case of Sweden may be due to the country-specific factors such as the technology gap, the low price elasticities of export products, and unfavorable exchange rates. The lack of causality from exports to TFP in the case of France may be due to the competitive conditions on the domestic market and the market structure as discussed in Section 2. Some authors have found that export diversification and structural changes in exports are more important in explaining growth than export growth *per se* [Amin Gutiérrez and Ferrantino, 1999]. In other words, there is a positive interaction between structural changes in the export sector and output growth, suggesting that dynamic changes in the composition of the export sector are more significant for output growth than the aggregate growth rates of exports.

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