PER CAPITA INCOME CONVERGENCE AND THE ROLE OF INTERNATIONAL TRADE

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ABSTRACT

The recent literature on cross-country convergence of per capita income has largely ignored international trade. The reason might be perspective. Most convergence papers frame the analysis in a "Solow world" in which countries exist independent of one another. But most international trade economists have a very different perspective of a world in which countries exchange goods, factors, and ideas. The goal of this paper is to sketch out some basic relationships between per capita income convergence and international trade. First, I briefly summarize a few interesting recent papers which have linked income convergence to trade. Their common inference is that for countries which are both somehow linked by trade and converging, trade helps cause the convergence. Second, I critique these papers in light of some simple accounting and trade theory. The key point here is that countries trading is not sufficient proof that trade helps cause per capita income convergence. Finally, I give two examples applying some of these ideas to real-world data. The basic point of the paper is that more work is needed to document carefully both the exact mechanisms by which trade helps convergence and the relative contribution of trade and non-trade factors.

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Per Capita Income Convergence and the Role of International Trade

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In recent years most papers analyzing cross-country convergence of per capita incomes have ignored international trade. The reason might be perspective. Most convergence papers frame the analysis in a "Solow world" in which countries exist independent of one another (e.g., Robert J. Barro and Xavier Sala-i-Martin (1992)). Convergence arises from cross-country differences in rates of capital accumulation financed entirely by domestic savings. International linkages don't contribute to the process.

Most international-trade economists have a very different perspective of a world in which countries exchange goods, factors, and ideas. Here, international linkages are precisely what drive any convergence process. Free trade in goods can equalize factor prices across countries according to the factor-price-equalization (FPE) theorem; international flows of factors can converge endowments and factor prices; and international flows of technology can converge factor prices as well. From the usual "Solow" perspective international linkages don't matter, but from the trade perspective they are everything.

The goal of this paper is to sketch out some basic relationships between per capita income convergence and international trade. First, I briefly summarize a few recent papers which have linked income convergence to trade. Their common inference is that for countries which are both somehow linked by trade and converging, trade helps cause the convergence. Second, I critique these papers in light of some simple accounting and trade theory. The key point here is that countries trading is *not* sufficient proof that trade helps cause per capita income convergence. Finally, I give an example applying some of the critique to real-world data. The basic point of the paper is that more-careful work linking income convergence to trade would be a good thing.

I Literature Survey

Three interesting recent papers linking trade to per capita income convergence are Dani Ben-David (1993, 1996) and Jeffrey Sachs and Andrew Warner (1995). All of them document

historical episodes of income convergence across a group of countries that started out relatively "open" to each other (Sachs and Warner 1995), that liberalized trade policy among each other (Ben-David 1993), or that trade a lot with each other (Ben-David 1996). The common idea in these papers is that international trade helps cause per capita income convergence.

Using several criteria, Sachs and Warner classify each country in 1970 as either "open" or "closed" to international trade. From 1970 to 1989, only in the group of open countries did the poorer countries in 1970 tend to grow faster over the next 19 years. They conclude that *"the open economies display a strong tendency towards economic convergence ...* We suggest that the most parsimonious reading of the evidence is that ... the convergence club is the club of economies linked together by international trade" (p.41). Ben-David (1993) documents that during several episodes of trade liberalization in the European Community (EC), the dispersion of per capita income among the liberalizing countries (i.e., the standard deviation across countries of the natural log of income) shrank. He writes that "This paper provides evidence that movement toward free trade may actually ... [be] leading to a *reduction* in income disparity across countries ... The factor price equalization [FPE] theorem provides a framework for relating trade's impact on income convergence" (p.653). And Ben-David (1996) finds that from 1960 to 1989, groups of relatively wealthy countries which trade significantly among each other also tend to display significant per capita income convergence. He invokes the original thinkers behind the FPE theorem in concluding that "These findings would appear to corroborate the intuition of Heckscher and Ohlin that trade does indeed play an equalizing role" (p.294).

All these papers make an important addition to the literature on per capita income convergence by explicitly testing for the role of international trade. But in all three papers this test basically consists of first finding income convergence among countries which are somehow linked by trade and then inferring that trade caused the convergence. In the next section I discuss how reasonable this inference is in light of some basic accounting and trade theory.

II Income Convergence and Trade: Some Accounting and Theory

To frame the discussion it helps to write out the equation accounting for per capita income (pcgdp) in a simplified world with just labor and capital as factors of production.

$$(1) \quad pcgdp = \frac{National\ Income}{L} = \frac{w \times L + r \times K}{L} = w + r \times \frac{K}{L}$$

Here, L and K are the national endowments of labor and capital and w and r are the respective national factor prices for labor and capital. Equation (1) assumes that the total value of gross domestic output accrues as national income to the two domestic factors and that for each factor there is one national market.

From a "Solow" perspective per capita income convergence arises from per capita capital stock convergence. Identical production technologies and time preferences across countries ensures that all countries tend towards the same $(\frac{K}{L})$ and thus the same w and r as well.[1] How can international trade can affect Equation (1)? I discuss three possible ways common to many standard trade models.

First is the FPE theorem, probably the most-analyzed way that trade can affect per capita income. The FPE theorem says that under certain circumstances a country in free trade has factor prices equal to factor prices in the rest of the world. In both his studies Ben-David (1993, 1996) concludes that this theorem explains the episodes of per-capita income convergence he documents.

But this conclusion has some problems. One is that the FPE theorem describes outcomes in steady-state free-trade equilibria: it does not say anything about the process of trade liberalization. This is a problem because the convergence literature is all about the process of converging to steady-state. One can imagine a dynamic analog to the FPE theorem which captures the idea that freer trade should tend to converge factor prices across countries. Edward E. Leamer (1995) calls this analog the factor-price convergence (FPC) theorem: "When two countries eliminate their mutual trade barriers, product-price equalization eliminates factor-price differences" (p.7).

A second well-known problem with the FPE theorem is it holds only under a set of very strict assumptions. For example, in Paul Samuelson's (1949) early proof requires eight assumptions

including zero trade barriers, identical linear homogeneous technology and preferences across regions, and all regions producing all products. The same problem holds for the FPC theorem. Leamer writes that "it challenges us to find combinations of assumptions regarding factor-supply differences, technological differences, and numbers of factors and goods for which economic integration reduces international factor-price differences" (p. 7). Alan V. Deardorff (1986) provides a good theoretical example of how a slight change of assumptions can invalidate the FPC theorem. In his example the close substitutability of some products in demand means economic integration which converges international product prices actually diverges international factor prices. And Matthew J. Slaughter (1995) provides an empirical example. He finds that the construction of canals and railroads in the antebellum United States generated significant interregional commodity-price convergence but very little interregional FPC.

And a third problem is that the FPE and FPC theorems address only factor prices. As written in Equation (1), per capita income is clearly a combination of both factor prices and factor quantities: it is the wage plus the per capita share of the capital earnings. Thus even if trade is converging factor prices according to the FPC theorem, per capita income can still diverge if endowments across countries are becoming sufficiently dissimilar. Indeed, the standard two-country, two-good, two-factor Heckscher-Ohlin model permits FPE but not income equality. In this model trade arises only from cross-country differences in $(\frac{K}{L})$ which trade alone does not eliminate. Farhad Rassekh and Henry Thompson (1996) clearly demonstrate this point.

A second way that international trade can affect per capita income is by mediating international flows of technology. If countries have different levels of technology which can somehow transfer across countries, trade might be an important medium through which the technology actually flows. This might happen as countries reverse engineer their imports or through the interpersonal contacts that accompany trade.

Whatever the exact mechanism, international trade-mediated technology flows change countries' factor prices and thus per capita income. Given a country's endowment of inputs, improved technology implies higher marginal physical productivities for factors and thus

(*assuming* fixed world product prices) higher prices for these factors. To the extent that technology tends to flow from advanced to less-advanced countries, trade raises factor prices in less-advanced countries up towards the factor prices in advanced countries.

But as with FPE, linking trade-mediated technology flows to per capita income is subject to the caveat that per capita income also depends on factor quantities. Again, if endowments are diverging then any converging effect of trade via technology might be obscured in the income data.

A third way that international trade can affect per capita income is through trade in capital goods. Trading capital goods directly affects a country's per capita income through its endowment of factor quantities. Income convergence across countries might be caused by capital-poor countries importing lots of capital goods from capital-rich countries such that the $(\frac{K}{L})$'s converge across countries. But the earlier price-quantity caveat applies here, too. Any $(\frac{K}{L})$ convergence will show up in the income data only if factor prices across countries are either also converging or diverging at a sufficiently slow rate.

This brief discussion demonstrates that there are at least three ways by which international trade can affect the international dispersion of per capita incomes. There are a lot of more complicated issues here which are beyond the scope of this paper.[2] What are the general conclusions?

First, if trade alone is causing per capita income convergence then data on per capita income alone cannot identify the mechanism by which this is happening. FPE and technology transfers affect factor prices, but international trade in capital goods affects factor quantities. Determining the contribution of these various mechanisms requires additional data on factor prices and factor quantities--and perhaps further data as well.[3]

Second, in reality lots of factors other than international trade can affect per capita income. Convincingly demonstrating that trade is contributing to convergence requires controlling for all other non-trade issues. One obvious thing to control for would be domestic savings and investment as modeled in the "Solow" perspective. Another would be demographic changes across countries such as baby booms and immigration flows. A third would be international transfer payments. For example, within the EC member countries net transfer income from richer

countries to poorer countries through "structural adjustment" payments. Income convergence among EC members might have a lot to do with transfers rather than trade. Finally, a fourth issue would be political-economy stories which reverse the causality between trade and convergence to explain how convergence stimulates trade, not vice versa. Perhaps countries liberalize and thus trade more primarily with countries with whom they're already similar or converging for some non-trade reasons. Countries might do this because trade liberalization requires that very few political interest groups get hurt from trade. If trade with similar countries entails only small changes in product prices there will be very little internal income redistribution via the Stolper-Samuelson theorem.

Thoroughly following these two conclusions would be a very tall order. It would require very detailed data and some careful thinking about methodology. But clearly the suggestive results in Ben-David (1993, 1996) and Sachs and Warner (1995) can be extended in a number of directions. These authors identify cases where the evidence on per capita income seems consistent with trade causing income convergence. More work is required to go beyond consistency to try to demonstrate causality.

III Two Brief Examples Revisiting the Data

As a brief example of what kind of work might be done, I present some empirical results which highlight the two conclusions just discussed. All three papers by Ben-David and Sachs and Warner use per capita income data from the Penn World Tables. These tables also report per worker capital stock data, so they permit analysis of the $(\frac{K}{L})$ component of Equation (1). I study two cases. The first, from Ben-David (1993), is the accession to the EC of Denmark, Ireland, and the United Kingdom in 1973. The second, from Sachs and Warner (1995), is the group of countries judged to be "open" as of 1970.

Figure 1 presents the convergence evidence of both per capita income and per worker capital among the three countries which joined the EC in 1973 (designated by the vertical line). Figure 2 presents similar data for the case of the open economies. Following the methodology in Ben-David (1993), in both figures I measure convergence as the standard deviation across countries at

each point in time of the natural log of per capita income (per worker capital). Convergence (divergence) implies that this standard deviation declines (increases) over time.[4]

Figure 1 is clearly consistent with Ben-David's claim that adopting EC trade policies converged income among the three new members in accord with the FPE theorem. But Figure 1 also reveals at least two other facts which temper this claim. First, the post-accession per worker income convergence was driven at least partly by post-accession per worker capital stock convergence. The FPE theorem is about trade changing factor prices, not factor quantities. So at least some of the income convergence was caused by non-FPE (and possibly non-trade) factors. Second, convergence of income and capital stocks was happening for several years before joining the EC. This is consistent with political-economy stories which claim that convergence drives trade, not vice versa.

Figure 2 is clearly consistent with Sachs and Warner's claim that between 1970 and 1989 the "convergence club" of open economies converged per worker income among themselves through international trade. But as with the Ben-David case, here the convergence was driven at least partly by per worker capital stock convergence. Without further evidence that trade in capital goods mattered here, this figure is also consistent with the claim that the convergence club was the club of countries with similar rates of domestic saving and investment.

IV Conclusion

The recent literature on cross-country convergence of per capita income has largely ignored international trade. Recent papers by Ben-David and Sachs and Warner present interesting evidence consistent with the claim that trade may have helped caused income convergence. But more work is needed to document carefully both the exact mechanisms by which trade helps convergence and the relative contribution of trade and non-trade factors.

Figure 1: Convergence Among Denmark, Ireland, and the United Kingdom

o std dev(log(per capita income)) △ std dev(log(per worker capital)
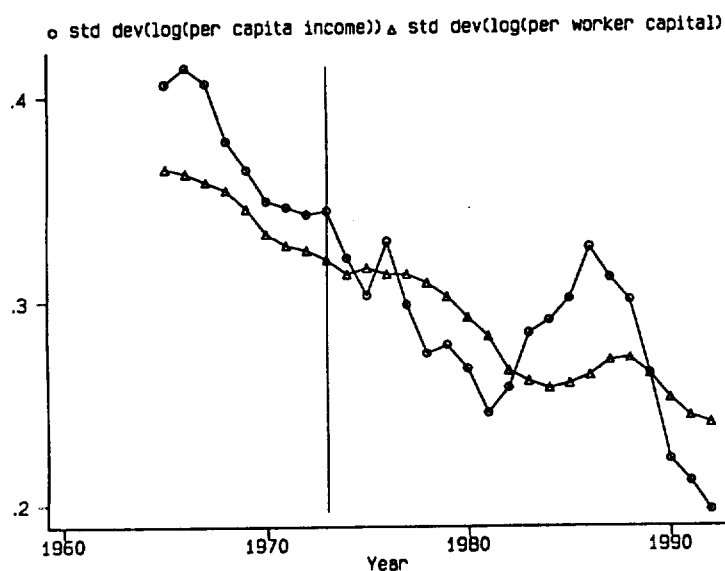
Notes: In 1973 these three countries joined the EC and liberalized trade in line with EC policies.
Source: Penn World Tables

Figure 2: Convergence Among the "Open" Economies of the World

o std dev(log(per capita income) △ std dev(log(per worker capital)
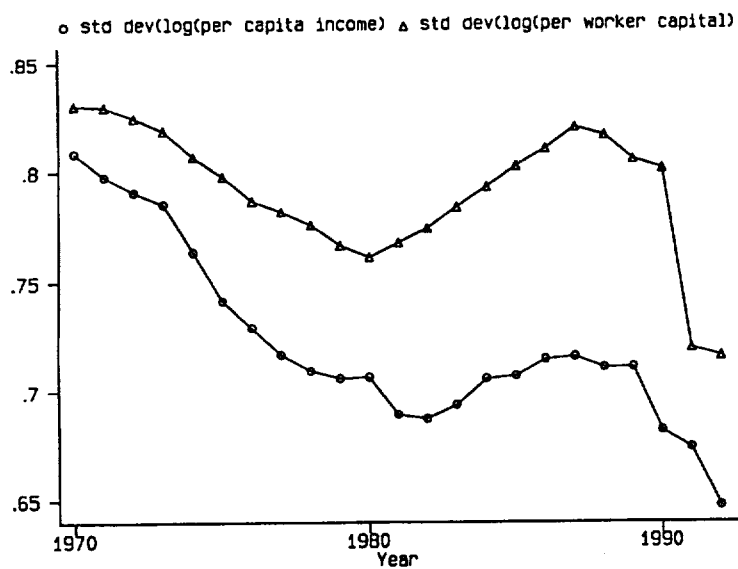
Notes: Sachs and Warner (1995) determine whether each country is "open" or "closed."
Source: Penn World Tables

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Footnotes

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1 $(\frac{K}{L})$ converges in levels if there is no exogenous technological progress. If there is technological progress then there is convergence in levels of capital per unit of "effective" labor.

2 One issue is "cones of diversification": FPE obtains for only those countries with sufficiently similar endowments that they produce the same bundle of products and thus face the same zero-profit conditions. Another is the possibility that FPE might affect not only factor prices but also factor quantities as well. When FPE holds capital accumulation does not trigger diminishing marginal physical productivity (mpp) as envisioned in the "Solow" model (instead, it triggers output adjustments as predicted by the Rybczynski theorem). Thus trade might help explain capital's constant mpp in the endogenous-growth models and also might lead capital-rich counties *not* to invest less. To address this second issue, in the trade literature there is a long history of rich models which extend the static Heckscher-Ohlin models to consider factor accumulation over time.

3 If factor prices are converging additional information will be required to determine if FPE or technology flows are causing this. As the recent literature on U.S. income inequality has demonstrated, disentangling the roles of trade (in this context the Stolper-Samuelson theorem) and technology can be very difficult.

4 The Penn World Tables report both per capita income and per worker income. The two are identical only if all people work. However, income convergence trends are very similar for the two measures. I use per capita income to make the results more comparable with Ben-David (1993). Also, Sachs and Warner test for convergence by regressing countries' 1970-1989 annualized income growth rates on 1970 income levels: a negative coefficient indicates convergence. This measure and the Ben-David measure need not imply each other in theory even though in reality they often seem to coincide. In the terminology of Barro and Sala-i-Martin, Sachs and Warner measure "beta" convergence while Ben-David measures "sigma" convergence.