

**EUROPEAN UNIVERSITY INSTITUTE, FLORENCE**

**DEPARTMENT OF ECONOMICS**

**EUI WORKING PAPER No. 89/386**

**Is the Export-Led Growth Hypothesis  
Valid for Industrialized Countries?**

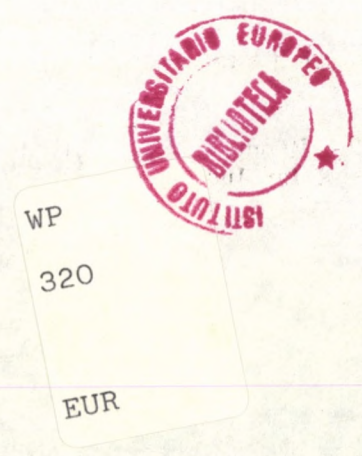
**DALLA MARIN\***

**\* Institute for Advanced Studies, Vienna**

I am grateful to Alasdair Smith for helpful comments on an earlier version of the paper. This paper is the outcome of research done during my stay as a Jean Monnet Fellow at the European University Institute 1987/88. It is part of ongoing research at the EUI on East-West Trade funded by the European Community.

**BADIA FIESOLANA, SAN DOMENICO (FI)**

All rights reserved.  
No part of this paper may be reproduced in any form  
without permission of the author.



© Dalia Marin  
Printed in Italy in May 1989  
European University Institute  
Badia Fiesolana  
- 50016 San Domenico (FI) -  
Italy

## ABSTRACT

The comovement between exports and productivity observed in many countries suggest a direct link between these two variables. Countries which do well in their export performance seem also to do well in their productivity performance and vice versa. What is the nature of this link? Does the comovement between exports and productivity reflect a growth accounting identity only – exports are a component of GDP – or a real causal link? The paper tries to answer this question for four developed market economies based on the cointegration and causality approach.

The export-productivity link requires reexamination in face of new developments in econometric techniques on the one hand and new insights in trade theory on the other. The new technique allows to tackle with the serious problems encountered in previous attempts to examine the relationship, while recent trade theory suggests the relationship between trade and productivity to be fundamentally ambiguous. Both reasons call for more empirical evidence.

The findings of the econometric analysis suggest that export, productivity, and the terms of trade (with and without the inclusion of world output) share common trends i.e. they move together in the long run in all countries except the UK. Furthermore, the causality tests indicate that exports Granger-cause productivity in all four countries. Based on these results, the hypotheses of export-led growth cannot be rejected for the four countries. Thus, an 'outward looking' regime seems to favour productivity performance of developed market economies as well and is therefore not restricted to developing countries only as commonly asserted.



## 1. INTRODUCTION

Casual inspection of exports and productivity in developed market economies reveals that these two time series move together. Countries which do well in their export performance seem also to do well in their productivity performance and vice versa. What is the nature of this link? Does the comovement between exports and productivity reflect only a growth accounting identity – exports are a component of GDP – or a real causal link?

The paper tries to answer this question for four developed market economies (US, Japan, UK, and Germany) based on the cointegration and causality approach recently developed. The former allows to study whether exports and productivity share a common trend so that they can be considered a long run equilibrium relationship which holds except for a stationary stochastic error (short run deviations). The causality analysis in turn allows to examine whether a causal link is present between these two variables. More specifically, the test is based on the criterion whether movements in exports help to predict movements in productivity e.g. whether exports "Granger cause" productivity.

The paper comes in five sections. Section 2 states that the exports–productivity link requires reexamination in face of new developments in econometric techniques on the one hand and new insights in trade theory on the other. The new technique allows to tackle with the serious problems encountered in previous attempts to examine the relationship, while recent trade theory suggests the relationship between trade and productivity to be fundamentally ambiguous. Thus, the subject calls for more empirical evidence. Section 3 describes the methodology and characterizes the time trend and unit root properties of the data while in section 4 the various causality tests are performed. Finally, section 5 summarizes the results and suggests tentative policy conclusion.

## 2. EXPORTS AND PRODUCTIVITY

The idea that trade might influence productivity is not new. The hypothesis of "export-led growth" sees the growth of exports as having a stimulating influence across the economy as a whole in the form of technological spillovers and other externalities. Export might exert these externalities because export industries are seen to be prime candidates to lead for various reasons: exposure to international markets calls for increased efficiency and provides incentives for product and process innovation, the increase in specialization allows to exploit economies of scale. The idea is that exports can be seen as economies of scale that are

external to the firms in the non-export sector but internal to the economy as a whole.<sup>1)</sup> Larger exports will contribute to the stock of knowledge and human capital in the economy thereby benefiting all firms. Thus, the hypothesis predicts that the rate of export growth will cause economy wide productivity gains.

In spite of the fact that the export-led growth hypothesis has originally been put forward for developed market economies (Beckerman 1965), previous studies have confined empirical testing of the hypothesis to countries with low or middle per capita income (see Balassa 1978, Feder 1982, Kormendi and Meguire 1985).<sup>2)</sup> Since there is no a priori reason why the relationship should be valid only for countries defined by some development criteria, I will look at developed market economies with Japan and Germany as cases of relatively favourable productivity and export growth rates and the US and UK as countries with relatively less favourable records in export and productivity.

Previous attempts to examine the relationship were based on cross country correlations between exports and GDP (or productivity). This empirical approach involves, however, the problem that the correlation is not very informative since it is not clear whether the result reflects primarily that exports are a component of the product or a real causal link as is suggested by the hypothesis. Another empirical treatment is therefore required.<sup>3)</sup>

Trade theory kept mostly silent until recently on the relationship between trade and technical efficiency (as opposed to allocative efficiency). In the "new" trade theory technical efficiency and trade becomes a central link.<sup>4)</sup> Unfortunately, however, the effect of trade on technical efficiency is not conclusive in models of imperfect competition and increasing returns to scale. The trade effect will depend on the type of competition assumed on the domestic market, on whether entry and exit is relatively frictionless and on whether the market structure will change in response to a trade disturbance in a way that is conducive to improvements in productivity and technical efficiency. In order to see the crucial role of entry for the productivity outcome consider the following case. Suppose firms produce with increasing returns to scale which

---

1) For the different types of economies of scale see Helpman/Krugman (1985). See also Romer (1986) who introduces external economies of scale in a neoclassic growth model through the externality of the economy's capital stock. In Romer's model the output level of an individual firm depends not only on its stock of capital, but on the economy's capital stock. The hypothesis of export-led growth can be thought of in a framework like Romer's but shifting the externality from capital to exports.

2) An exception in this is Helpman and Trajtenberg (1987) who find that exports influence the growth potentials of countries regardless of their ranking in terms of per-capita income.

3) Feder (1982) and Helpman and Trajtenberg (1987) use a fully specified growth equation, in which the role of exports is modelled explicitly so that in their analysis the export variable has a clear structural interpretation.

4) See Helpman and Krugman (1985) for the integration of trade theory with increasing returns to scale.

result from the existence of fixed costs for product development. Firms producing differentiated goods engage in monopolistic competition under free entry so that domestic price equals average costs since firms cannot make excess profits. With increasing returns to scale, average costs are a declining function of firm-level output. In such an environment an export expansion (however brought about) will allow domestic firms to sell larger quantities at the initial price, making in turn an increase in prices and an expansion of production profitable. This means that activities which were operating at an inefficiently small scale have been expanded thus increasing average productivity. However, increased profitability of the home production increases the returns to product development thereby inducing entry into the market. Induced entry of firms producing additional varieties will reduce the demand of the incumbent firms thereby forcing them to contract output. Whether output per firm and thus productivity rises or declines will depend on which of the opposing forces dominate. One possible outcome is the co-existence of too many firms, producing too many varieties of products. Thus an export expansion might crown in too many firms producing at too low levels of output which might dampen or reverse the original export induced productivity increase.<sup>5)</sup>

Whether a trade expansion will enhance/retard productivity growth will also depend on the competitive conditions on the domestic market as can be seen by the following example. Suppose firms on the domestic market face oligopolistic competition and behave in a Bertrand (price setting) fashion. Incumbent firms could increase profits by committing themselves to lower sales, since some of their profits are wasted by "excessive" competition. One credible commitment to less aggressive behavior is the choice of outdated or costly technology. Collusion is facilitated by maintaining costs artificially high. The profits to the firms from a greater degree of collusion can outweigh the losses in productivity. How does an export expansion affect the technological choice in such a framework? As the level of exports increases, excess profits of domestic firms increase as well. This will, in turn, reemphasize the strategic motive for under-investment in technology, since the potential payoffs to a strategy of high costs rise. Thus, an export expansion will lead to lower productivity growth, as long as firm's strategic behavior is conducive to an increase in costs. The export-productivity result is, however, not robust to changes in competitive behavior, since it relies on the assumption that firms compete "too aggressively". The productivity outcome will be reversed if firms behave in a Cournot (quantity setting) fashion. Then strategic incentives will work to enhance productivity. There will be over-investment in technology as firms would like to precommit themselves to a larger scale of output. By raising profits, an export expansion will reinforce the strategic motive

---

5) See Flam and Helpman (1987) for the conditions for output per firm to rise in response to industrial and trade policy. The importance of entry/exit for the quantitative welfare effects of trade liberalizations (restrictions) is also confirmed by simulation experiments see Venables/Smith (1986), Baldwin/Krugman (1986).

for over-investment thereby increasing productivity.<sup>6)</sup> The example illustrates how the export induced productivity effect will depend on the type of competition assumed on the domestic market. It also shows how innovation might be related to market structure.<sup>7)</sup>

To summarize, I conclude that the arguments given in this section suggest exports to cause productivity. The sign of the causal impact is, however, ambiguous. Exports are supposed to cause productivity gains the smaller the country is and the less entry occurs. In small countries it is more likely that minimum efficient scale is large relative to the home market size, indicating that the potential for exports to allow the exploitation of economies of scale is large. Furthermore, productivity gains in response to an export disturbance are more likely if tougher competition induced by entry of new firms will on the one hand lead to the exit of uncompetitive firms and to an increase in X-efficiency and will create an incentive to invest in R&D on the other. Whether exports will cause productivity gains or losses can, in the end, only be decided empirically.

Empirical research on the new trade issues has proved to be a challenging exercise. Since data requirements are very demanding and the adequate data not yet easily available, econometric estimation and hypothesis testing have been precluded until now. Empirical studies have, therefore, employed calibration experiments. The method makes assumptions about economic behavior and uses econometric estimates and industry case studies to measure key behavioral parameters and infers then missing parameters by making the assumed behavior and one period's data mutually consistent (see Baldwin and Krugman (1986), Venables and Smith (1986), Cox and Harris (1985).

I will take a quite different route in order to explore the export-productivity relationship. Based on aggregate data I will employ VAR techniques which are commonly used in applied macroeconomics (see Sims (1972), (1980), Stock and Watson (1987). The VAR technique differs considerably in its philosophy from calibration methods. Calibration is theory-driven, while VAR is data driven. The theory-driven feature of calibration comes from maintaining economic behavior (such as e.g. mark-up pricing) to be true for the purpose of the empirical analysis and making the data consistent with the assumed behavior. The data-driven feature of VAR comes from letting the data "speak" without imposing theory-induced a priori restrictions and then looking at whether or not the data are consistent with what the theory

---

6) For the argument in the context of trade policy see Rodrik (1988).

7) The relationship between market structure and innovation is one of the oldest concerns in the industrial organization literature. It deals with the question of whether more or less competition will be more conducive to R&D and innovation, see Kamien/Schwartz (1982). Recently there have been attempts to analyse the role of trade in this relationship, see Helpman (1988), Grossman and Helpman (1988).



implies. The only way theory comes in is in the choice of variables included in the time series analysis.<sup>8)</sup> Both techniques seem not to be adequate for testing theories, because the former assumes that the model is true and makes the data consistent with it, while in the latter many models might be consistent with the data.

### 3. TREND PROPERTIES OF THE DATA

In order to explore the comovement of exports and productivity I begin by characterizing the time trend and unit root properties of the data included in the analysis since the neutrality and causality tests are sensitive to unit roots in the series (see Sims, Stock and Watson (1986)). The data consist of quarterly observations on the log of exports of manufacturing goods ( $x$ ), the log of labour productivity (manufacturing output per employee) ( $pr$ ), the log of the terms of trade (export unit value divided by import unit value for manufacturing goods in local currency) ( $tot$ ), and the log of OECD output at constant prices ( $q$ ). Since all variables are treated as endogenous in a first stage, OECD output and the terms of trade are included in the time series analysis in order to control for export growth which results either from price competitiveness or from growth in the world economy. The terms of trade is also supposed to detect possible linkages of the real exchange rate (and possible effects of trade policy in the form of tariff and non-tariff barriers if they are reflected in the terms of trade) on productivity; a link much stressed by the literature on the "new" trade issues and by the "hysteresis" model of trade (see Grossman and Richardson (1985) and Baldwin and Krugman (1986)).

#### 3.1 Testing for Integration

A key step in understanding the comovement of exports and productivity is to find out first whether each of the series contain a stochastic trend and second whether they share a common stochastic trend. The former is called a test whether a series is integrated of order  $d$  ( $I(d)$ ), while the latter refers to a test whether two or more variables are cointegrated.

A variable is said to be integrated of order one  $I(1)$  if it must be differenced one time to be stationary.<sup>9)</sup> To test for integration the following regression is formed

---

8) This is controversial. see Leamer (1985).

9) A time series random variable is said to be stationary if its distribution does not depend on time. A variable that is integrated is said to have a unit root in its autoregressive representation. Thus, the statements " $z_t$  has a unit root" and " $z_t$  is integrated of order one" are equivalent.

$$\Delta z_t = \beta z_{t-1} + \sum_{j=1}^p \delta_j \Delta z_{t-j} + e_t \quad (1)$$

where  $p$  is selected to be large enough to ensure that the residual  $e_t$  is empirically white noise. The test statistic is the ratio of  $\hat{\beta}$  to its calculated standard error obtained from an OLS regression. The null hypothesis is  $H_0: z_t \sim I(1)$ , that is  $z_t$  is not stationary in levels. The null is rejected if  $\beta$  is negative and significantly different from zero. The test-statistic does not have a  $t$ -distribution under the null, because of the theoretically infinite variance of  $z_t$ , but tables of significance levels have been provided by Dickey and Fuller (1979).

Table 1 investigates the possibility that the series  $x$ ,  $pr$ ,  $tot$ , and  $q$  might have up to two unit roots for Germany, the UK, the USA and Japan. The first block presents the Dickey–Fuller tests (with  $p=0$ ) and the Augmented Dickey–Fuller tests (with  $p=4$ ) for a single unit root. In no case is there significant evidence against the unit root hypothesis. Thus, the null hypothesis that the series are not stationary in levels cannot be rejected. The block B shows the result of the Dickey–Fuller (1979) tests for a second unit root, i.e. for a unit root in the first difference of the series, allowing for the alternative that the series are stationary in first differences. According to these tests, no series contains two unit roots. In other words, since all series for the four countries have significant test statistics, the null hypothesis that the series are not stationary in first differences has to be rejected. Thus, exports, productivity, the terms of trade and OECD output appear to be  $I(1)$ , i.e. to contain a stochastic trend over the 1960.1 – 1987.2 sample, a feature that they share with most macroeconomic time series.<sup>10)</sup>

10) When variables contain stochastic trends, as most macroeconomic series do, the distinction between "trend" and "cycle" becomes blurred. Changes in growth trends seem to be associated with some of the shorter "cyclical" swings in the series suggesting that there is an important connection between them. see Nelson and Plosser (1982) and Campbell and Mankiw (1987), and with respect to the export–productivity relation see Marin (1989).

TABLE 1

**TESTS FOR INTEGRATION**  
1960.1 - 1987.2

Series	GERMANY		UK		USA		JAPAN			
A: single unit root										
	DF	ADF	DF	ADF	DF	ADF	DF	ADF	DF	ADF
x	-1.6	-1.6	-0.29	-0.22	-0.86	-0.82	-2.9	-2.4		
pr	-1.3	-1.3	-1.5	-1.5	-0.15	-0.11	-1.9	-1.5		
tot	-1.8	-2.4	-1.2	-2.3	-0.94	-0.99	-1.3	-2.0		
q									-3.1	-2.1
B: second unit root										
	DF	ADF	DF	ADF	DF	ADF	DF	ADF	DF	ADF
$\Delta x$	-10.0	-5.4	-13.6	-3.8	-12.3	-3.3	-5.7	-3.9		
$\Delta pr$	-10.9	-5.0	-9.7	-3.7	-8.8	-4.2	-8.1	-5.6		
$\Delta tot$	-8.3	-4.7	-7.2	-5.3	-7.1	-5.2	-6.2	-5.2		
$\Delta q$									-4.7	-4.7

Notes: DF, ADF -Dickey-Fuller and Augmented Dickey Fuller Test:  $\Delta z_t = \beta z_{t-1} + \sum_{j=1}^p \alpha_j \Delta z_{t-j} + e_t$   
with  $p=0$  for DF and  $p = 4$  for ADF

Critical values for the tests at the 1% and 5% significance level, respectively are -4.07 (DF), -3.77 (ADF) and -3.37 (DF), -3.17 (ADF).

### 3.2 Testing for Cointegration

Since all series appear to contain a stochastic trend the question arises whether they contain a common stochastic trend. If that were the case, then changes in the "trend" of e.g. productivity observed in the early 70's would appear as shifts in exports (and the terms of trade and world output) as well, indicating that exports and productivity move together in the long run. Testing for cointegration is a way of testing the long-term relatedness between time series that have individually a unit root.

Two variables are said to be cointegrated of order one  $CI(1,1)$ , if they are individually  $I(1)$ , but some linear combination of the two is  $I(0)$  (see Engle and Granger 1987). In our case we want to test if it exists a linear combination of  $x$  and  $pr$  (with or without the inclusion of  $tot$  and  $q$ )

$$u_t = x_t - \alpha pr_t \quad (2)$$

which reduces the number of unit roots implying that the low frequency components of  $x_t$  and  $pr_t$  would virtually cancel out to produce the mean-reverting so-called "equilibrium error"  $u_t$ . Hence, in order to test for cointegration between  $x$  and  $pr$  a test is required for whether or not  $u_t$  is stationary. If  $u_t$  follows an integrated process of order zero  $I(0)$ , it can be concluded that a long-run equilibrium condition holds for  $x$  and  $pr$  ( $x - \alpha pr = 0$ ), except for a stationary disturbance  $u_t$  with finite variance. In other words, deviations from the long-run equilibrium condition will show mean reversal, even if there is not such a tendency in exports and productivity. If  $x$  and  $pr$  are cointegrated, the long-run elasticity of productivity with respect to exports can be estimated without specifying any dynamics and without deciding a priori the direction of causality, since both variables are endogenous and can be treated symmetrically.

In order to test for cointegration the "cointegration regression" (equation 2) is estimated using OLS.<sup>11)</sup> The null hypothesis of no cointegration, is tested based on the Durbin-Watson statistic (CRDW), but testig whether CRDW is significantly greater than zero. An alternative way is to perform the Dickey-Fuller tests (DF, ADF) for the estimated residual  $u_t$ , assuming that a first order model is correct. All three tests are reported in Table 3, while the cointegrating regressions are shown in Table 2.

In the cointegrating regression of  $x$  on  $pr$  alone (equations 4, 10, 16 and 22 in Table 2) the coefficient of  $x$  ranged between .26 and .44 in the four countries examined. In the reversed regression of  $pr$  on  $x$ , the coefficient of  $pr$  ranged between 2.2 and 3.63, which has reciprocal

11) If variables are cointegrated, OLS gives a consistent and efficient estimate of the cointegrating coefficient as has been shown by Stock (1987).

between .27 and .45, about the same as the coefficients in the forward regression (see equations 1, 7, 13 and 19 in Table 2). However, the CRDW and DF indicate that the data fail to reject the null of non-cointegration at any significance level below 10 per cent (the critical value at 10% for 100 observations of the CRDW is 0.322 and of the DF  $-3.03$  as tabulated by Engle and Granger 1987). For the German and Japanese data the ADF accepts cointegration at the 5 per cent level while for the UK and the USA the ADF does not reject the null even at the 10 per cent level (critical values of ADF are  $-3.17$  and  $-2.84$  at the 5% and 10% significance level, respectively)<sup>12)</sup> (See Table 3).

Since cointegration between  $x$  and  $pr$  alone fails to be accepted for the four countries (at least on the basis of DF and CRDW) I proceed by including the terms of trade ( $tot$ ) in the cointegrating regression. Apart from the UK, tests for cointegration among these three variables reject now the null that the series are not cointegrated, suggesting that the trivariate specifications have less unit roots than variables. Since the cointegrating vector constitutes an equilibrium, the tests should not give different results when the cointegrating equation is estimated in its different inversions. This is indeed confirmed by the data in the trivariate case, since the tests indicate cointegration (or fail to indicate as with UK data) independently of whether  $x$  or  $pr$  has been used as the dependent variable in the regression (see Table 3).

---

12) Since  $x$  and  $pr$  are not cointegrated the parameter estimates may be biased and should be taken with care see Stock (1987).

COINTEGRATING REGRESSIONS: OLS ESTIMATES  
 1960.1 - 1987.2

	$R^2$		$R^2$
<b>GERMANY</b>			
1. $x = 2.94 \text{ pr} + 3.7$ (77.7) (41.1)	.982	USA	
2. $x = 2.95 \text{ pr} - .57 \text{ tot} + 3.7$ (85.3) (4.75) (45.2)	.985	13. $x = 3.47 \text{ pr} + 4.9$ (32.1) (31.2)	.904
3. $x = 2.73 \text{ pr} - .64 \text{ tot} + .20 \text{ q} + 3.4$ (9.87) (4.15) (.83) (7.7)	.985	14. $x = 2.1 \text{ pr} - 3.2 \text{ tot} + 7.7$ (27.3) (23.3) (55.7)	.984
4. $\text{pr} = .34 \text{ x} - 1.2$ (77.7) (26.0)	.982	15. $x = 1.05 \text{ pr} - 3.2 \text{ tot} + .87 \text{ q} + 5.4$ (6.24) (27.5) (6.6) (14.5)	.989
5. $\text{pr} = .33 \text{ x} + .19 \text{ tot} - 1.2$ (85.3) (4.75) (28.8)	.985	16. $\text{pr} = .26 \text{ x} - 1.12$ (31.9) (14.0)	.904
6. $\text{pr} = .18 \text{ x} - .07 \text{ tot} + .43 \text{ q} - 1.38$ (9.87) (1.95) (9.03) (37.3)	.992	17. $\text{pr} = .42 \text{ x} + 1.16 \text{ tot} - 3.02$ (27.3) (11.34) (17.11)	.956
<b>UK</b>			
7. $x = 3.63 \text{ pr} - 0.9$ (43.0) (4.0)	.944	18. $\text{pr} = .26 \text{ x} + .67 \text{ tot} + .3 \text{ q} - 2.6$ (6.24) (4.47) (4.23) (13.6)	.962
8. $x = 3.65 \text{ pr} - 1.36 \text{ tot} - .96$ (45.6) (3.67) (4.71)	.951	<b>JAPAN</b>	
9. $x = 3.77 \text{ pr} - 1.44 \text{ tot} - .12 \text{ q} - .74$ (14.05) (3.55) (0.46) (1.42)	.950	19. $x = 2.2 \text{ pr} - 1.4$ (60.8) (8.9)	.971
10. $\text{pr} = .26 \text{ x} + .36$ (43.0) (7.13)	.945	20. $x = 1.8 \text{ pr} - .95 \text{ tot} + 0.59$ (49.4) (12.94) (3.3)	.989
11. $\text{pr} = .26 \text{ x} + .37 \text{ tot} + .37$ (45.6) (3.76) (7.8)	.951	21. $x = 1.1 \text{ pr} - 1.04 \text{ tot} + 1.2 \text{ q} - 1.5$ (5.0) (13.9) (3.4) (2.4)	.990
12. $\text{pr} = .17 \text{ x} + .45 \text{ tot} + .34 \text{ q} - .39$ (14.1) (5.66) (7.7) (3.63)	.968	22. $\text{pr} = .44 \text{ x} + .72$ (60.6) (12.7)	.971
		23. $\text{pr} = .52 \text{ x} + .43 \text{ tot} - .11$ (49.36) (9.2) (1.1)	.984
		24. $\text{pr} = .18 \text{ x} + .06 \text{ tot} + 1.05 \text{ q} - 1.8$ (5.0) (1.16) (10.1) (9.9)	.992

TABLE 3

**TEST FOR COINTEGRATION**  
1960.1 - 1987.2

System	Unit Roots under Null and Alternative	DF	ADF	CRDW
<b>GERMANY</b>				
x.pr	2 vs 1	-2.6	-3.2	.25
x.pr.tot	3 vs 2	-2.9	-3.3	.32
x.pr.tot.q	4 vs 3	-2.8	-3.3	.30
pr.x	2 vs 1	-2.7	-3.3	.25
pr.x.tot	3 vs 2	-3.0	-3.5	.33
pr.x.tot.q	4 vs 3	-3.1	-3.8	.44
<b>UK</b>				
x.pr	2 vs 1	-1.4	-1.4	.12
x.pr.tot	3 vs 2	-1.7	-1.7	.14
x.pr.tot.q	4 vs 3	-1.6	-1.7	.15
pr.x	2 vs 1	-1.2	-1.2	.12
pr.x.tot	3 vs 2	-1.6	-1.6	.15
pr.x.tot.q	4 vs 3	-1.5	-1.4	.19
<b>USA</b>				
x.pr	2 vs 1	-1.5	-2.5	.09
x.pr.tot	3 vs 2	-4.0	-3.9	.55
x.pr.tot.q	4 vs 3	-4.8	-5.2	.71
pr.x	2 vs 1	-1.3	-2.5	.09
pr.x.tot	3 vs 2	-3.4	-3.3	.44
pr.x.tot.q	4 vs 3	-2.1	-2.2	.24
<b>JAPAN</b>				
x.pr	2 vs 1	-2.0	-3.8	.16
x.pr.tot	3 vs 2	-3.1	-5.0	.37
x.pr.tot.q	4 vs 3	-2.8	-4.6	.31
pr.x	2 vs 1	-2.0	-4.0	.16
pr.x.tot	3 vs 2	-3.1	-5.1	.34
pr.x.tot.q	4 vs 3	-3.1	-4.6	.33

Notes: CRDW=coinTEGRation Regression Durbin-Watson statistic, DF=Dickey-Fuller Test:  $\Delta u_t = -\phi u_{t-1} + \epsilon_t$

ADF=Augmented Dickey Fuller Test:  $\Delta u_t = -\phi u_{t-1} + \sum_{j=1}^4 b_j \Delta u_{t-j} + \epsilon_t$

Critical values for the tests in the 2 variable case at the 5% and 10% significance level, respectively are: 0.386, 0.322 (CRDW), -3.37, -3.03 (DF), -3.17, -2.84 (ADF), and in the 3 variable case 0.367, 0.308 (CRDW), -3.13, -2.82 (ADF).

Looking at the regressions of  $x$  and  $tot$  on  $pr$ , we find .33, .42 and .52 for  $x$ , and .19, 1.16, and .43 for  $tot$ , for Germany, USA and Japan, respectively suggesting that exports and productivity on the one hand and productivity and the terms of trade on the other are positively related in the long run (see equations 5, 17, and 23 in Table 2). Although the reverse regressions of  $pr$  and  $tot$  on  $x$  give the same cointegration results, they give different estimates of the equilibrium parameters i.e. the equilibrium is not unique. One interpretation of this result might be to let these estimates define the limits of an equilibrium sub-space, so that the true long-run equilibrium might be anywhere within the area defined by these points. An alternative view is given by Stock (1987) who establishes that the estimates of the cointegrating regression are consistent but subject to a finite sample bias. This bias is supposed to be related to the overall goodness of fit of the regression suggesting that the regression with the highest  $R^2$  should be subject to the smallest bias. Since the  $R^2$ 's do not differ, they do not offer themselves as criteria for choosing the specification with the smallest bias, so that we are left with the first interpretation of not unique equilibrium relationships.

The inclusion of OECD output  $q$  in the cointegration regression does not change the picture considerably. The DF, ADF, and CRDW tests have increased in some of the cases and declined in others. But again, the hypothesis that  $x$ ,  $pr$ ,  $tot$  and  $q$  are not a cointegrated vector has to be rejected for Germany, the USA and Japan, while it fails to be rejected for the UK. It is worth noting that in one of the cases (with US data) the inversion of the regression failed to lead to consistent cointegration results. We nevertheless interpret that these four variables are cointegrated in the US, since we could find at least one cointegrated vector. The estimated equilibrium parameters drop now to .18, .26, and .18 for  $x$  and to  $-.07$ , .67 and .06 for  $tot$ , for Germany, USA and Japan, respectively, while the coefficient of  $q$  varied between .30 and 1.05 in the three countries (excluding the UK) suggesting that productivity and OECD output is positively related in the long run.

Summarizing these results, all variables included in the analysis can be characterized as being  $I(1)$  i.e. they have a single unit root. While  $pr$  and  $x$  alone do not share a common trend,  $(pr,x,tot)$  and  $(pr,x,tot,q)$  constitute a cointegrated vector in all countries except the UK. The sign of the long-run elasticities indicates that  $x$ ,  $tot$  and  $q$  are positively related to productivity in the long-run.



#### 4. CAUSALITY TESTS

Having characterized the trend properties of the data, we can now turn to their causal orderings.  $x$  is said to cause  $y$  if the forecast for  $y$  is improved (has a smaller mean square error) by using additionally the history of  $x$  than by using just the history of  $y$  alone (see Granger 1969). This means that the hypothesis that  $x$  causes  $y$  can be examined by estimating

$$y_t = \left( \sum_{i=1}^p \theta_i L^i \right) y_t + \left( \sum_{j=1}^z \psi_j L^j \right) x_t + \epsilon_t \quad (3)$$

and testing whether the  $\left( \sum_{j=1}^z \psi_j L^j \right)$  are jointly significantly different from zero based on an  $F$ -test of the OLS regression.<sup>13)</sup> The test requires that the disturbance term  $\epsilon_t$  is close to being white noise which involves a careful choice of suitable values of  $p$  and  $z$ . The order of own lags (the value of  $p$ ) has been estimated by the Bayesian information criterion (BIC), while 4 (6 or 8) lags have been included for the other variables in the VAR.<sup>14)</sup> Besides the correct treatment of the lag structure the causality test requires mean zero stationary variables. Otherwise the  $F$ -statistics will have nonstandard distributions (see Sims, Stock and Watson 1986 who offer alternative test statistics when variables have unit roots).

Before turning to the empirical results, it is worth noting two points. First, all four variables included in the analysis appear to have a unit root. Second, the four variables constitute a cointegrated vector (excluding the UK) so that they can be seen to have been generated by an 'error-correction' model as described by Engle and Granger (1987). This has three implications for the causality tests. First, the appropriate way to detrend the series is to take first differences (in our case fourth differences in order to get rid also of possible seasonality in the data) and by doing so they become mean zero, stationary variables. Second, the standard asymptotic distribution theory can be used to interpret the  $F$ -tests in the causality procedure, since all variables are mean zero, stationary. Third, an error-correction term has to be included in the VAR's in those cases in which the variables have common stochastic trends which captures the extent to which the system is out of equilibrium. Moreover, cointegration between two or more variables is already sufficient for the presence of causality at least in one direction. That cointegration already implies causality seems somewhat surprising, since cointegration is concerned with the long run and equilibrium, whereas causality refers to

13) The concept of causality to which we refer is narrow, since it is based only on the zero restrictions in a VAR. For deeper interpretations of causality, predictability and exogeneity see Geweke (1984).

14) BIC is defined as  $\log \sigma_{pq}^2 + (p+q) \frac{\log T}{T}$  where  $\sigma_{pq}^2$  is the estimated variance of the innovations in the ARMA process of order  $(p,q)$  and  $T$  is the sample size. The procedure searches over different values of  $p$  and  $q$  within a specified range until the criterion function is minimized.

short-run forecastability. The intuition behind it is that for two or more series to have an attainable long-run equilibrium, there must be some causation between them to provide the necessary dynamics. If the error-correction term is not included in the VAR when the series are cointegrated, on some occasions one would not detect causation when it is, in fact, present (see Granger 1988).

The results of the causality tests are presented in Table 5. Additionally Table 4 is giving the sum of the coefficients on lagged variables included in the VAR's in order to look at whether e.g. detrended export and terms of trade growth is found to be non-neutral in the sense that a permanent increase in the level of detrended export and terms of trade growth lead to a permanent increase (decrease) in productivity.<sup>15)</sup> Four different specifications of the causality tests have been performed: with and without an error-correction term (ec) taking into account that the series are cointegrated; with and without the inclusion of a deterministic time trend allowing for the possibility that some of the series are stationary in first differences around a linear time trend.<sup>16)</sup>

Focusing first on the productivity equation at the lower part of Table 4 and 5, exports appear to 'Granger-cause' productivity in all four countries (independently of specifications) at either the 1% or 5% significance level. Thus, the inclusion of past information on  $x$  improves the forecast for  $pr$ . However, the quantitative impact of exports on productivity ( $pr.x$ ) seems to be negligible as the sum of the coefficients of lagged exports in the productivity equations indicate.  $\sum \hat{\beta}_{prx}$  ranges between  $-.13$  and  $.03$  with positive signs for Germany and negative ones for the three other countries.<sup>17)</sup>

The predictive role of the terms of trade for productivity finds support only for the UK data with improvements in the terms of trade (an increase in the real exchange rate) dampening productivity. The  $\hat{\beta}_{prtot}$ 's vary between  $-.15$  and  $-.22$  depending on specifications. That increases in the real exchange rate retard productivity growth seems also to be the case in the other countries, although the effect is not statistically significant below the 10% level (the  $p$ -values range between 12.7 and 53.1 depending on specification and country).

15) For transitory and permanent effects of exports on productivity see Marin (1989), and for Tables of the estimated VAR's see Marin (1988).

16) When regressing the first difference of each of the series against a constant, time and four of its own lags the  $t$ -statistics on the time trend have been significant for OECD output and Japanese exports suggesting that  $q$  and  $x$ -Japan may be well described by a single unit root and a quadratic time trend.

17) For a different result for another OECD country see Kunst/Marin (1989).

TABLE 4

EXPORT PRODUCTIVITY NEUTRALITY:  $\Sigma \hat{\beta}_{zz}$ 

$\Delta x_t = f(\Delta x_{t-j}, \Delta pr_{t-j}, \Delta tot_{t-j}, \Delta q_{t-j})$												
	GERMANY			UK			USA			JAPAN		
Specification	$\bar{x}_{pr}$	$\bar{x}_{tot}$	$\bar{x}_q$	$\bar{x}_{pr}$	$\bar{x}_{tot}$	$\bar{x}_q$	$\bar{x}_{pr}$	$\bar{x}_{tot}$	$\bar{x}_q$	$\bar{x}_{pr}$	$\bar{x}_{tot}$	$\bar{x}_q$
const: $\Delta z_t$	-0.32	-0.29	0.56	-0.18	-0.68	-0.24	-0.13	-0.69	0.47	0.14	-0.3	0.53
const: $\Delta z_t:t$	-0.27	-0.30	0.46	-0.56	-1.1	0.28	-0.16	-0.67	0.53	0.14	-0.29	0.42
const: $\Delta z_t:ec$	-0.36	-0.28	0.51	-0.39	-0.64	-0.27	-0.3	-0.15	0.27	0.10	-0.30	0.59
const: $\Delta z_t:ec:t$	-0.05	-0.29	0.38	-0.77	-1.0	0.28	-0.3	-0.16	0.32	0.05	-0.28	0.45

$\Delta pr_t = f(\Delta pr_{t-j}, \Delta x_{t-j}, \Delta tot_{t-j}, \Delta q_{t-j})$												
	GERMANY			UK			USA			JAPAN		
Specification	$\bar{pr}_x$	$\bar{pr}_{tot}$	$\bar{pr}_q$	$\bar{pr}_x$	$\bar{pr}_{tot}$	$\bar{pr}_q$	$\bar{pr}_x$	$\bar{pr}_{tot}$	$\bar{pr}_q$	$\bar{pr}_x$	$\bar{pr}_{tot}$	$\bar{pr}_q$
const: $\Delta z_t$	0.03	-0.06	0.21	-0.1	-0.15	-0.05	-0.08	-0.12	-0.05	0.01	-0.003	0.18
const: $\Delta z_t:t$	0.01	-0.06	0.14	-0.13	-0.19	-0.00	-0.07	-0.10	-0.09	-0.03	-0.01	0.13
const: $\Delta z_t:ec$	0.02	0.04	1.09	-0.12	-0.21	-0.04	-0.08	-0.12	-0.05	-0.01	-0.02	0.12
const: $\Delta z_t:ec:t$	-0.04	-0.06	0.17	-0.13	-0.22	-0.02	-0.07	-0.11	-0.09	-0.04	-0.02	0.09

Notes: The order of own lags for  $\Delta x$  and  $\Delta pr$  is determined by the BIC criterion. all other regressors include 4 lags.  $\Sigma \hat{\beta}_{zz}$  denotes the sum of the 4 lags of the estimated coefficients.

TABLE 5

## EXPORT-PRODUCTIVITY CAUSALITY TESTS: F-STATISTICS AND P-VALUES

$\Delta x_t = f(\Delta x_{t-j}, \Delta pr_{t-j}, \Delta tot_{t-j}, \Delta q_{t-j})$												
Specification	GERMANY			UK			USA			JAPAN		
	$\bar{x}_{pr}$	$\bar{x}_{tot}$	$\bar{x}_q$	$\bar{x}_{pr}$	$\bar{x}_{tot}$	$\bar{x}_q$	$\bar{x}_{pr}$	$\bar{x}_{tot}$	$\bar{x}_q$	$\bar{x}_{pr}$	$\bar{x}_{tot}$	$\bar{x}_q$
const: $\Delta x_t$	.97 (43.02)	4.3 (.32)	2.62 (4.08)	.13 (96.9)	2.7 (3.9)	.91 (46.6)	.63 (64.5)	1.34 (26.2)	1.4 (25.1)	2.2 (7.1)	5.8 (.04)	2.5 (4.85)
const: $\Delta x_t:t$	.91 (45.2)	4.3 (.32)	1.84 (12.8)	.67 (61.4)	3.6 (1.0)	1.89 (12.3)	.61 (65.4)	1.3 (27.2)	1.2 (30.1)	2.4 (6.0)	5.4 (.07)	1.8 (14.4)
const: $\Delta x_t:ec$	1.01 (40.9)	3.9 (.56)	1.9 (11.7)	.32 (86.6)	2.4 (5.5)	1.1 (36.4)	.78 (54.2)	.78 (54.4)	.89 (47.6)	2.0 (10.4)	3.84 (.65)	2.6 (4.06)
const: $\Delta x_t:ec:t$	.99 (41.9)	3.9 (.59)	1.38 (24.9)	.94 (44.6)	3.1 (2.2)	1.72 (15.6)	.78 (54.3)	.78 (54.2)	.89 (47.4)	2.2 (8.2)	3.2 (1.8)	1.77 (14.3)
$\Delta pr_t = f(\Delta pr_{t-j}, \Delta x_{t-j}, \Delta tot_{t-j}, \Delta q_{t-j})$												
Specification	GERMANY			UK			USA			JAPAN		
	$pr_x$	$pr_{tot}$	$pr_q$	$pr_x$	$pr_{tot}$	$pr_q$	$pr_x$	$pr_{tot}$	$pr_q$	$pr_x$	$pr_{tot}$	$pr_q$
const: $\Delta x_t$	3.25 (1.58)	1.72 (15.4)	3.1 (2.0)	4.82 (.17)	3.01 (2.39)	3.22 (1.76)	3.5 (1.1)	1.5 (21.4)	.18 (94.8)	2.54 (4.6)	.94 (44.6)	2.53 (4.6)
const: $\Delta x_t:t$	2.8 (3.0)	1.7 (16.0)	2.5 (4.9)	4.7 (.21)	3.5 (1.2)	4.2 (.46)	3.3 (1.5)	1.6 (19.2)	.44 (77.8)	2.43 (5.4)	.80 (53.1)	1.68 (16.2)
const: $\Delta x_t:ec$	3.2 (1.7)	1.9 (12.7)	3.9 (.96)	5.3 (.09)	3.1 (2.0)	3.95 (.6)	3.1 (2.1)	1.45 (22.3)	.19 (94.5)	2.8 (3.1)	1.1 (35.4)	2.1 (9.2)
const: $\Delta x_t:ec:t$	2.9 (2.6)	1.5 (22.3)	2.4 (5.9)	4.7 (.21)	3.1 (2.2)	3.89 (.68)	2.7 (3.7)	1.42 (23.5)	.47 (75.6)	2.65 (3.9)	.91 (46.4)	1.53 (20.2)

Notes: p-values appear in parentheses. The p-value indicates the probability of obtaining an F-ratio at least as large as the test statistic under the null. A p-value smaller than 5 indicates rejection of the null of no causality at the 5% level.

Looking at the relation between  $pr$  and  $q$ , the null hypothesis of no causality has to be rejected except for the US and possibly Japan. While the sum of the coefficients of lagged OECD output is positive in Germany and Japan, the sign is negative for the UK and the US. That there is an independent causal linkage between OECD output and productivity not mediated via exports, might be an indication of international increasing returns to scale as described by Ethier (1979) in which productivity of an industry depends on the size of the world market rather than the domestic market as long as middle products are traded.

Focusing next on the export equations at the upper part of Table 4 and 5, one finds a predictive role of the terms of trade (price competitiveness) for exports ( $x,tot$ ) in all countries except the US either the 1% or 5% significance level. Productivity is Granger causing exports ( $x,pr$ ) only in Japan (at the 10% level), and the inclusion of lagged OECD output improves the forecast of exports ( $x, q$ ) in Japan only.

It is worth noting that the specification does matter for the causality test results. The inclusion of the error-correction terms and/or the time trend have changed the  $p$ -values and  $F$ -statistics considerably in most cases, although the basic results do not depend on the specification. It almost never happened that one specification rejected the null of no causality, while another specification failed to do so (except for  $(x,q)$ ,  $(pr,q)$  in Germany and Japan).

Since export disturbances might take some time until they affect productivity as the productivity effect is supposed to take place via changes in market structure, I have increased the number of lags of export growth from four to eight (for the US and Japanese data) and from four to six (for the UK and German data) in order to account for longer term influences. In all countries, upon increasing the number of lags of exports, the sum of the estimated coefficients  $\hat{\Sigma}_{ZZ}$  remains more or less the same (shown in the bottom part of Table 6). In contrast, increasing the export lag length sharply changes the Granger causality  $F$ -tests.<sup>18</sup> Now, exports Granger causes productivity only at the 10% level in Germany and Japan, while the  $F$ -statistics have become much larger for US data and have remained the same only for the UK. Thus, the general result that exports cause productivity remains valid. Focusing on the terms of trade-productivity link, it appears that, besides the UK, the terms of trade has become now a predictive role for productivity in the US as well (even at the 1% significance level). The causal linkage between OECD output and productivity has become weaker in Germany (but

---

18) Different results for longer term influences based on a subset model approach were obtained by Kunst/Marin (1989).

still remains significant somewhat around the 5% level) and has become stronger in Japan (it is now significant at the 5% level).<sup>19)</sup>

Summarizing these results, in all countries, labour productivity is Granger-caused by exports, independent of specification and lag length. The sum of coefficients of lagged exports is, however, not much different from zero (between  $-.14$  and  $.01$ ) indicating that the quantitative effect of exports on productivity is not great. Causality from the terms of trade to productivity has been identified for the UK and the US (depending on lag length of exports) with deteriorations in the terms of trade (devaluations of the real exchange rate) favouring productivity (the sum of coefficients of lagged tot is around  $-.20$ ). With the exception of the US, in all other countries a direct causal link from OECD output to productivity has proved to be statistically significant (independently of specification and lag length) with increases in OECD output improving productivity in Japan and Germany (with the sum of coefficients of lagged q ranging between  $.09$  and  $1.09$  depending on specification and lag length) and tending to retard productivity in the UK (sum of coefficient estimates between  $-0.1$  and  $-0.5$ ). Additionally, price competitiveness Granger caused exports in all countries except the US. OECD output in Japan and Germany only, while productivity Granger caused exports in Japan only.

---

19) The stronger causality results for some of the variables when the lag length of exports is increased stand in contrast to the money-income causality results obtained by Stock and Watson (1987)

TABLE 6

## EXPORT-PRODUCTIVITY CAUSALITY AND NEUTRALITY TESTS

$$\Delta pr_t = f(\Delta pr_{t-j}, \Delta x_{t-j}, \Delta tot_{t-j}, \Delta q_{t-j})$$

6 or 8 lags of x and 4 lags of tot and q												
A: Causality Tests: F-statistics and P-values												
	GERMANY			UK			USA			JAPAN		
Specification	Pr.X	Pr.tot	Pr.q	Pr.X	Pr.tot	Pr.q	Pr.X	Pr.tot	Pr.q	Pr.X	Pr.tot	Pr.q
const: $\Delta x_t$	1.81 (10.77)	1.12 (35.25)	2.49 (4.98)	4.05 (.17)	3.78 (.82)	3.78 (.82)	3.74 (.10)	3.72 (.80)	.60 (66.64)	1.67 (11.92)	.88 (47.95)	3.28 (1.55)
const: $\Delta x_t:ec$	1.99 (7.77)	.84 (50.41)	2.65 (5.48)	3.76 (.30)	2.9 (2.78)	3.40 (1.42)	3.64 (.12)	3.85 (.66)	.57 (68.31)	1.85 (8.94)	.99 (42.02)	2.59 (4.32)
B: Neutrality: $\hat{E}_{zz}^{\Delta}$												
	GERMANY			UK			USA			JAPAN		
Specification	Pr.X	Pr.tot	Pr.q	Pr.X	Pr.tot	Pr.q	Pr.X	Pr.tot	Pr.q	Pr.X	Pr.tot	Pr.q
const: $\Delta x_t$	.01	-.02	.18	-.14	-.19	-.01	-.12	-.22	-.09	.01	-.03	.28
const: $\Delta x_t:ec$	-.08	-.01	.20	-.14	-.23	-.01	-.13	-.21	-.10	.01	-.04	.25

Notes: For the USA and Japan 8 lags of  $\Delta x$  and for the UK and Germany 6 lags of  $\Delta x$  have been included  $\hat{E}_{zz}^{\Delta}$  denotes the sum of the 8, 6 and 4 lags, respectively, of the estimated coefficients.

## 5. SUMMARY AND CONCLUSIONS

This paper investigates the relationship between exports, productivity, the terms of trade and world output for four OECD countries based on the cointegration and causality concept. The findings of the econometric analysis can be summarized as follows. Exports, productivity, and the terms of trade (with and without the inclusion of world output) share common trends, i.e. they move together in the long run in all countries except the UK. The signs of the estimated equilibrium parameters in the cointegrating regressions indicate that exports, the terms of trade and world output are all positively related to productivity in the long-run. Furthermore, the causality F-tests suggest that exports Granger-cause productivity in all four countries. Based on these results, I conclude that the hypothesis of export-led growth cannot be rejected for the US, Japan, UK and Germany. An 'outward looking' regime seems to favour productivity performance of developed market economies as well and seems, therefore, not to be restricted to developing countries only as commonly asserted. The findings might also be an explanation for the favourable productivity performance in Japan and Germany and the relatively poor one in the US and UK. Exports seem to have played a role here.

Moreover, the positive long-run relation between the terms of trade and productivity, and the significant causal link from the terms of trade to productivity in the US and UK suggest that improvements in the terms of trade (reevaluations of the real exchange rate) have enhanced productivity in these two countries. Interpreting this result, increases in the real exchange rate might have induced entry of foreign low-cost producers into the British and US market leading to the exit of high-cost domestic producers giving rise to improvements in average productivity. If the number of firms declines as a result, the productivity effect might work via two channels. First, through the exit of low-productivity firms. Second, through the scale effect of production, since the market share of the exiting firms is taken by the incumbent firms which might lead to increased output per firm. Output per firm will increase only, however, if price elasticities of exports are sufficiently low preventing overall output from declining substantially due to reduced exports. Additionally, the real exchange rate might have lowered 'X-inefficiency' (if present) by creating an environment in which managerial effort and risk taking behavior is increased. The story is consistent with the data. Whether it is, in fact, the right one cannot be decided on the basis of the empirical evidence presented.

Given these results for the UK and US, the exchange rate might play a productivity enhancing role in two different ways. Either through devaluations of the real exchange rate boosting productivity via exports (the terms of trade as a proxy for price competitiveness has, however, a significant causal impact on exports in the UK only, but not in the US), or through



reevaluations of the real exchange rate improving productivity through the rationalization of production of the import competing sector at the disadvantage of the export sector<sup>20</sup>.

And finally, world output proved to Granger cause productivity independently of exports in all countries except the US which might be an indication of international increasing returns to scale in which productivity of an industry depends on the size of the world market rather than the domestic market.

---

20) For inferences about policy effectiveness from the results of Granger-causality tests see Buiter (1984). Granger (1988).

## REFERENCES

- BALASSA, B. (1978): Exports and Economic Growth: Further Evidence. Journal of Development Economics 5, 181–189.
- BALDWIN, R. and P.R. KRUGMAN (1986): Market Access and International Competition: A Simulation Study of 16K Random Access Memories. NBER Working Paper No. 1936, Cambridge.
- BALDWIN, R. and P.R. KRUGMAN (1986): Persistent Trade Effects of Large Exchange Rate Shocks. NBER Working Paper No. 2017, Cambridge.
- BRANDER, J.A. and B.J. SPENCER (1985): Export subsidies and International Market Share Rivalry. Journal of International Economics 18, 83–100.
- BUITER, W.H. (1984): Granger–Causality and Policy Effectiveness. Economica 51, 151–162
- CAMPBELL, J.Y. and N.G. MANKIW (1987): Are Output Fluctuations Transitory? Quarterly Journal of Economics 4, 856–880
- COX, D. and R. HARRIS (1985): Trade Liberalization and Industrial Organization: Some Estimates for Canada. Journal of Political Economy 93, 115–45.
- DICKEY, D.A. and W.A. FULLER (1979): Distribution of the Estimators for Autogressive Time Series With a Unit Root. Journal of the American Statistical Association 74, 427–431.
- DIXIT, A.K. (1984): International Trade Policy for Oligopolistic Industries. Economic Journal 94, 1–16.
- DIXIT, A.K. (1987): Tariffs and Subsidies under Oligopoly: The Case of the US Automobile Industry. in: H. Kierzkowski (ed.) Protection and Competition in International Trade. Oxford 1987, 112–127.
- DIXIT, A.K. and G.M. GROSSMAN (1984): Targeted Export Promotion with Several Oligopolistic Industries. Discussion paper in Economics No. 71, Woodrow Wilson School, Princeton University.
- ENGLE, R.F. and C.W.J. GRANGER (1987): Co–Integration and Error Correction: Representation, Estimation, and Testing. Econometrica 2, 251–276.
- ETHIER, W. (1979): Internationally Decreasing Costs and World Trade. Journal of International Economics 9, 1–24.
- FEDER, G. (1982): On Exports and Economic Growth. Journal of Development Economics 12, 59–73.
- FLAM, H. and E. HELPMAN (1987): Industrial Policy Under Monopolistic Competition. Journal of International Economics 22, 79–102.
- GEWEKE J. (1984): Inference and Causality in Economic Time Series Models. Handbook of Econometrics. Vol. 2, edited by Z. GRILICHES and M.D. INTRILIGATOR, Amsterdam: North-Holland.
- GRANGER, C.W.J. (1969): Investigating Causal Relations by Econometric Models and Cross-spectral Methods. Econometrica 37, 424–438.
- GRANGER, C.W.J. (1988): Causality, Cointegration, and Control. Journal of Economic Dynamics and Control 12, 551–559.

- GROSSMAN, G.M. and E. HELPMAN (1988): Product Development and International Trade, mimeo.
- GROSSMAN, G.M. and J.D. RICHARDSON (1985): Strategic Trade Policy: A Survey of Issues and Early Analysis, Special Papers in International Economics, No. 15, International Finance Section, Princeton University.
- HELPMAN, E. and P. KRUGMAN (1985): Market Structure and Foreign Trade, Cambridge.
- HELPMAN, E. and M. TRAJTENBERG (1987): Dynamic Comparative Advantage and the Hypothesis of Export-led Growth, mimeo.
- HELPMAN, E. (1988): Growth, Technological Progress, and Trade, Empirica 1, 5-25.
- KAMIEN, M.I. and N.L. SCHWARTZ (1982): Market Structure and Innovation, Cambridge: Cambridge University Press.
- KORMENDI, R.C. and P. MEGUIRE (1985): Macroeconomic Determinants of Growth: Cross-Country Evidence. Journal of Monetary Economics 16, 141-164.
- KUNST, R. and D. MARIN (1989): On Exports and Productivity: A Causal Analysis. Review of Economics and Statistics, forthcoming.
- LEAMER, E. (1985): Vector Autoregressions for Causal Inference? Carnegie Rochester Conference Series on Public Policy 22, 255-304.
- MARIN, D. (1988): Trade and Scale Economies, EUI Working Paper No. 88/332, European University Institute, Florence.
- MARIN, D. (1989): Transitory and Permanent Effects of Exports on Productivity, mimeo.
- NELSON, Ch.R. and Ch.I. PLOSSER (1982): Trends and Random Walks in Macroeconomic Time Series: Some Evidence and Implications. Journal of Monetary Economics 10, 139-162.
- RODRIK, D. (1988): Closing the Technology Gap: Does Trade Liberalization Really Help? NBER Working Paper No. 2654, Cambridge.
- ROMER, P.M. (1986): Increasing Returns, Specialization, and External Economies: Growth as Described by Allyn Young, Working Paper No. 64, Rochester Center for Economic Research.
- SIMS, Ch.A. (1972): Money, Income and Causality, American Economic Review 62, 540-552
- SIMS, Ch.A. (1980): Macroeconomics and Reality, Econometrica 48, 1-48.
- SIMS, Ch.A., J.H. STOCK, and M.W. WATSON (1986): Inference in Linear Time Series Models with Some Unit Roots, mimeo, Stanford University.
- STOCK, J.H. (1987): Asymptotic Properties of a Least Squares Estimators of Cointegrating Vectors. Econometrica 55, 1035-1056.
- STOCK, J.H. and M.W. WATSON (1987): Interpreting the Evidence on Money-Income Causality, NBER Working Paper No. 2228, Cambridge.
- VENABLES, A.J. and A. SMITH (1986): Trade and Industrial Policy Under Imperfect Competition, Economic Policy 3, 622-660.



WORKING PAPERS ECONOMICS DEPARTMENT

- 86/206: Volker DEVILLE Bibliography on The European Monetary System and the European Currency Unit.
- 86/212: Emil CLAASSEN  
Melvyn KRAUSS Budget Deficits and the Exchange Rate
- 86/214: Alberto CHILOSI The Right to Employment Principle and Self-Managed Market Socialism: A Historical Account and an Analytical Appraisal of some Old Ideas
- 86/218: Emil CLAASSEN The Optimum Monetary Constitution: Monetary Integration and Monetary Stability
- 86/222: Edmund S. PHELPS Economic Equilibrium and Other Economic Concepts: A "New Palgrave" Quartet
- 86/223: Giuliano FERRARI BRAVO Economic Diplomacy. The Keynes-Cuno Affair
- 86/224: Jean-Michel GRANDMONT Stabilizing Competitive Business Cycles
- 86/225: Donald A.R. GEORGE Wage-earners' Investment Funds: theory, simulation and policy
- 86/227: Domenico Mario NUTI Michal Kalecki's Contributions to the Theory and Practice of Socialist Planning
- 86/228: Domenico Mario NUTI Codetermination, Profit-Sharing and Full Employment
- 86/229: Marcello DE CECCO Currency, Coinage and the Gold Standard
- 86/230: Rosemarie FEITHEN Determinants of Labour Migration in an Enlarged European Community
- 86/232: Saul ESTRIN  
Derek C. JONES Are There Life Cycles in Labor-Managed Firms? Evidence for France
- 86/236: Will BARTLETT  
Milica UVALIC Labour Managed Firms, Employee Participation and Profit Sharing - Theoretical Perspectives and European Experience.
- 86/240: Domenico Mario NUTI Information, Expectations and Economic Planning
- 86/241: Donald D. HESTER Time, Jurisdiction and Sovereign Risk

- 86/242: Marcello DE CECCO Financial Innovations and Monetary Theory
- 86/243: Pierre DEHEZ Competitive Equilibria with Increasing  
Jacques DREZE Returns
- 86/244: Jacques PECK Market Uncertainty: Correlated Equilibrium  
Karl SHELL and Sunspot Equilibrium in Market Games
- 86/245: Domenico Mario NUTI Profit-Sharing and Employment: Claims and  
Overclaims
- 86/246: Karol Attila SOOS Informal Pressures, Mobilization, and  
Campaigns in the Management of Centrally  
Planned Economies
- 86/247: Tamas BAUER Reforming or Perfecting the Economic  
Mechanism in Eastern Europe
- 86/257: Luigi MONTRUCCHIO Lipschitz Continuous Policy Functions for  
Strongly Concave Optimization Problems
- 87/264: Pietro REICHLIN Endogenous Fluctuations in a Two-Sector  
Overlapping Generations Economy
- 87/265: Bernard CORNET The Second Welfare Theorem in Nonconvex  
Economies
- 87/267: Edmund PHELPS Recent Studies of Speculative Markets  
in the Controversy over Rational Expecta-  
tions
- 87/268: Pierre DEHEZ Distributive Production Sets and Equilibria  
Jacques DREZE with Increasing Returns
- 87/269: Marcello CLARICH The German Banking System: Legal Foundations  
and Recent Trends
- 87/270: Egbert DIERKER Quantity Guided Price Setting  
Wilhelm NEUFEIND
- 87/276: Paul MARER Can Joint Ventures in Hungary Serve as  
a "Bridge" to the CMEA Market?
- 87/277: Felix FITZROY Efficiency Wage Contracts, Unemployment,  
and Worksharing
- 87/279: Darrell DUFFIE Equilibrium and the Role of the Firm  
Wayne SHAFER in Incomplete Markets
- 87/280: Martin SHUBIK A Game Theoretic Approach to the Theory  
of Money and Financial Institutions

- 87/283: Leslie T. OXLEY  
Donald A.R. GEORGE Perfect Foresight, Non-Linearity and  
Hyperinflation
- 87/284: Saul ESTRIN  
Derek C. JONES The Determinants of Workers' Participation  
and Productivity in Producer Cooperatives
- 87/285: Domenico Mario NUTI Financial Innovation under Market Socialism
- 87/286: Felix FITZROY Unemployment and the Share Economy:  
A Sceptical Note
- 87/287: Paul HARE Supply Multipliers in a Centrally Planned  
Economy with a Private Sector
- 87/288: Roberto TAMBORINI The Stock Approach to the Exchange Rate:  
An Exposition and a Critical Appraisal
- 87/289: Corrado BENASSI Asymmetric Information and Financial  
Markets: from Financial Intermediation  
to Credit Rationing
- 87/296: Gianna GIANNELLI On Labour Market Theories
- 87/297: Domenica TROPEANO The Riddle of Foreign Exchanges: A  
Swedish-German Debate (1917-1919)
- 87/305: G. VAN DER LAAN  
A.J.J. TALMAN Computing Economic Equilibria by Variable  
Dimension Algorithms: State of the Art
- 87/306: Paolo GARELLA Adverse Selection and Intermediation
- 87/307: Jean-Michel GRANDMONT Local Bifurcations and Stationary  
Sunspots
- 87/308: Birgit CRODAL  
Werner HILDENBRAND Income Distributions and the Axiom  
of Revealed Preference
- 87/309: Eric PEREE  
Alfred STEINHERR Exchange Rate Uncertainty and Foreign  
Trade
- 87/312: Pietro REICHLIN Output-Inflation Cycles in an Economy with  
Staggered Wage Setting
- 87/319: Peter RAPPOPORT  
Lucrezia REICHLIN Segmented Trends and Nonstationary  
Time Series
- 87/320: Douglas GALE A Strategic Model of Labor Markets  
with Incomplete Information
- 87/321: Gianna GIANNELLI A Monopoly Union Model of the Italian  
Labour Market: 1970-1984

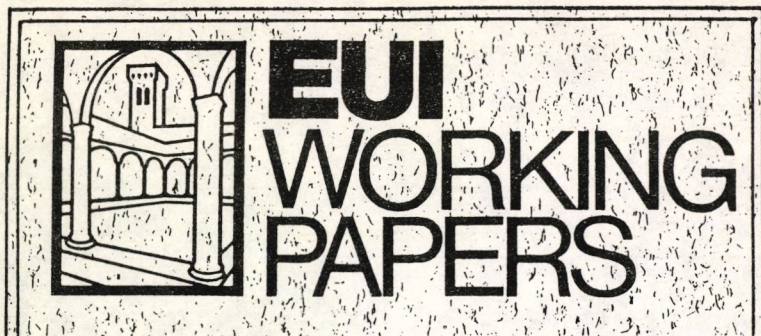
- 87/322: Keith PILBEAM Sterilization and the Profitability of UK Intervention 1973-86
- 87/323: Alan KIRMAN The Intrinsic Limits of Modern Economic Theory
- 87/324: Andreu MAS-COLELL An Equivalence Theorem for a Bargaining Set
- 
- 88/329: Dalia MARIN Assessing Structural Change: the Case of Austria
- 88/330: Milica UVALIC "Shareholding" in Yugoslav Theory and Practice
- 88/331: David CANNING Convergence to Equilibrium in a Sequence of Games with Learning
- 88/332: Dalia MARIN Trade and Scale Economies. A causality test for the US, Japan, Germany and the UK.
- 88/333: Keith PILBEAM Fixed versus Floating Exchange Rates Revisited.
- 88/335: Felix FITZROY  
Kornelius KRAFT Piece Rates with Endogenous Monitoring: Some theory and evidence
- 88/337: Domenico Mario NUTI On Traditional Cooperatives and James Meade's Labour-Capital Discriminating Partnerships
- 88/338: Pietro REICHLIN  
Paolo SICONOLFI Government Debt and Equity Capital in an Economy with Credit Rationing
- 88/339: Alfred STEINHERR The EMS with the ECU at Centerstage: a proposal for reform of the European rate system
- 88/340: Frederick VAN DER PLOEG Monetary and Fiscal Policy in Interdependent Economies with Capital Accumulation, Death and Population Growth
- 88/341: David CANNING Optimal Monetary Policy in an Economy without a Forward Market for Labour
- 88/344: Joerg MAYER Intervention Mechanisms and Symmetry in the EMS
- 88/345: Keith PILBEAM Exchange Rate Management and the Risk Premium



- 88/348: Milica UVALIC                   The Investment Behaviour of the Labour-  
Managed Firm: an econometric analysis
- 88/351: Alan P. KIRMAN                 On Ants and Markets
- 88/352: Gianna GIANNELLI             Labour Demand, Pricing and Investment  
Decisions in Italy: An econometric  
Analysis
- 88/353: Niall O'HIGGINS             The Progressivity of Government Taxes and  
Benefits in Ireland: a comparison of two  
measures of redistributive impact
- 88/356: Mary McCARTHY               Do Women Cause Unemployment? Evidence  
Lucrezia REICHLIN                 from Eight O.E.C.D. Countries
- 88/357: Richard M. GOODWIN         Chaotic Economic Dynamics
- 88/358: Fernando PACHECO            Duopoly under Demand Uncertainty  
Eric PEREE  
Francisco S. TORRES
- 88/360: Domenico Mario NUTI         Economic Relations between the European  
Community and CMEA
- 88/361: Domenico Mario NUTI         Remonetisation and Capital Markets in  
the Reform of Centrally Planned Economies
- 88/362: Domenico Mario NUTI         The New Soviet Cooperatives: Advances  
and Limitations
- 88/368: Stephen MARTIN             Joint Ventures and Market Performance  
in Oligopoly
- 89/370: B. BENSaid                 The Strategic Aspects of Profit-Sharing  
Robert GARY-BOBO                 in the Industry  
S. SIDERBUSCH
- 89/374: Francisco S. TORRES         Small Countries and Exogenous Policy  
Shocks
- 89/375: Renzo DAVIDDI               Rouble Convertibility: a Realistic Target?
- 89/377: Elettra AGLIARDI            On the Robustness of Contestability Theory
- 89/378: Stephen MARTIN             The Welfare Consequences of Transaction  
Costs in Financial Markets
- 89/381: Susan SENIOR NELLO         Recent Developments in Relations between  
the EC and Eastern Europe

- 89/382: Jean GABSZEWICZ  
Paolo GARELLA  
Charles NOLLET  
Spatial Price Competition with Uninformed Buyers
- 89/383: Benedetto GUI  
Beneficiary and Dominant Roles in Organizations: the Case of Nonprofits
- 89/384: Agustín MARAVALL  
Daniel PEÑA  
Missing Observations, Additive Outliers and Inverse Autocorrelation Function
- 89/385: Stephen MARTIN  
Product Differentiation and Market Performance in Oligopoly
- 89/386: Dalia MARIN  
Is the Export-Led Growth Hypothesis Valid for Industrialized Countries?
- 89/387: Stephen MARTIN  
Modeling Oligopolistic Interaction
- 89/388: Jean-Claude CHOURAQUI  
The Conduct of Monetary Policy: What have we learned from recent experience?
- 89/390: Corrado BENASSI  
Imperfect Information and Financial Markets  
A General Equilibrium Model

Spare copies of these Working Papers can be obtained from the Economics Department secretariat.



EUI Working Papers are published and distributed by the European University Institute, Florence.

Copies can be obtained free of charge - depending on the availability of stocks - from:

The Publications Officer  
European University Institute  
Badia Fiesolana  
I - 50016 San Domenico di Fiesole (FI)  
Italy

**Please use order form overleaf**

**PUBLICATIONS OF THE EUROPEAN UNIVERSITY INSTITUTE**

To The Publications Officer  
European University Institute  
Badia Fiesolana  
I - 50016 San Domenico di Fiesole (FI)  
Italy

From Name .....  
Address .....  
.....  
.....  
.....

Please send me the following EUI Working Paper(s):

No. ....  
Author, title: .....  
.....  
.....  
.....

Date .....

Signature .....



© The Author(s). European University Institute.

Digitised version produced by the EUI Library in 2020. Available Open Access on Cadmus, European University Institute Research Repository.

- 88/329: Dalia MARIN                      Assessing Structural Change: The Case of Austria \*
- 88/330: Milica UVALIC                    "Shareholding" in Yugoslav Theory and Practice
- 88/331: David CANNING                   Convergence to Equilibrium in a Sequence of Games with Learning
- 88/332: Dalia MARIN                    Trade and Scale Economies. A causality test for the U.S., Japan, Germany and the UK
- 88/333: Keith PILBEAM                   Fixed versus Floating Exchange Rates Revisited
- 88/334: Hans Ulrich Jessurun d'OLIVEIRA                    Die EWG und die Versalzung des Rheins
- 88/335: Felix Fitzroy and Kornelius Kraft                    Piece Rates with Endogenous Monitoring Some Theory and Evidence
- 88/336: Norbert LORENZ                   Die Übertragung von Hoheitsrechten auf die Europäischen Gemeinschaften - verfassungsrechtliche Chancen und Grenzen einer europäischen Integration erläutert am Beispiel der Bundesrepublik Deutschland, Frankreichs und Italiens -
- 88/337: Domenico Mario NUTI                    On Traditional Cooperatives and James Meade's Labour-Capital Discriminating Partnerships
- 88/338: Pietro REICHLIN and Paolo SICONOLFI                    Government Debt and Equity Capital in an Economy with Credit Rationing
- 88/339: Alfred STEINHERR                    The EMS with the ECU at Centerstage: A proposal for reform of the European Exchange rate system
- 88/340: Frederick VAN DER PLOEG                    Monetary and Fiscal Policy in Interdependent Economies with Capital Accumulation, Death and Population Growth
- 88/341: David CANNING                    Optimal Monetary Policy in an Economy without a Forward Market for Labour
- 88/342: Gunther TEUBNER                    "And God Laughed..." Indeterminacy, Self-Reference and Paradox in Law
- 88/343: Jean BLONDEL                    Ministerial Careers in Western European Governments

\* :Working Paper out of print

- 88/344: Joerg MAYER Intervention Mechanisms and Symmetry in the EMS
- 88/345: Keith PILBEAM Exchange Rate Management and the Risk Premium
- 88/346: Efisio ESPA The Structure and Methodology of International Debt Statistics
- 88/347: Francesc MORATA and and Jaume VERNET Las Asambleas Regionales en Italia y España: Organización Institucional y Reglas de Funcionamiento
- 88/348: Milica UVALIC The Investment Behaviour of the Labour-Managed Firm: An Econometric Analysis
- 88/349: Massimo PANEBIANCO Inter-Regional Co-Operation in the North-South Dialogue Latin America and the European Community
- 88/350: Gregorio ROBLES La Cour de Justice des CE et les Principes Généraux du droit
- 88/351: Alan KIRMAN On Ants and Markets
- 88/352: Gianna GIANNELLI Labour Demand, Pricing and Investment Decisions in Italy: An Econometric Analysis
- 88/353: Niall O'HIGGINS The Progressivity of Government Taxes and Benefits in Ireland: A Comparison of Two Measures of Redistributive Impact
- 88/354: Christian JOERGES Amerikanische und deutsche Traditionen der soziologischen Jurisprudenz und der Rechtskritik
- 88/355: Summary of Conference, debates and abstracts of selected interventions The Future Financing of the EC Budget: EPU Conference 16-17 October 1987
- 88/356: Mary MCCARTHY and Lucrezia REICHLIN Do Women Cause Unemployment? Evidence From Eight O.E.C.D. Countries
- 88/357: Richard M. GOODWIN Chaotic Economic Dynamics
- 88/358: Fernando PACHECO Eric PEERE and Francisco S. TORRES Duopoly Under Demand Uncertainty
- 88/359: Jaakko NOUSIAINEN Substance and Style of Cabinet Decision-Making

\* :Working Paper out of print

- 88/360: Domenico Mario NUTI Economic Relations between the European Community and CMEA
- 88/361: Domenico Mario NUTI Remonetisation and Capital Markets in the Reform of Centrally Planned Economies
- 88/362: Domenico Mario NUTI The New Soviet Cooperatives: Advances and Limitations
- 88/363: Reiner GRUNDMANN Marx and the Domination of Nature Alienation, Technology and Communism
- 88/364: Tony PROSSER The Privatisation of Public Enterprises in France and Great Britain The State, Constitutions and Public Policy
- 88/365: Silke BRAMMER Die Kompetenzen der EG im Bereich Binnenmarkt nach der Einheitlichen Europäischen Akte
- 88/366: Goesta ESPING-ANDERSEN The Three Political Economies of the Welfare State
- 88/367: Goesta ESPING-ANDERSEN Paul FARSUND and Jon Eivind KOLBERG Decommodification and Work Absence in the Welfare State
- 88/368: Stephen MARTIN Joint Ventures and Market Performance in Oligopoly
- 88/369: Giuseppe RAO The Italian Broadcasting System: Legal and Political Aspects
- 89/370: B. BENSaid/  
S. FEDERBUSCH/  
R.J. GARY BOBO The Strategic Aspects of Profit Sharing in the Industry
- 89/371: Klaus-Dieter STADLER Die Europäische Zusammenarbeit in der Generalversammlung der Vereinten Nationen zu Beginn der Achtziger Jahre
- 89/372: Jean Philippe Robé Countervailing Duties, State Protectionism and the Challenge of the Uruguay Round
- 89/373: Giovanni FEDERICO/  
Antonio TENA On the Accuracy of Historical International Foreign Trade Statistics Morgenstern Revisited
- 89/374: Francisco TORRES Small Countries and Exogenous Policy Shocks

- 89/375: Renzo DAVIDDI                      Rouble Convertibility:  
A Realistic Target?
- 89/376: Jean STAROBINSKI                  Benjamin Constant:  
La fonction de l'eloquence
- 89/377: Elettra AGLIARDI                  On the Robustness of Contestability  
Theory
- 89/378: Stephen MARTIN                    The Welfare Consequences of  
Transaction Costs in Financial Markets
- 89/379: Augusto De Benedetti              L'equilibrio difficile. Linee di  
politica industriale e sviluppo  
dell'impresa elettrica nell'Italia  
meridionale: la Società Meridionale  
di Elettricità nel periodo di  
transizione, 1925-1937
- 89/380: Christine KOZICZINSKI              Mehr "Macht" der Kommission?  
Die legislativen Kompetenzen der  
Kommission bei Untätigkeit des Rates.
- 89/381: Susan Senior NELLO                Recent Developments in Relations  
Between the EC and Eastern Europe
- 89/382: J. GABSZEWICZ,  
P. GARELLA and  
Charles NOLLET                              Spatial Price Competition With  
Uninformed Buyers
- 89/383: Benedetto GUI                      Beneficiary and Dominant Roles in  
Organizations: The Case of Nonprofits
- 89/384: Agustin MARAVALL and  
Daniel PEÑA                                  Missing Observations, Additive  
Outliers and Inverse Autocorrelation  
Function
- 89/385: Stephen MARTIN                    Product Differentiation and Market  
Performance in Oligopoly
- 89/386: Dalia MARIN                        Is the Export-Led Growth Hypothesis  
Valid for Industrialized Countries?
- 89/387: Stephen MARTIN                    Modeling Oligopolistic Interaction
- 89/388: Jean Claude CHOURAQUI            The Conduct of Monetary Policy: What  
has we Learned From Recent Experience?
- 89/389: Léonce BEKEMANS                  Economics in Culture vs. Culture in  
Economics
- 89/390: Corrado BENASSI                   Imperfect Information and Financial  
Markets: A General Equilibrium  
Analysis