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Productivity Growth and Trade Specialization

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1. Introduction

The productivity panic in Canada continues unabated with little resolution yet as to what the major proximate causes of the decline in Canadian living standards might be attributed. The long standing gap in Canada-U.S productivity levels remains a continuing puzzle which thus far has defied a single coherent explanation. Andrew Sharpe in his overview paper covers a number of the potential explanations. This paper focuses on the class of explanations which are primarily motivated by the role of international trade as it relates to manufacturing and productivity growth rates between countries. Now it is entirely possible that the 'reasons' for the gap have nothing to do with trade per se. Other explanations may ultimately prove to be more compelling. However the interaction between trade and productivity growth has historically been important, and in the Canada-U.S. case the substantial growth in trade volumes in the last two decades strongly suggests that the two trends might be related.

Why should one focus on explanations related to trade in particular? There are at least three reasons why trade and trade patterns are potentially important explanations of the gap. First, trade breaks the direct link between productivity and real incomes that holds in closed economy models. Two, Canada-U.S. trade volumes are amongst the largest in the world, and Canada is heavily specialized by region in its trade with the United States[1]. Close to 90 percent of Canadian manufacturing exports go to the United States. The growth in trade and openness vis-a-vis the U.S. has been nothing short of phenomenal in the 90's with export to GDP ratios going from the 25 percent range to the 40 percent range in a decade. The well documented convergence effect should have been working in Canada's favor--with Canada catching-up to the US after the implementation of the FTA/NAFTA, but this does not appear to be the case. Third, the increased trade and factor mobility, including the mobility of knowledge, has raised the counterfactual question as to how North American regional specialization is likely to evolve and where the Canadian regions might fit in that broader pattern.

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[1] See Grady and MacMillan(1998).

Even within the class of 'trade explanations' the analyst is confronted with a serious problem in sorting out measurement issues , competing hypotheses, causality versus correlation, and data constraints. This paper is an attempt to sort out some aspects of this puzzle. Ideally one would like to have a tight theoretical framework in which to conduct the data analysis. Part of the problem however is that different theories of trade suggest different interpretations, and ourpurpose here is not to test a particular trade theory. It is useful thought to review briefly what two major trade theories, an amended version of Heckscher-Ohlin for productivity differences, and the Ricardian trade model, have to say about changes in productivity and trade. The paper then goes on to look at the productivity growth process in Canadian manufacturing and its interaction with trade. Again here there are many alternative theories of endogenous productivity change which have been advanced in the last decade (Grossman and Helpman(1991)) which suggest different causal linkages between trade and productivity growth. The most famous of these is Baumol's convergence hypothesis, and empirically there is a fairly strong aggregate evidence for conditional convergence which tends to be faster the greater the degree of openness.

A trade explanation for the Canada-U.S. gap in productivity levels, or the persistence of the gap, could arise in at least two different ways. Think of a general model with a two way linkage running between trade and productivity growth. Productivity patterns influence trade patterns through comparative advantage effects, and trade influences productivity growth through a variety of endogenous growth mechanisms. Both trade specialization and productivity change over time as a consequence of long lived investment decisions by governments and firms. Moreover policy and luck can have a significant influence on how a country specializes and the success of attempts to invest in productivity improvements. Ex post a gap can increase or persist for two quite different reasons.

a. The pattern of investments in specialization turn out to be inconsistent with the sectors/industries in which productivity improvements are most successful.

b. The pattern of productivity improvements are not in those areas which have the highest rates of growth in demand in external markets. a f

The first hypothesis suggests that for some reasons the economy tended to allocate resources towards the sectors which had lower productivity potential. The second set of reasons suggests that the productivity growth process itself has been in the wrong direction, or at least inconsistent with external developments. It should be recognized that in both cases we are looking for plausible ex post rationalizations for the gap. It is important to remember that Canada's poor productivity performance is hardly novel among the OCED countries. For other countries that have been low on the productivity pole, for e.g. Norway, Australia and the United Kingdom, similar concerns have been expressed. For many years U. S. productivity growth lagged European growth rates and it is only the more recent years which show signs of a significant acceleration of U.S. productivity growth. Owever explanations which may be valid in each of those cases may not be valid in the case of the Canada-U.S. comparison.

2. Productivity and Trade Theories.

In this section I want to review two major trade theories and discuss how international productivity differences are manifested in trade patterns, and how productivity growth and levels are affected by trade. The two main theories are a) the Hecksher-Ohlin framework amend to incorporate neutral productivity differences. And b) the Ricardian and other models of trade specialization.

2. a) Heckscher-Ohlin with Neutral Productivity Differences.

This set of theories is most closely related to the various measurement frameworks which emphasize TFP accounting at the sectoral level, and PPP adjustments for constructing comparable real output levels comparisons. It would be reasonable to claim that the bulk of the measurement literature falls within this framework. To keep matters simple think of a two country framework. The Home country (Canada) corresponds to the variables without an * and the US variables will be denoted by an *. We ignore third countries.[2] There are n homogenous tradable goods, trading under

[2] In the case of the smaller country Canada who is assumed to be a price taker in world goods markets in this theory, ignoring third country issues is not that important.

conditions of non-distorted free trade at prices P_i. Each good i can be thought of a produced under competitive classical constant returns conditions with output Y_i of good i the home and foreign country are given by

$$Y_i = A_i F_i (K_i, L_i, M_i)$$

$$Y_i* = A_i * F_i * (K_i *, L_i *, M_i *)$$

where the inputs are capital labour and materials. The materials input M_i a sub-aggregate of the n traded goods. The Hicks neutral productivity differences are the terms A_i One can disaggregate capital and labour and quality adjust. Trade is explained both by productivity differences A/A* and by factor endowment differences K/K* etc. Countries tend to export goods which are intensive in the use of their abundant factor and goods in which they have a comparative advantage as measured by A_i/A_i*. Factor prices in equilibrium reflect average productivity differences between countries.

The substitution aspects of the technology as summarized in the functions F_i and F_i* are usually taken as similar across countries. If both the F_i and A_i are different across countries, then the H-O-V model of trade does not have an predictive content. In any case provided one can measure either growth rates of TFP or do levels comparisons provided are outputs and inputs can be measured in comparable units across countries.

The HOV model without specialization assumes all goods are produced in all countries. This is usually implemented at the 2 or 3 digit industry level with an explicit assumption that the steel industry in Canada, for example, is producing a homogeneous output which is the same as that produced in the United States. This allows meaningful comparison of both average labor productivity, ALP, and TFP across the same sectors. The HOV framework automatically both suggests and constrains the manner in which the productivity trade question is framed.

Real incomes, the gap and terms of trade effects

Most Canadian economists are familiar with this model. Canada is usually treated as a small open economy. If we think of manufacturing as one large sector with resources K and L available, the production sector equilibrium can be represented by the manufacturing GDP function

$$G(p,A,K,L) = \max_{k,l,y}\left\{\sum_{i)} p_i Y_i : Y_i = A_i F_i(K_i, L_i); \sum_i K_i = K; \sum_i L_i = L\right\}$$

where p is the vector of internationally determined goods prices. If we normalize GDP say by dividing by the number of workers L in each country relative GDP per worker (v/v*) is measured by

$$v / v^* = \frac{G(p,A,K,L)/L}{G(p,A^*,K^*,L^*)/L^*}.$$

Changes in productivity holding all else constant will change the gap. In fact the change in manufacturing GDP due to a change in the productivity of sector i TFP A_i alone is given by

$$\hat{v} = s_i \hat{A}_i$$

where s_i is the value share of sector i's output in total manufacturing output, and hats denote percentage changes. The change in the total gap reflects therefore the growth rates of the TFP's in both countries and the relative output shares in each country.

In this amended HOV model with productivity differences the gap for a small open economy is either due to factor endowment differences, or to TFP differences. Note that the theory is dependent only on international prices, p and supply side effects of technology or resources. Over time as the PPF's of the two economies shift out in theory competitive markets will choose the GDP maximizing resource allocation given the evolution of exogenous productivity patterns. In practice however economies do not costlessly and instantly change sectoral patterns of specialization. Large investments are required in both physical and human capital for this to occur. Moreover taxes, subsidies, and other economic policies can affect this resource allocation. Ex post therefore we can ask whether the revealed pattern of specialization is consistent with one predicted by the theory--that is did specialization occur in sectors with the highest productivity growth and most advantageous terms of trade shifts?

2.b Ricardian International Specialization

An alternative to the Heckscher-Ohlin framework and one with quite different implications resides in the famous Ricardian model of trade in which economies specialize through trade in different goods. International specialization implies that the set of goods across which comparisons are made are increasingly disparate--that is they involve comparing apples and oranges. Or to put it more specifically a steel plant in Hamilton may be producing a different set of products than a steel plant in Buffalo and thus productivity comparisons are not easily made or in fact even possible. Countries will differ in aggregate productivity levels depending upon how one weights the different outputs each country produces. More generally this approach suggests the following:

- One, as production becomes internationally specialized the real growth effects of productivity change will be increasingly transmitted through terms of trade changes in the short to medium term, and over the longer term in changes in the particular pattern of specialization.
- Two, relative real income levels are ultimately dependent upon the pattern of specialization. A country will tend to have a higher relative income the larger the share of global spending on manufactures that fall on its goods. Productivity is important because is determines which goods a nation specializes in.

As the Ricardian trade theory fallen out of style in recent years it may be useful to review its productivity implications. To do this we lay out a simple three good, two country model.

A Ricardian Model of Productivity Growth

In this section a simple two country version of trade and specialization is reviewed. The model is quite traditional except for the introduction of a non-traded good in each country (good 1) to add a necessary dose of realism, and one quite important from the perspective of interpreting measurement exercises. There are two trade goods (2 and 3) and two countries Home and Foreign. The Foreign country is denoted by a * superscript on most variables. What is slightly novel is that we shall focus on an equilibrium with international specialization, and secondly one which is in steady-state growth equilibrium but with exogenous productivity growth across all activities.

Output of each good i is denoted by Y_i and a value added input aggregator whose quantity is denoted by L_i and whose nominal factor price is W. Hence forth this factor will simply be called 'labour'. Factors are mobile between sectors but not countries. Each sector has a constant returns production function

$$Y_i = A_i L_i \qquad i = 1,2,3$$

In equilibrium with competition goods price P_i and the economy wide factor price is given by

$$P_i = \frac{1}{A_i} W$$

The growth rate of any particular variable will be hatted ie ^. The growth rate of rate of average labour productivity in sector i is denoted by g_i so that

$$\hat{A}_i = g_i$$

Labour market clearing requires that the inelastically supplied labour endowment L equals labour supply to each sector; $L = L_1 + L_2 + L_3$. To keep things simple assume Mill-Cobb-Douglas preferences on the part of all consumers with expenditure shares α_i. Demand for each good i is then given by

$$D_i = \frac{\alpha_i WL}{P_i} = \alpha_i A_i L$$

and supply is given by

$$S_i = A_i L_i$$

In autarky market clearing implies that labour is allocated according to the rule

$$L_i^a = \alpha_i L$$

Real income (as calculate by the indirect utility function of the representative Mill consumer) is denoted by U and

$$U = \frac{I}{P_1^{\alpha_1} P_2^{\alpha_2} P_3^{\alpha_3}} = \frac{WL}{\left(\frac{W}{A_1}\right)^{\alpha_1}\left(\frac{W}{A_2}\right)^{\alpha_2}\left(\frac{W}{A_3}\right)^{\alpha_3}} = LA_1^{\alpha_1} A_2^{\alpha_2} A_3^{\alpha_3}$$

The growth of real income will be denoted by y--this is what we would conventionally think of as the appropriate index of the change in living standards if we hold L fixed. Assume there are no issues of labour force participation or hours worked. For the most part we will stick with this interpretation. In general with increases in L the aggregate change in real income is given by

$$y \equiv d\,log\,U = \hat{L} + \alpha_1 g_1 + \alpha_2 g_2 + \alpha_3 g_3$$

The important point here is that in a closed economy the aggregate change in living standards is given by the weighted sum of productivity growth rates in each of the three sectors with weights corresponding to expenditures shares.

International Trade and Specialization

We now introduce trade between the two countries. We shall use the convention of taking tothe price of non-traded goods in the foreign country as the numeraire. (You can think of this as simply US dollars to measure all values in). With this normalization wages in Foreign are simply equal to productivity in the non-traded sector in foreign, so that $Set\ P_1^* = 1 \Rightarrow W^* = A_1^*$.

We now want to concentrate on an equilibrium in which both countries are specialized. As the number of goods becomes large this will be the 'normal case'. Country size is reflected in the number of goods each country is specialized in. Assume therefore that Home is specialized in good 2 and Foreign in good 3. This will require that in equilibrium the unit cost of producing good 2 is no greater in Home than in Foreign, and conversely for good 3. Hence it must be the case that

$$c_2 = \frac{1}{A_2} W \leq \frac{W^*}{A_2^*} \qquad and \qquad \frac{1}{A_3} W \geq \frac{W^*}{A_3^*}$$

Together these imply the following comparative productivity inequalities which imply that Home has a relative productivity advantage in good 2 and Foreign in good 3;

$$\frac{A_3^*}{A_2^*} \geq \frac{A_3}{A_2}$$

A number of important and interesting implications follow from this simple model. First relative wages (the factoral terms of trade) reflect taste and aggregate endowments--not relative productivities/

$$\frac{W}{W^*} = \frac{L^*}{L}\left(\alpha_2 / \alpha_3 \right).$$

Real income growth in Home and Foreign (lower case y) is given by the equations

$$\begin{aligned} y &= d\ \log u \\ &= \alpha_1 g_1 + \alpha_2 g_2 + \alpha_3 g_3^* \end{aligned}$$

$$\begin{aligned} y^* &= d \log u^* \\ &= \alpha_1 g_1^* + \alpha_2 g_2 + \alpha_3 g_3^* \end{aligned}$$

This equation illustrates a simple and important result. Real income growth is identical in the two countries provided productivity growth is the same in both countries non-traded sectors. Thinking of manufacturing as 'traded goods';this implies that differential rates of growth of productivity in manufacturing do not lead to differential rates of growth in real income. Why? Real income growth and GDP growth diverge however in this framework due to the presence of terms of trade effects. Real GDP growth calculated as the weighted average growth rates of sectoral growth, with the weights corresponding to value of output weights. In equilibrium the value share of output devoted to sector 1 is in fact constant since

$$Y_1 = A_1 L_1 = \alpha_1 A_1 L_1$$

$$Y_2 = (1 - \alpha_1) A_2 L$$

and thus

$$S_1 \equiv \frac{P_1 Y_1}{P_1 Y_1 + P_2 Y_2} = \frac{\alpha_1 \frac{W}{A_1} A_1 L}{WL} = \alpha_1$$

The growth rate of real GDP in Home is given by

$$r \equiv \alpha_1 g_1 + (1 - \alpha_1) g_2$$

The *difference* between growth rates of real income and GDP in Home are given by

$$\mathrm{y} - \mathrm{r} = \alpha_1 \mathrm{g}_1 + \alpha_2 \mathrm{g}_2 + \alpha_3 \mathrm{g}*_3 - \alpha_1 \mathrm{g}_1 - (1 - \alpha_1) \mathrm{g}_2$$

$$= (\alpha_2 + \alpha_1 - 1) \mathrm{g}_2 + \alpha_3 \mathrm{g}*_3 = \alpha_3 (\mathrm{g}*_3 - \mathrm{g}_2)$$

The implications of this equation are that real income and real GDP growth will diverge to the extent that growth rates of productivity of the goods in which each country has specialized have diverged. In particular has Home has specialized in good 2, if productivity growth in Home industry 2 proceeds at a faster pace than productivity growth in Foreign's exports sector 3, Home will have GDP growth which is faster than real income growth. Real output gains on the GDP side are more than offset by terms of trade losses. The argument is completely symmetric and the opposite would hold for foreign.

Simple levels comparisons on productivity in a model with complete specialization could try to measure of A_2/A_3. It should be clear that in this model the actual value of these relative productivities are not directly related to the relative real incomes. Indeed this ratio (the 'gap') could diverge or converge and have no impact on relative real incomes. The real income in each country is the Wage divided by the cost of living index dual to the Cobb-Douglas utility function. This v and v* denote real income levels per unit labour in Home and Foreign. In a free trade equilibrium we have that the ratio of real value added (or real income) per unit of composite factor is given by

$$\frac{v}{v*} = \frac{L*}{L}(\frac{\alpha_2}{\alpha_3})(\frac{A_1}{A_1^*})^{\alpha_1}$$

Note that relative real incomes reflect the *demand side* of the model. In particular the ratio of expenditure shares on the goods in which each country has specialized affect relative real incomes. Holding productivity in services constant a country tends to be relatively better off--that is it has a higher relative real income to the extent a larger share of expenditures on manufactures falls on its manufacturing sector. Furthermore if expenditure shares change over time, a country specialized in a good with a growing expenditure share will tend to have a rising relative income. Productivity affects the gap, as measure by v/v*, only to the extent that it affects the patterns of specialization.

To address the question of changes in the patterns of specialization would really needs a dynamic model. In the short run it is useful to think of the pattern of specialization as being fixed and only changing slowly. This simple model can be generalized in a number of ways. In fact there are a variety of trade theories which hinge on some combination of scale economies at the level of the firm or plant, and either vertical or horizontal product differentiation which give rise to similar results. The important point to emphasize is that unlike the HOV model the demand side matters. A country that is specialized in a good with a high growth in demand will experience a rising real income level. Demand might shift in favor of one country because it develops new goods which the other country does not. Observed real income growth therefore reflects a combination of productivity changes on existing goods which are transmitted abroad through terms of trade changes, and real income increases due to the development of new goods or industries in the country in question has a comparative advantage.

3. The Dynamics of Productivity Growth

How does trade interact with productivity growth? In the HOV model productivity differences will have effects which tend to bias growth in favor of high growth sectors, given unchanged terms of trade. In the Ricardian model productivity growth will tend to shift specialization patterns towards sectors in which the country achieves comparative advantage (assuming policy allows this to happen). Much of the endogenous growth literature has been summarized in terms of the openness and convergence hypothesis which can be viewed as a reduced form specification of productivity dynamics consistent with either the Ricardian or HOV model an dsome unspecified process generating technological change both at Home and internationally.

1. Most of the explanations of why productivity differs tend to go strictly speaking beyond either the HOV or Ricardian framework, but the bulk of the literature tends to focus on *national specific explanations.*
2. Two of the most important explanations relating productivity growth to openness and trade have been a)the conditional convergence hypothesis. Countries with the lower TFP levels will tend, ceteris paribus to have productivity growth rates which are higher, and b) the spillovers approach which suggests that trade and foreign direct investment are important mediators of the transmission of technical change across counties. The latter is discussed by Jeff Bernstein at this conference.[3]

A typical convergence equation for productivity growth looks like

$$\hat{A}_i = \alpha_i + \lambda \left(\frac{A_i - A_i *}{A_i *}\right) + \gamma Z_i$$

Various theories offer different explanations for the determinants of the sector-country specific rates of technological change, and for the rate of convergence *s* λ as a function of the productivity gap. The set of variables Z may a number of other productivity growth drivers depending upon which endogenous growth theory is appealed to. Strictly speaking this equation is probably best viewed as a reduced form rather than a structural

[3] See also Bernstein(1996).

equation. It has been applied most frequently in the case of national economies, but there is now a growing literature which uses panel data for manufacturing industries to test for similar effects.

The issue of whether connditional-β convergence occurs in the manufacturing sector is far from resolved. There are a number of studies which document the non-convergence in measured productivity of the manufacturing sector industrial counties, a trend which began in the mid 1980's, after three decades of almost continuous convergence. The general convergence hypothesis seems to describe aggregate GDP OECD data fairly well and there is a large literature on this issue. At the sectoral level however there appears to have been an increase in dispersion of manufacturing productivity levels at least since the mid 1980's. Bernard and Jones(1996) report that substantial reductions in the β conditional convergence parameter suing average labour productivity data from the period 1970-1987 (β=-0.032) relative to the period 1975-87(β=-0.0275.) but in both cases are insignificant. The ratio between the least productive and most productive was 1.96 in 1987 and is at least as high as in 1975 using a variety of measures of productivity. More recent data using the OECD ISDB data show that as of 1996 the situation has changed little with substantial divergence between the leader country (the US) and all other countries on labour productivity. As is well known Canada using these measures Canada converged through the late 80's and subsequently has fallen behind the US substantially.[4]

There is now a large theoretical literature which argues that 'openness' affects productivity dynamics through a variety of channels. In the endogenous growth literature knowledge drives growth and openness will affect growth to the extent that its affects incentives to innovate, the underlying productivity of innovation or the transmission of research discoveries across national borders. One can classify these effects to the extent they effect (a) the rate of technological progress which is independent of the stock of ideas abroad , (b) the rate at which knowledge diffuses across international borders , and (c) the available stock of knowledge available internationally. Quantitatively an

[4] Specifically the OCED reports using value added per hour worked that Canada in 1985 stood at 85 percent of the US level and in 1996 was at 69 percent of the US level.

important question is whether openness has a more important effect on α or λ. The former or spillovers approach may reflect general spillovers associated with trade and Foreign Direct Investment while the latter 'convergence effect' bears directly on the technology which is available abroad and whom the trading partners are. In the case of Canada, a sudden forging ahead by the U.S. would be ultimately good news if the most important effect of openness is on the rate of convergence. However the absence of convergence of manufacturing productivity levels is the international analogue of the Canada-US gap problem. Is the convergence hypothesis incorrect or is something else at work?

In the case of nation specific explanations one looks for common national determinants of either the α or λ parameters. This can be applied fairly naturally in the HOV framework. One may also be interested however in sectoral differences in productivity growth--in particular is productivity growth concentrated in particular sectors due to differences in either openness or other variables?

A natural question to ask is whether productivity growth is forward looking. This makes sense as investments are required to produce productivity growth. Thus one could include under the list of Z factors which affect investments in productivity. Under the HOV framework it is natural to ask whether productivity growth has been concentrated in sectors with favorable terms of trade developments. In the Ricardian model demand variables could be important. That is did productivity growth occur in sectors with good growth in external demand, measured for example by either exports or other proxies for foreign demand?

4. Measuring Specialization

One prior question to ask is whether there is any evidence that specialization is becoming relatively more important as the Canadian economy has opened up to trade with the United States over the past two decades. There are a number of ways to do this. At a broad inter-industry level looking at industry importance by the share of value added the Canadian manufacturing structure remains remarkably stable. See table 1. The top 10 sector from 1988 to 1995 increased their share of total value from 46 percent to 50 percent. But once you get below the top two, Transportation Equipment and Pulp and Paper you get remarkably little variation over the period.

What about trade? First let's examine some traditional aggregate indexes of inter versus intro industry trade reported in Table 2. G, N and Z are the conventional indexes of gross, inter-industry and intra-industry trade (IIT index) on a bilateral basis. G is the sum of N and Z.[5] There have been substantial increases in intra-industry trade between Canada and the United States, but also in gross international specialization and inter-industry trade. The IIT index is conventionally taken as an indicator of increased horizontal specialization. At the level of individual sectors there are some sectors that have had substantial increases in intra-industry trade as reported in Table 3. Note that many of these industries are either intermediate or capital goods industries. This leads to the question of whether the specialization that is going on is primarily vertical or horizontal. It could be either but a number of studies for the EU suggest the pattern of specialization emerging there is primarily vertical.

[5] Fuentes-Godoy et al. (1996) provides a useful discussion of the use of trade specialization indexes.

Table 1

Top 10 Manufacturing Industries by Share of Value Added of Total Manufacturing

1988 and 1995

Top 10 1988	rank	share	Top 10 1995	share
TRANSPORTATION EQUIPMENT IND.	1	13.17	TRANSPORTATION EQUIPMENT IND.	16.154
PULP & PAPER INDUSTRIES	2	9.018	PULP & PAPER INDUSTRIES	10.019
INDUSTRIAL CHEMICALS INDUSTRIES	3	3.57	ELECTRONIC EQUIPMENT INDUSTRIES	4.12
NON-FERROUS SMELTING & REFINING	4	3.484	OTHER MACHINERY & EQUIPMENT	3.807
PRIMARY STEEL INDUSTRIES	5	3.402	SAWMILLS, PLANING & SHINGLE	3.186
OTHER MACHINERY & EQUIPMENT	6	3.306	INDUSTRIAL CHEMICALS INDUSTRIES	2.933
ELECTRONIC EQUIPMENT INDUSTRIES	7	3.134	PRIMARY STEEL INDUSTRIES	2.906
SAWMILLS, PLANING & SHINGLE MIL	8	2.938	NON-FERROUS SMELTING & REFINING	2.523
:OMBINED PUBLISHING AND PRINTING IND.	9	2.036	COMMERCIAL PRINTING	2.294
MEAT & POULTRY PRODUCTS	10	1.957	PHARMACEUTICAL & MEDICINE INDUS	1.927
Top 10 share of total value added mfg.		46.015		49.869

Table 2

Indices of Gross(G) , Inter-Industry(N) and Intra-Industry Specialization(Z) in

Aggregate Canadian Bilateral Trade between Canada and U. S. A.

Year	1980	1985	1988	1995
G	0.619	0.704	0.755	1.048
N	0.276	0.262	0.313	0.423
Z	0.344	0.442	0.442	0.625

Table 3.
Ranking of Industries Based on Changes in Intra-Industry Specialization Arising from Bilateral Trade between Canada and U.S.A During 1980 to 1988.

INDUSTRY	1980-1988	
	Ranking	Change in IIT index
OTHER FURNITURE & FIXTURE IND.	1	0.705
AGRICULTURE IMPLEMENT INDUSTRY	2	0.501
FISH PRODUCTS INDUSTRY	3	0.406
OTHER CONVERTED PAPER PRODUCTS	4	0.295
WIRE AND WIRE PRODUCTS INDUSTRI	5	0.274
GLASS & GLASS PRODUCTS INDUSTRI	6	0.262
HOUSEHOLD FURNITURE INDUSTRIES	7	0.235
TIRE, TUBE, RUBBER HOSE & BELTING and OTHER PROD.	8	0.230
PLASTIC & SYNTHETIC RESIN INDUS	9	0.226
HEATING EQUIPMENT INDUSTRY	10	0.185
AIRCRAFT, TRANSPORT, RAILROAD IND.	11	0.156
NATURAL FIBRE, CANVAS and RELATED PROD. .And OTHER TEXTILE PROD..	12	0.141
FOAM, PLASTIC, PIPE, PLASTIC FILM AND OTHER PLASTIC PROD.	13	0.133
COPPER ROLLING CASTING & EXTRUD	14	0.129
ALUMINUM ROLLING CASTING, EXTRU	15	0.128
REFINED PETROLEUM AND OTHER PETROLEUM AND COAL PRODUCTS IND.	16	0.117
OFFICE, STORE & BUSINESS MACHINERY	17	0.116
WOODEN BOX &PALLET, COFFIN AND CASKET IND.	18	0.111
VENEER AND PLYWOOD INDUSTRIES	19	0.106
COMMUNICATIONS, ENERGY WIRE & C	20	0.104

Trade in Intermediate Inputs and Vertical Specialization

There is growing evidence of increased trade in intermediate inputs, which reflects an increase in vertical international specialization. A number of studies have identified this phenomena in some cases as 'outsourcing', but more generally it can be thought of as increased two-way trade in intermediate inputs as global production chains become increasingly specialized. Measuring the increase in this trade is difficult but some recent estimates using input-output tables suggests it is growing. For products such as electrical machinery and transportation equipment estimates (see Table 4) for Canada suggest this trade appears to have been growing rapidly.

Table 4

Share of Imported to Total Intermediate Inputs (percent)

Country	1974	1984	1993
All Manufacturing Industries			
Canada	15.9	14.4	20.2
United States	4.1	6.2	8.2
Chemical and Allied Products			
Canada	9.0	8.8	15.1
United States	3.0	4.5	6.3
Industrial Machinery (non-electric)			
Canada	17.7	21.9	26.6
United States	4.1	7.2	11.0
Electrical Equipment and Machinery			
Canada	13.2	17.1	30.9
United States	4.5	6.7	11.6
Transportation Equipment			
Canada	29.1	37.0	49.7
United States	6.4	10.7	15.7

Notes: U.S. estimates are for 1975, 1985, and 1995.

Source: Campa and Goldberg (1997, Tables 1,3,5,7).

There appears to evidence of increases in specialization within Canadian trade patterns looked at from an intra-industry perspective and some weak evidence of increased specialization at the inter-industry level. In general it is supportive of Ricardian theories which appeal to specialization as a response to increased openness.

5. An Empirical model of Productivity Growth and Openness.

We now examine the empirical relationship between trade and productivity for Canadian manufacturing. To recall, there was evidence of the levels gap closing at the aggregate manufacturing level through the 80's; but since that time the gap appears to have widened. The data we use compares the 1980-88 period to the 88-95 period.[6] In a number of ways this particular comparison may be unfortunate. As is well known the Canadian economy was hit with a number of 'shocks' in the early 90's which may have exacerbated the economic situation, including a slowdown in productivity growth. These include tight monetary policy, a rapidly appreciating exchange rate, a political crisis, and a fiscal crisis which necessitated sharp reductions in spending. The net effect was a dramatic reduction in growth rates and as significant output gap according to conventional macroeconomic calculations. See Fortin(1996) for a discussion. In manufacturing the situation was not much better. According to BLS data there was a 5.75 percentage point gap in favor of the U.S. over the 1888-1995 period, between U.S. and Canadian manufacturing output growth. However even during the 1980's the situation was little different with US manufacturing output growth (cumulative) from 1980 to 1988 7 percentage points over the Canadian growth over the same period.

As noted in our previous discussion there are reasons to suspect a connection between productivity growth and openness. We estimate an empirical openness and growth equation for Canadian manufacturing for the period 1980-1995. We concentrate on the two periods 1980-88 and 1988-1995 with the 88 break corresponding to the last year prior to the CUSFTA. This also allows us to use some recent Industry Canada estimates of productivity growth. The dependent variable is the annual growth in TFP

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[6] This data was kindly provided to us by Industry Canada and is the outcome of a large study which is also being presented at this conference. See the paper by Wolong Gu and Mun Ho.

over the period express as a percentage. The openness variable can be measured in a variety of ways but we chose to use OPEN measured by the ratio of exports to shipments. The RATIO variable is the ratio of the Canadian to US TFP levels at the beginning of the period which reflects the productivity gap by industry. Other variables are incorporated including human capital (measured by the ratio of workers with university education to total workers) (HUMAN) and various indexes of demand growth (DEMAND) thought to be important from the Ricardian perspective.

$$GTFP_{it} = a_1 + a_2 OPEN_{it} + a_3 RATIO_{it} + a_4 HUMAN_{it} + a_5 DEMAND_{it} + \varepsilon_{it}$$

This was estimated as a panel across the two periods with 17 manufacturing industries, with some regressions including fixed effects for industries and a dummy for the post 88 period (time dummy) labeled FTA.. Results are reported in Table 5 for the models without industry fixed effects and Table 6 with industry fixed effects. The model without industry fixed effects has very little explanatory power. Adding Industry Fixed effects improves the R-square. Some comments on the results worth noting.

1. The levels RATIO variable and openness variable are invariably insignificant although of the correct sign when entered separately. However when entered interactively so that increased openness is more valuable to countries with a higher productivity gap, the coefficients become significant and of the correct sign. Thus contrary to the general pessimism there appear to be evidence in favor of the conditional convergence effect for Canadian manufacturing industries.
2. The FTA time dummy appears with a negative coefficient in the non-fixed effects model. With industry fixed effects it is generally positive and marginally significant. Model 4 allows for a slope dummy on the Open/Ratio variable and while of the correct sign is not significant.
3. The Human capital variable generally is not significant which is somewhat surprising given that is has shown up in a number of aggregate convergence and openness studies.
4. The Demand growth variable is not significant without or without industry fixed effects. Two demand models were tried-model 6 with growth in the value of exports as the proxy for demand, and model 7 with U.S. output growth(real) proxying demand growth in the same industry

Table 5

Productivity Dynamics

CAN_GTFP	Model 1	Model 3
RATIO		
OPEN		
OPEN/RATIO	0.5037 0.4940	0.5177 0.490
FTA*OPEN/RATIO		
HUMAN		
DEMAND		3.67 2.9646
Time/Post FTA	-0.1791 0.22415	-0.2450 0.2287
R-squared	0.03815	0.0797

* Significant, 90%

** Significant, 95%

Table 6

Productivity Dynamics-Industry Fixed Effects

CAN_GTFP	Model 1	Model 2	Model 3	Model 4	
RATIO	-2.406	-1.149			
	1.316*	1.515			
OPEN		6.504			
		4.285			
OPEN/RATIO			7.041	6.088	
			2.484**	2.615**	2
FTA*OPEN/RATIO				1.032	
				0.9348	
HUMAN					
					1
Time/Post FTA	0.112 0.624	0.739 0.133	0.838 0.019	1.132 0.015	
R-squared	0.509	0.571	0.601	0.629	

* Significant, 90%

** Significant, 95%

Table 6, continued.

CAN_GTFP	Model 6		Model 7	
RATIO(CAN/US)				
OPEN				
OPEN/RATIO	7.185		6.957	
	2.423**		2.5619**	
FTA*OPEN/RATIO				
HUMAN				
DEMAND1	5.774			
	4.178			
DEMAND2			0.03513	
			0.1002	
Time	0.953	0.010	0.832	0.330
R-squared	0.644		0.604	

On average the combined coefficient on the gap and openness ratio seems to be in the range of 0.7 to 0.9. Given the increasing and substantial openness of the Canadian economy this suggests the substantial gap in productivity levels, which the Industry Canada study suggests stands at about 88 percent based on adjusted TFP comparisons. One can translate that into about a 0.4 percent convergence effect per year for an industry with an export to shipments ratio of 40 percent and the average productivity gap. On the issue of demand effects there is no evidence that productivity growth was concentrated in sectors with strong demand growth potential. We conclude (weakly) that at least on that score there seems to a case that Canadian manufacturing missed the boat in terms of concentrating its productivity efforts in those sectors where it could have had greater impact. We are cautious however in this interpretation for two reasons. First, there were a few sectors with spectacularly *negative* productivity growth in the 88-95 period including Printing. Lumber, and Stone, clay and glass products. It is possible the FTA, and possibly commodity price developments were responsible for the unusual productivity performance in these sectors. To the extent they constitute outliers they may seriously be biasing the results. One could of course go on extensive specification searches for other productivity drivers besides trade. Perhaps this conference will provide us some useful suggestions as where to look.

5. Explaining the Pattern of Export Growth

We now ask the reverse question to that posed in the last section. Is the pattern of trade which emerged over the period consistent with an improved aggregate productivity performance, or in fact was it counterproductive? Note that this is related to another well trodden issue --the testing of Ricardian trade models in which productivity explicitly appears as a determinant of relative costs. Choudri and Schembri(1998) have recently carried such an exercise using a more modern version of the theory. The purpose here thought is slightly different. We are not interested in testing a structural model of trade. Rather what is at issue here is the investment (and policy) decisions which within the manufacturing sector which led to the observed pattern of specialization in Canada and resulting export growth. To do this we estimate a simple model of real export growth (value of exports deflated by a general selling price index). In line with a variety of theories we expect the pattern of export growth to depend positively on productivity growth, relative price increases, and a number of other potential variables. Under the HOV model in particuular would like to control for factor intensity differences across sectors to pick up Rybczinksi effects but we will ignore these due to data problems. A failure to find growth positively associated with the cross sectional variation in TFP, particularly in the both FTA period, would be be a smoking gun indicative of a flawed pattern of comparative advantage. On the other hand if export growth is associated with TFP growth this particular class of explanations for the 'gap' may be suspect.

In the Ricardian framework there should be a similar set of forces at work, although ideally we would like to correct for other factors in addition to productivity which would have led certain export sectors to expand relative to others. Ideally one would like to control for the import competitiveness of the US industry. To do that we will use US productivity growth.

It is useful to begin with a couple of scatter plots for the two-digit data of output growth versus TFP growth and Relative Product Price changes. See figures 1 and 2 for the post FTA years. There is a positive but fairly weak correlation between TFP and output growth. With respect to relative prices however the expected positive association associated from a small open economy supply side model does not appear at first cut to be very evident. Other interpretations of this are obviously possible.

We begin first with the disaggregated 3-digit matched trade and industry data. Three models of export growth on TFP growth are estimated. Model 1 include industry effect, Model 2 does not have a time dummy for the FTA, and Model 3 has no industry fixed effects. In all cases the TFP growth variable is insignificant and in the case of Model 3 is actually negative. This suggests there is at first past little evidence of export specialization in those sectors where productivity growth was high.

Table 7

Export Growth and TFP: 104 Industries

D-Export Growth	Model 1	Model 2	Model 3
D-TFP growth	.700 0.5912	0.518 0.6039	-0.1822 0.4540
FTA dummy	-0.227		0.2079 1.931
R-square	.606	0.673	.0142*

** Adjusted R-square.*

The second model estimated is on the 2-digit data. In this case we control for two additional factors. First, relative price changes across industries, and second, productivity growth in the United States. Under the Ricardian model one would expect that strong U.S. productivity growth would reduce exports in Canada. The estimated model is a panel on the 80-88 and 88-95 periods using the same data as in the previous section. Export growth is the dependent variable denoted by D-X regressed on the change in Canadian TFP growth, D-TFPCAN, US-Productivity Growth, D-TFPUS, and changes in relative price, D-PRICE.

Model 1 is the basis model with all effects included (there are industry fixed effects in any of these results. Basically all the coefficients are insignficant, although the TFP growth rates comes out with the correct sign. The Relative price term is virtually insignficant in the models. The FTA dummy is postive in models 1 and 2 although its effect is not large. When the FTA coefficient is interacted with Canadian productivity growth this coefficent is significant. It remains signficant in fact with any of the other variables included or excluded.

In general the conclusion is basically mildly negative. There is little evidence that Canadian exports responded in a complementary way to the emerging pattern of productivity growth in the 80-95 period. More puzzling is the fact that patterns of relative export growth appear to be unrelated to relative price increases.

Table 8

Models of Export Growth

D-X Canada	Model 1	Model 2	Model 3
D-TFP CAN	.01408 .01238	0.0141 0.01194	
D-TFP US	-0.00103 0.0089		
FTA*D-TFPCAN			.0288** .0135
D-PRICE	0.0012 0.0069	0.001261	0.0025 .0058
FTA DUMMY	0.0403 0.01435	0.0403 0.0140	
R-Square	.21208		0.1209

Conclusion to follow:

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Figure 1

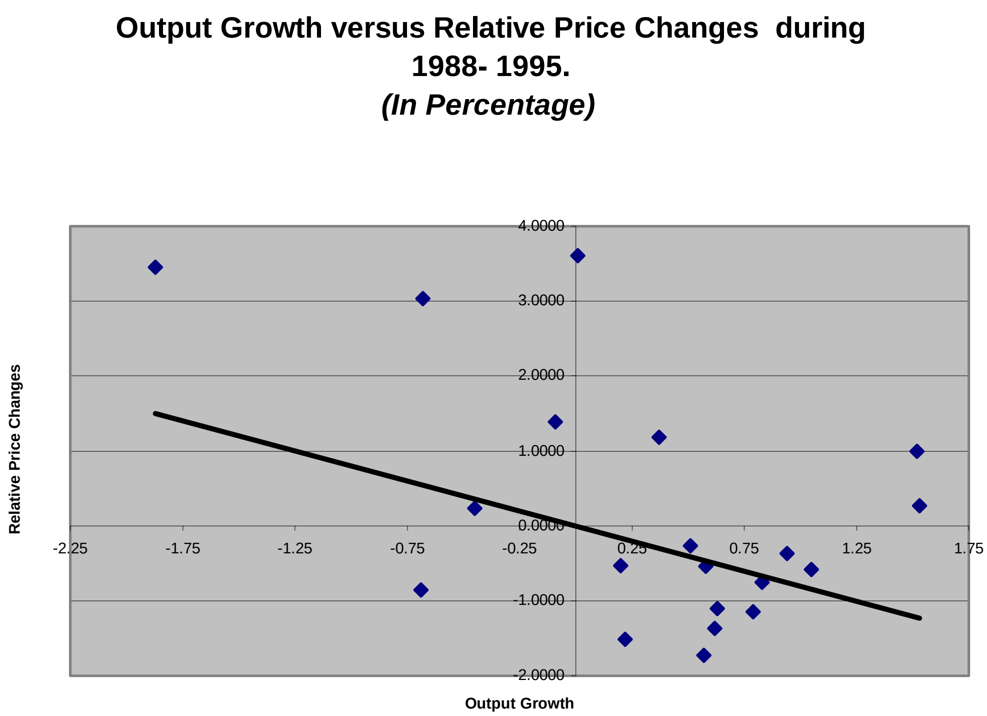

Figure 2