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Abstract

Several types of theoretical literature on the topic of trade, growth and specialisation, including neoclassical approaches, post-Keynesian literature and some models in evolutionary economics, have shown that it is possible enjoy higher rates of economic growth, given the presence of certain sectors in the economy, being it high-tech or fast-growing sectors.

This paper investigates these propositions empirically. Basically the idea is to conduct a constant market share (CMS) analysis, and afterwards include the obtained effects in regression models, using panel data techniques in explaining aggregate economic growth.

The results display that the fixed effects model is the most appropriate technique, and that using this tool, the initial level of income (the catch up variable) is significant and has a negative sign as expected. The investment (growth of the capital stock) variable is also significant, while the growth adaptation effect (measuring whether the country in question has actively (more than the average country) moved into slow or fast growing sectors) is the only significant variable (positive sign) of the CMS effects. Hence, it is concluded that a certain dynamism in terms of structural *change* is required by countries in order to achieve high levels of economic growth at the macro level. The final part of the paper deals with the question of whether the fast-growing sectors (as measured in the CMS analysis) are high-tech or not. Based on a comparison between the OECD growth vector from the CMS analysis, on the one hand, and R&D intensities in the 22 sectors (for the 1970s and for the 1980s), on the other, it is concluded that the fast-growing sectors are in general also high-tech sectors.

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trade specialisation, economic growth, constant market share analysis, panel data.

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1. Introduction

The proposition that economic structure matters for economic growth is not uncontroversial in the mainstream of economic theory and analyses. The underlying notion of 'competitiveness' has been attacked recently by Krugman (1994) for being theoretically meaningless. The main point of the argument in this context is that the standard of living of a country is related to growth in productivity in the domestic country, and is not related to growth of productivity with respect to other countries (full stop!). However, if comparative advantage (stemming from economies of scale or from endowments) forces countries to specialise in certain sectors, and sectors differ in terms of learning opportunities and/or asymmetric demand structures, 'competitiveness' (as a relativistic concept) makes a difference for economic growth of countries.

The aim of this paper is to investigate empirically, whether or not Ricardian trade specialisation[1] matters for economic growth (measured as growth of the gross national product) at the level of the country (18 OECD countries); that is, whether or not initial specialisation in, or a movement into fast-growing sectors, matters for economic growth.

The paper is structured as follows. In Section 2, we briefly outline some theoretical considerations on the topic. Section 3 contains the empirical analysis. The first part of the section is devoted to regression analysis (using fixed- and random effects models), including effects stemming from constant market share analysis, in explaining growth of GDP, across 18 OECD countries. One advantage of this procedure is that while we would like the variables to be time invariant, from a technical point of view, the CMS methodology allows for (possibly) time invariant effects, while the underlying sectoral composition can change quite dramatically over time (like in the case 'computers', where this sector grew much faster in the 1980s, as compared to the growth in the 1970s).

Of the CMS effects, the parameter for the variable expressing the movement into fast-growing sectors turns out to be positive and significant. Following up on that result, the last part of the section deals with the question of whether fast-growing sectors are (in general) high-tech. Finally, Section 4 contains some conclusions, and warns that policy conclusions are not straight forward.

1 'Ricardian specialisation' refers to specialisation in specific kinds of activity (e.g. in clothes or in electronics) as opposed to 'Smithian specialisation', where the concept of specialisation refers to the level of specialisation (Dowrick, 1997).

2. Theoretical considerations

This section will briefly outline some of the theoretical background for the empirical analysis to be carried out in Section 3. For a more comprehensive treatment of the topic see Dalum *et al.* (1996). Krugman (1987) showed that in a model in which technical progress results from learning-by-doing (over time), and at the level of the industry, it is possible for a predatory trade policy to raise one country's relative wage and perhaps it livings standard at other countries' expense. However, Krugman did not specify differences in terms of learning opportunities (or level of increasing returns) between sectors. Hansen (1997) has extended the model of Krugman to incorporate such a feature. While the paper of Hansen accentuates the endogenous character of comparative advantage, as modelled by Krugman, it also has something to say about the industrial structure in an open economy. The point is that if one country is initially the stronger one in the 'dynamic' sectors, there will only be room for 'dynamic' sectors when the economy is opened up to free trade in that country. The disadvantaged country could, in contrast, end up with a mixed structure consisting both of 'dynamic' and 'non-dynamic' sectors. It should be pointed out however, that the models of Krugman and Hansen are basically both trade models and not growth models.

Grossman and Helpman (1991, chapters 7 & 8 in particular) construct a two-country, two-sector growth model. The model encompasses a manufacturing sector that offers no prospect for technological change ('the traditional sector'), while in another manufacturing sector new goods are continuously being introduced ('the high technology sector'). The main idea is to answer the question of what are the characteristics of a country that makes a contribution to comparative advantage in a high-technology sector (the answer is that it depends on the nature of spill-overs). However, the model implies that for a country, specialised in the high-technology sector, real output growth is faster in that country, compared to the other country, as the overall growth rate is a weighted average of the growth rate of the two sectors. However, it should be pointed out that the fast growing country does not, in long run equilibrium, experience a higher growth rate of real consumption. The reason for this is that consumers enjoy benefits from innovation through the purchase of traded goods. Hence, the deteriorating terms of trade offsets the faster growth of output by the country specialised in 'high-tech', in the long run.

These new developments in neoclassical trade and growth theory are basically supply oriented.

There is not allocated any prevalent role to the demand side, whether domestic or foreign. The opposite is the case in the post-Keynesian approaches of demand induced ('export-led') growth by Kaldor (1966; 1970); or the Thirlwall (1979); McCombie and Thirlwall (1995) version in terms of 'balance-of-payments constrained' growth. The starting point of the latter theory is that of the factors which constrain aggregate demand in a situation in which there is full utilisation of capacity, associated with the highest possible level of economic growth. Accordingly, it is argued that it is only through increased exports that the growth rate can be raised, if a balance-of-payments equilibrium is to be maintained in the long run. This argument leads Thirlwall to focus on the characteristics of the goods produced across countries, as the main driving force of economic growth. However, the 'characteristics of the goods' are treated as income elasticities of demand for the country's exports. Thus, the approach treats the export sector as a 'black box' - with no further considerations of the export structure of countries. Nevertheless, it should be pointed out that the composition of exports (whether a country is specialised in fast- or slow-growing) is one possible interpretation of the elasticities.

From an evolutionary perspective Verspagen (1993, chapter 8) constructed a model inspired by the post-Keynesian tradition. Thus, growth is basically driven by growth of exports (determined by competitiveness, argued to be mainly determined by technological factors), under a balance-of-payments constraint. In the model a 'domestic' country competes with a 'foreign' country (the rest of the world) in a number of sectors. If the competitiveness of a country in a given sector is higher than average, the country expands its market share in that sector and thus - all other things being equal - expands its aggregate market share, as the sum of the individual sectors add up to the country aggregate (there are no spill-overs in the model). An important aspect of the model, in the context of this paper is that both supply side factors (non-symmetric learning rates across sectors) as well as demand side factors (non-symmetric consumption structures) cause differences in growth rates among countries.

From an empirical point of view, the hypothesis of Ricardian specialisation being of importance for economic growth has gained support from e.g. Dalum *et al.* (1996). With data for 75 product groups, assigned to 11 industries, the impact of Ricardian specialisation (among other variables) on the growth of value added in each of the 11 industries (20 OECD countries), was investigated. It was shown that the *type* of intra-industry specialisation (measured as 'revealed comparative advantage') does matter for economic growth, although the impact seems to be gradually wearing off during the 1980s. Amable (1997) looked at the effect of inter-industry specialisation on economic growth in a sample of 39 countries over the period 1965-1990, using the Michaely-index as the indicator of specialisation. Amable included (among other variables) one ‘Smithian’ specialisation variable (measuring the level of specialisation); and two variables measuring aspects of ‘Ricardian’ specialisation (one measuring the degree to which a country’s specialisation profile match international demand; the other measuring whether or not a country is seen to be specialised in electronics). The conclusions are that the level of specialisation does matter for growth, as does specialisation in electronics, although the effect of the latter seemed to be rather small. However, the results also suggest (against intuition) that being specialised in fields were international demand is rather low, has a significant and positive impact on growth, over the period. However, it should be pointed out that this result could be the outcome of the (arbitrary) size of the commodity classification applied. Meliciani and Simonetti (1998) made a similar set-up to that of Amable, but used technological specialisation (measured as the ‘revealed technological advantage’) in fast-growing fields (specialisation in top 8, out of 91 US patent classes), as well as specialisation in information and communication technologies, as the specialisation variables applied. The authors found a positive impact of both types of specialisation, but the relationship appears to hold only for the 1980s, and not for the 1970s.

3. Empirical analysis

3.1. The data

The investment, GDP (volume) and population data have been taken from OECD Economic Outlook and Reference Supplement (No. 59). The patent data used are taken from the U.S. patent office, and concerns patent grants, dated by the year of grant. The attribution of patents to countries and industrial sectors is done by the patent office. Whenever a patent is attributed to more than one, say *m* sectors, the patent is counted as 1/*m* in each of these. It was chosen to work with U.S. patents because, rather than patent statistics from each of the national patent offices, US patents are subject to a common institutional system (novelty requirements, etc.), and moreover, the U.S., for most of the period under consideration, constituted the largest 'technology market' in the world. The export data are taken from the STAN data base, as this data is available from 1970 and onwards on an annual basis.

3.2. The importance of structural change for economic growth

The starting point for the type of structural decomposition analysis, conducted on trade data, namely constant market share (CMS) analysis, is whether or not a country expands its exports as a percentage of total OECD exports over time, between two periods. The basic idea of the method is then to decompose the growth rate, in such a way that structural change gets isolated. It is then possible to say something about whether a rise (or fall) of a country's share of OECD exports is due to (i) *the structural market effect* (SME); i.e. having the 'right' ('or wrong') specialisation pattern in the initial year; (ii) *the market growth adaptation effect* (GAE); i.e. a movement into sectors with fast-growing (or stagnating) exports; (iii) *the market stagnation adaptation effect* (SAE); i.e. a movement out of sectors with generally stagnating market activity (or fast-growing), and finally; (iv) *the market share effect* (MSE); i.e. whether the rise (or fall) is due to the fact that the country has gained shares of markets, assuming that the structure is the same in the two periods in question. As described by Laursen (1996), the decomposition can be conducted for growth in export market shares as follows:

$$\Delta x_j = \sum_i (\Delta x_{ij} y_{ij}^{t-1}) + \sum_i (x_{ij}^{t-1} \Delta y_{ij}) + \sum_i (\Delta x_{ij} \frac{\Delta y_{ij} + |\Delta y_{ij}|}{2}) + \sum_i (\Delta x_{ij} \frac{\Delta y_{ij} - |\Delta y_{ij}|}{2}), \quad (1)$$

Market share effect — Structural market effect — Market growth adaptation effect — Market stagnation adaptation effect

where:

$x_j = \sum_i X_{ij} / \sum_i \sum_j X_{ij}$ (a country's aggregate share of OECD exports to the world);

$x_{ij} = X_{ij} / \sum_j X_{ij}$ (a country's share of a given sector in terms of exports);

$y_{ij} = \sum_j X_{ij} / \sum_i \sum_j X_{ij}$ (a sector's share of total OECD exports to the world),

where X_{ij} denotes exports by firms situated in country *j* in sector *i*.

The CMS effects are calculated as a kind of three year moving average. An example of this procedure is that for the first period we decompose the change in market shares, is the change of market shares between 1970 and 1973; the second period is 1971 and 1974, and so on. The (aggregate country level) technology variable has been calculated as follows:

$$T_{j\,n}^{stock} = \sum_{t=1}^{n} t/n \; T_{j\,t}, \qquad (2)$$

where T_{jn}^{stock} is the stock of technology in period n in country j, measured as numbers of US patents granted to firms in country j. T_{jn}^{stock} is in other words the sum of US patents in n (in our case n=9) periods held by the firms of country j, allowing for linear depreciation over the (nine) years. The reason for choosing a nine year period was the data availability, as data on US patenting was made available electronically from 1963 onwards, and in combination with the fact that we want to use the variable together with growth rates in GDP from 1972 onwards.[2]

The basic empirical model, explaining economic growth among 18 OECD countries, can be set up as follows:

$$\hat{y}_j = \alpha_j + \beta_1 Y0_j + \beta_2 \hat{K}_j + \beta_3 \hat{T}_j + \beta_4 M\hat{S}E_j + \beta_5 S\hat{M}E_j + \beta_6 G\hat{A}E_j + \beta_7 S\hat{A}E_j + \epsilon_j, \qquad (3)$$

where $\hat{y}_j$ is the annual growth rate of GDP. $Y0_j$ is the level of income per capita in country j, relative to the US, in the initial year; $\hat{K}_j$ is the annual growth rate of the stock of physical capital (investment with nine years depreciation) for each country; while $\hat{T}_j$ is the growth rate of the stock of technology (nine years depreciation), measured as US patents, and held by the firms of country j. Both the variable expressing the growth of the stock of technology and the variable expressing the growth of capital are expressed in relation to the average values of the 18 OECD countries[3] for each period. As mentioned above, we apply a three year 'moving average' for the CMS variables in order to avoid too much short term fluctuation in the figures. When we subsequently compare the annual growth rates of GDP to the CMS variables, we apply the end year as the connecting point. Hence, e.g. growth in GDP 1972-1973 is to be measured against CMS variables, calculated on the basis of growth rates between 1970 and 1973. For what

2 We also wanted to include growth of the capital stock (investment) in a similar way to that of technology. Since investment figures are not available for all countries in 1963, this particular year was excluded.

3 Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany (West), Greece, Italy, Japan, The Netherlands, New Zealand, Norway, Spain, Sweden, United Kingdom, United States.

concerns expectations of the direction of the parameters, one would expect all variables to have a positive sign, but the catching up variable.

It should be pointed out that the CMS variables, as well as the patent variable are based on manufacturing only, while the rest of the data includes all of the economy. This is of course a limitation of the analysis, as it would have been preferable to have included specialisation in the service sector as well. However, with the present data set such a procedure is not possible.

The results of the regressions are given in Table 1. As we are dealing with a panel data set, the model has been estimated as both a random effects model, as well as a fixed effects model. However, OLS estimates are also shown in Table 1, as a kind benchmark in relation to the more appropriate panel data techniques. In the fixed effects model, the intercept is taken to be a group specific constant in the regression model. In the random effects model, the intercept is a group specific disturbance, and for each group, there is but a single draw that enters the regression identically in each period. As the cross sectional dimension is countries in the model, it might be expected *a priori*, that there are country-specific fixed effects present, especially if the literature on national systems of innovation (see Lundvall, 1992; Nelson, 1993) is correct in asserting national differences in terms the institutional set-up (e.g. differences in firm organisation; technological support systems; education systems; financial systems; and university systems). In his context, two specification tests were conducted. Since it is assumed in the random effects model that the individual effects are uncorrelated with the other regressors, the random effects model may suffer from the inconsistency, due to omitted variables. Hence, a Hausman test was carried out. The Hausman (1978) test is devised to test for orthogonalility of the random effects and the regressors. The test (see Table 1) rejects the hypothesis that the individual effects are uncorrelated with the other regressors in the model, at the two per cent level. Thus, the test strongly indicates that the assumption behind the random effects model does not hold. In addition, the outcome of the *F*-test for the hypothesis stating that the country effects are the same can be rejected at any plausible level. Given the outcome of the specification tests, with regard to the technique applied, it can be concluded that the fixed effects model appears to be the most appropriate one. This finding is in accordance with the *a priori* expectations, based on the literature on national systems of innovation, emphasising differences among countries.

The fixed effects model estimated in Table 1 is significant overall, at any reasonable level (as are the two other models). The capital stock variable has a positive sign and is significant at a six

Table 1: The effect of different variables on economic growth in a panel of 18 OECD countries and across the years 1972-1990 (n=324).

	OLS R^2 = 0.09		Random effects model R^2 = 0.09		Fixed effects model R^2 = 0.16	
	Estimate	*P*-value	Estimate	*P*-value	Estimate	*P*-value
Y0	0.627	0.2213	0.539	0.3541	-11.89	0.0018
K	0.210	0.0448	0.204	0.0548	0.223	0.0534
T	0.031	0.3673	0.035	0.3290	0.045	0.2547
MSE	-0.009	0.6671	-0.009	0.6649	-0.014	0.5018
SME	-0.035	0.3461	-0.029	0.4366	-0.018	0.6451
GAE	0.504	0.0045	0.492	0.0057	0.464	0.0107
SAE	-0.254	0.0954	-0.246	0.1068	-0.229	0.1386
Hausman test				0.0187		
F Test for No Fixed Effects						0.2009

per cent level, while the catching up variable has the expected negative sign, and has a significant (and large) parameter at any reasonable level. It can be seen from Table 1 that the catching up variable is only significant, when fixed country effects are controlled for. Hence country-specific developments appear to be ‘crowding out’ the catch-up variable, when the fixed effects are not included. The aggregate technology (stock) growth variable has the expected sign, but is not significant. However, it should be pointed out that the link between technology and growth is very (too) simple in this set-up. First, it has been shown that not all sectors are technology intensive in the sense that the firms in those sectors base their competitiveness on R&D (Soete, 1981; Pavitt, 1984; Amable and Verspagen, 1995). Second, the patenting activity is mainly related to manufacturing, while the dependent variable includes all of the economy. However, an analysis allowing for the variables to interact, reveals that the technology (patent) variable do play a role in the present setting, but in an indirect way. Hence, it can be seen from Table 2, that the effect of technology in this setting travels trough the channel of growth in physical capital. High growth in terms of technological competence exerts a positive impact on growth in an interaction with high growth of physical capital, as the interaction variable (*K**T*) between the capital variable and the technology variable always turns out to be significant.

Of the effects from the constant market share analysis, only the ‘growth adaptation effect’ is

Table 2: The effect of different variables on economic growth in a panel of 18 OECD countries and across the years 1972-1990. Various fixed effects specifications (n=324).

	(1) R^2=0.15		(2) R^2=0.13		(3) R^2=0.15		(4) R^2=0.16		(5) R^2=0.17	
	Estimate	*P*-value	Estimate	*P*-value	Estimate	*P*-value	Estimate	*P*-value	Estimate	*P*-value
Y0	-12.149	0.0014	-13.310	0.0005	-12.318	0.0011	-12.817	0.0007	-12.515	0.0010
K	0.214	0.0608	0.267	0.0194	0.211	0.0616	0.271	0.0164	0.239	0.0381
T	-0.018	0.7073	0.001	0.9785	-0.006	0.9008	-0.014	0.7619	-0.013	0.7804
*K*T*	0.057	0.0178	0.056	0.0205	0.051	0.0312	0.059	0.0138	0.053	0.0254
MSE	0.032	0.0083							-0.012	0.5577
SME			-0.008	0.8421					-0.019	0.6229
GAE					0.415	0.0008			0.430	0.0178
SAE							-0.287	0.0146	-0.241	0.1160

significant (at the two per cent level), in Table 1. In this context it is interesting to note that the variable measuring whether a country has been 'fortunately' specialised in the initial year, with respect to trade growth in the period in question (i.e. the 'structural effect') is far from being significant. Hence, it can be concluded that, whether a country has a 'dynamic' specialisation pattern initially does not appear to be important for economic growth. However, a certain dynamism in terms of structural *change* (i.e. countries actively moving into fast-growing sectors) is required by countries in order to achieve high levels of economic growth at the macro level, given the positive and significant impact of the 'growth adaptation effect'.

Table 2 tests for the stability of the 'specialisation' (CMS) variables. In this context it can be noted that the growth adaptation effect is not sensitive to the removal of any of the CMS variables. In addition, interactions between the 'standard' variables (*Y0*, *K* and *T*) was also tested for. The interaction between the technology variable and the physical capital variable, mentioned above, was the only significant of these three interaction variables.

3.3. Are fast-growing sectors high-tech?

As mentioned previously, one can interpret the elasticities with respect to demand in the post-Keynesian growth literature as being related to the sectoral composition of countries' exports.

Building on this literature, Verspagen provided an evolutionary model, which incorporates this feature in an explicit manner, highlighting that one of the reasons for some countries growing faster than others is higher learning opportunities on the supply side, and non-symmetric consumption structures on the demand side. In both of these types of literature, what matters for economic growth (in the context of trade) is whether a country is specialised in fast-growing sectors in terms of trade or not. The empirical set-up of this paper basically corresponds to that. However, in the neoclassical literature, only supply side factors matter (i.e. higher learning opportunities in some sectors, as compared to others). Hence, in order to be in accordance with the neoclassical predictions, the fast-growing sectors need to be high-tech, as these models focus exclusively on learning opportunities, related to investment in R&D. Hence, this section will deal with the question of whether fast-growing sectors are high-tech. However, the growth of the various sectors over different time periods is also interesting per se.

Table 3 displays the technology intensities of the sectors, as well as the growth of the various sectors, expressed as the sum of the change of a sector's share of total OECD exports to the world, over two 9 year periods (the 1970s and the 1980s):

$$TG_{ij} = \sum_{t} \Delta y_{ij}. \quad (4)$$

Hence, TG_{ij} is the sum (over time) of the OECD growth (sectoral) vectors, as applied in the CMS analysis in the section above (see Equation 1, above). It should be noted that the trade growth columns are relative to each other; in other words the two columns (1973-81 and 1982-90 respectively) sum up to zero. From Table 3 the decline of some low-tech sectors in terms of exports is clearly displayed when using the TG_{ij}, as food, drink and tobacco; textiles, footwear and leather; as well as shipbuilding are losing relative importance at a relatively high pace. At the same time some high-tech sectors, such as electrical machinery; motor vehicles; aerospace; and instruments, are growing at a relatively high speed. Also some interesting differences

Table 3: Trade growth and R&D intensity in the 1970s and in the 1980s.

		Sum of CMS trade growth vectors (TG)*		Annual trade growth (relative to the average)		R&D intensity (R&D as % of value added)	
No.	Sector	1973-81	1982-90	1973-81	1982-90	1977	1986
1	Food, drink and tobacco	-9.82	-31.86	0.87	0.88	0.75	1.11
2	Textiles, footwear and leather	-64.64	-9.48	0.69	1.13	0.34	0.59
3	Wood, cork and furniture	0.60	-4.06	0.77	1.16	0.33	0.40
4	Paper and printing	-16.64	13.78	0.96	1.22	0.58	0.57
5	Industrial chemicals	84.97	-0.56	1.21	1.09	6.54	8.47
6	Pharmaceuticals	-1.38	6.01	1.01	1.09	14.66	17.17
7	Petroleum refineries (oil)	53.87	-60.95	1.54	0.11	3.99	5.50
8	Rubber and plastics	5.13	2.26	1.07	1.19	2.73	2.67
9	Stone, clay and glass	1.46	-4.64	0.99	1.03	1.33	2.75
10	Ferrous metals	-36.14	-56.30	0.77	0.54	1.50	2.62
11	Non-ferrous metals	-9.08	-15.05	0.86	1.01	2.30	3.70
12	Fabricated metal products	23.54	-27.01	1.22	0.78	0.82	1.47
13	Non-electrical machinery	-46.45	-24.45	0.95	1.00	2.97	4.68
14	Office machines and computers	0.61	65.09	1.13	1.77	24.04	27.42
15	Electrical machinery	24.72	12.68	1.24	1.19	9.63	8.58
16	Communic. eq. and semiconductors	2.52	59.48	1.05	1.44	14.77	20.74
17	Shipbuilding	-41.08	-18.35	0.33	0.10	0.78	1.33
18	Other transport	-6.08	-8.65	0.88	0.52	3.76	10.32
19	Motor vehicles	11.32	69.85	1.05	1.24	6.57	11.35
20	Aerospace	3.50	22.79	1.26	1.31	44.78	42.30
21	Instruments	11.04	15.39	1.18	1.18	6.08	9.86
22	Other manufacturing	8.03	-6.00	0.98	1.03	1.91	1.63

* Note: See definition in Equation 4.

between growth of different sectors, over time emerge, as e.g. the high speed of growth for the two ICT sectors (office machinery and computers; and communication equipment and semiconductors) in the 1980s as compared to the growth in the 1970s, is clearly evident. Also the effect of the stark fall of oil prices between the 1970s and the 1980s, is evident from Table 3, as well as is the decline of the industrial chemical sector.

In addition, Table 3 contains calculations on annual growth rates, expressed relative to the average, across the 22 sectors (using the end years). It can be seen that the measure based on the CMS growth vectors (TG_{ij}), broadly corresponds to the calculations based on annual growth

Table 4: Correlation matrix (Spearman) between trade growth (*TG*) and R&D intensities (n=22)

	Trade growth 82-90	RD int. 1977	RD int. 1986
Trade growth 1973-1981	0.313	0.486	0.395
P-value	*0.156*	*0.022*	*0.069*
Trade growth 1982-1990		0.584	0.566
P-value		*0.004*	*0.006*
RD int. 1977			0.971
P-value			*0.000*

rates. However, there are some differences between the results, based on two measures. One such difference concerns e.g. ‘wood cork and furniture’, where the TG_{ij} measure indicates that the sector has grown slower than average over the 1980s, whereas the annual growth rate calculation points to a growth rate higher than the average. The difference is due to the fact that TG_{ij} takes into account the importance of the sector’s importance for the overall *level* of exports. Hence, the negative TG_{ij} value is due to the fact that the sector has not grown much in terms of volume. The same phenomena can be observed for ‘office machines and computers’, where the importance for overall exports was not so large in the 1970s, although the annual growth rate was factor 1.13 larger than the average growth rate.

Table 4 contains simple correlations, based on Table 3. First of all it can be seen that R&D intensities are very stable over time (σ=0.971), while the growth of various sectors (measured as TG_{ij}) appears to be much more volatile over time (a non-significant σ). Nevertheless, the most important observation coming out of Tables 3 and 4, is that *in general* fast-growing sectors are high-tech, as the Spearman rank correlations, in Table 4, display a positive and significant relationship between R&D intensities on the one hand, and relative trade growth on the other.

4. Conclusions

The aim of this paper was to investigate empirically, whether or not Ricardian trade specialisation matters for economic growth at the level of the country (18 OECD countries); that is, whether or not initial specialisation in, or a movement into fast-growing sectors, matters for economic growth.

The dependent variable was annual data on economic growth, in the period 1972-1990. The independent variables were the four CMS effects, as well as the initial level of income relative to the US (a catching up variable); growth in terms of technology, based on number of US patents held by the firms of the country in question; and growth in terms of the capital stock.

The results displayed that the fixed effects model is the most appropriate technique, and that using this tool, the initial level of income (the catch up variable) was significant and had a negative sign as expected. The investment (growth of the capital stock) variable was also significant, while the technology variable was significant only through its interaction with the growth of the capital stock variable. The growth adaptation effect was the only significant variable (positive sign) of the CMS effects. Hence, it was concluded that a certain dynamism in terms of structural *change* is required by countries in order to achieve high levels of economic growth at the macro level.

The final part of the paper dealt with the question of whether the fast-growing sectors (as measured in the CMS analysis) are high-tech or not. Based on a comparison between the OECD growth vector from the CMS analysis, on the one hand, and R&D intensities in the 22 sectors (for the 1970s and for the 1980s), on the other, it was concluded that the fast-growing sectors are in general also high-tech sectors.

If the results of this paper are compared to the empirical earlier findings, discussed in Section 2, the findings all points to the importance of economic structure for economic growth performance. However, some possible contradictions can be identified, although the empirical set-ups vary greatly amongst the studies. For instance, the finding of Dalum, Laursen and Verspagen (1996) at the sectoral level, stating that initial specialisation in certain types of activities matters for economic growth, could not be confirmed at the aggregate country level used in this paper, as the ‘structural effect’ could not be shown to have any impact on economic growth. Likewise, the finding by Meliciani and Simonetti (1998) showing that initial specialisation in fast-growing technological classes (based on patent data) has an impact on economic growth (although only for a certain period) could neither be supported by the trade data applied in this paper. Given these observations, it is an important task for future research to investigate whether the apparent contradictions between the studies are due to the different empirical set-ups, or whether the differences in terms of results are due to real world phenomena.

Such a task should be fulfilled by applying the same methodology on the various types of data.

It should be pointed out that the present paper (as most other papers in this field) probably underestimates the effects technology as a determinant of economic growth, as technological spill-overs from other sectors are not included in the model. The task of including such spillovers is an important task for future research. Another limitation of this paper is the exclusion of specialisation in services. As the service sector makes up a large part of the economies i advanced countries, specialisation in certain types of services could be an explanatory factor in accounting for economic growth, especially in advanced countries.

The prime aim of the present paper was to identify some of the sources of economic growth, among countries. Given the results of the analysis, our claim is that this aim has been achieved. However, it is important to stress a distinction between analytical results on the one hand, and policy implications on the other hand, as analytical results might not easily translate into straight forward policy conclusions. Our finding stating that countries which adapt their specialisation pattern in the direction of fast-growing sectors, grow faster than the average of countries, seems to suggest that there is some room for active technology and industrial policies, attempting to influence specialisation patterns of countries, even though it is a 'stylised fact' that specialisation patterns both in trade and technology are known to be very stable over time (Cantwell, 1991; Dalum *et al.*, 1998). However, as it is a 'stylised fact' that technological innovation involves fundamental uncertainty (Dosi, 1988), it might be difficult (if not impossible) to predict precisely which sectors are going to grow fastest *ex ante*. An indication of this problem was hinted in Section 3.3, given the fact that the fast-growing sectors are different ones over time; in this case between the 1970s and the 1980s.

References

Amable, B. 1997, 'The effect of foreign trade specialisation on growth: Does specialisation in electronics foster growth?', paper presented at the Conference on 'trade economic integration and social coherence', Vienna, Austria.

Amable, B. and B. Verspagen, 1995, The role of technology in market shares dynamics, Applied Economics 27, 197-204.

Cantwell, J., 1991, Historical trends in international patterns of technological innovation, in: J. Foreman-Peck (Editor), New perspectives on the late Victorian economy (Cambridge University Press, Cambridge).

Dalum, B., K. Laursen and B. Verspagen, 1996, Does Specialization Matter for Growth?, Technology, Economic Integration and Social Cohesion (TEIS) Working Paper no. 5 (MERIT, University of Maastricht, Maastricht).

Dalum, B., K. Laursen and G. Villumsen, 1998, Structural Change in OECD Export Specialisation Patterns: De-specialisation and 'Stickiness', International Review of Applied Economics 12, 447-467.

Dosi, G., 1988, Sources, Procedures and Microeconomic Effects of Innovation, Journal of Economic Literature 26, 1120-1171.

Dowrick, S., 1997, Innovation and Growth: Implications of the New Theory and Evidence, in: J. Fagerberg, L. Lundberg, P. Hansson and A. Melchior (Editors), Technology and international trade (Edward Elgar, Cheltenham).

Grossman, G.M. and E. Helpman, 1991, Innovation and Growth in the Global Economy (MIT Press, Cambridge Massachusetts).

Hansen, J.D., 1997, Dynamic comparative advantage in a Ricardian model, in: J. Fagerberg, L. Lundberg, P. Hansson and A. Melchior (Editors), Technology and international trade (Edward Elgar, Cheltenham).

Hausman, J., 1978, Specification Tests in Econometrics, Econometrica 46, 1251-1271.

Kaldor, N., 1966, Causes of the Slow Rate of Economic Growth of the United Kingdom (Cambridge University Press, Cambridge).

Kaldor, N., 1970, The Case for Regional Policies, Scottish Journal of Political Economy 17, 337-348.

Krugman, P., 1987, The Narrow Moving Band, the Dutch Disease, and the Competitive Consequences of Mrs. Thatcher: Notes on Trade in the Presence of Dynamic Scale Economics, Journal of Development Economics 27, 41-55.

Krugman, P., 1994, Competitiveness: A Dangerous Obsession, Foreign Affairs 73, 28-44.

Lundvall, B.-Å., (Editor), 1992, National Systems of Innovation. Towards a Theory of Innovation and Interactive Learning (Pinter Publishers, London).

McCombie, J.S.L. and A.P. Thirlwall, 1995, Economic Growth and the Balance-of-Payments Constraint (St. Martin's Press, New York).

Meliciani, V. and R. Simonetti, 1998, Specialisation in Areas of Strong Technological Opportunity and Economic Growth, in: G. Eliasson, C. Green and C. McCann (Editors), Microfoundations of Economic Growth (University of Michigan Press, Ann Arbor).

Nelson, R.R., (Editor), 1993, National Innovation Systems: A Comparative Analysis (Oxford University Press, New York).

Pavitt, K., 1984, Sectoral Patterns of Technical Change: Towards a Taxonomy and a Theory, Research Policy 13, 343-373.

Soete, L.L.G., 1981, A general Test of the Technological Gap Trade Theory,

Weltwirtschaftliches Archiv 117, 638-666.
Thirlwall, A.P., 1979, The Balance of Payments Constraint as an Explanation of International Growth Rate Differences, Banca Nazionale del Lavoro Quarterly Review, 32, 45-53.
Verspagen, B., 1993, Uneven Growth Between Interdependent Economies (Edward Elgar, Aldershot).

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The Research Programme

The DRUID-research programme is organised in 3 different research themes:
- The firm as a learning organisation
- Competence building and inter-firm dynamics
- The learning economy and the competitiveness of systems of innovation

In each of the three areas there is one strategic theoretical and one central empirical and policy oriented orientation.

Theme A: The firm as a learning organisation

The theoretical perspective confronts and combines the ressource-based view (Penrose, 1959) with recent approaches where the focus is on learning and the dynamic capabilities of the firm (Dosi, Teece and Winter, 1992). The aim of this theoretical work is to develop an analytical understanding of the firm as a learning organisation.

The empirical and policy issues relate to the nexus technology, productivity, organisational change and human ressources. More insight in the dynamic interplay between these factors at the level of the firm is crucial to understand international differences in performance at the macro level in terms of economic growth and employment.

Theme B: Competence building and inter-firm dynamics

The theoretical perspective relates to the dynamics of the inter-firm division of labour and the formation of network relationships between firms. An attempt will be made to develop evolutionary models with Schumpeterian innovations as the motor driving a Marshallian evolution of the division of labour.

The empirical and policy issues relate the formation of knowledge-intensive regional and sectoral networks of firms to competitiveness and structural change. Data on the structure of production will be combined with indicators of knowledge and learning. IO-matrixes which include flows of knowledge and new technologies will be developed and supplemented by data from case-studies and questionnaires.

Theme C: The learning economy and the competitiveness of systems of innovation.

The third theme aims at a stronger conceptual and theoretical base for new concepts such as 'systems of innovation' and 'the learning economy' and to link these concepts to the ecological dimension. The focus is on the interaction between institutional and technical change in a specified geographical space. An attempt will be made to synthesise theories of economic development emphasising the role of science based-sectors with those emphasising learning-by-producing and the growing knowledge-intensity of all economic activities.

The main empirical and policy issues are related to changes in the local dimensions of innovation and learning. What remains of the relative autonomy of national systems of innovation? Is there a tendency towards convergence or divergence in the specialisation in trade, production, innovation and in the knowledge base itself when we compare regions and nations?

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