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ABSTRACT

Growth and European Integration: Towards an Empirical Assessment*

Broadly speaking, European integration affects growth by stimulating the accumulation of physical capital and/or knowledge capital (i.e. technology). This paper surveys existing empirical work on integration and growth concluding that there is strong evidence that trade liberalization promotes growth by boosting investment in physical capital. Because European integration has substantially liberalized European trade, we conclude that it has promoted European growth. We find much less econometric support for trade-induced technology-led growth. Nonetheless cross-country data reveals a rough correlation between the national total factor productivity growth rates and the degree (and duration) of European integration. Our exploratory regressions into this phenomenon prove inconclusive, but we suggest several directions for future research.

JEL Classification: F10, F15, O4
Keywords: growth and trade, European integration, trade-induced investment-led growth

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NON-TECHNICAL SUMMARY

If a nation's labour-force is to produce more, year after year, the economy must provide the work-force with more 'tools', year after year. Here, 'tools' is meant in the broadest possible sense; it refers to any type of capital, and we define three categories: physical capital (machines, etc.), human capital (skills, training, education, etc.) and knowledge capital (technology). Given that accumulation drives growth, the next question is: 'What drives accumulation?' The answer is, of course, investment by private, profit-motivated firms and individuals. The rate at which they invest depends on the costs and benefits of doing so.

This sequence of rather obvious statements directs our attention to the only way that government policy can affect growth, namely via its impact on investment in machines, skills and technology. Some policies directly alter the rate of investment, but tend, for the most part, to affect growth by changing the incentives facing private firms. While all this is quite clear, it is important to make these points given the confusion that the term 'export-led growth' has created. At the very best, the notion of export-led growth is a leftover from naïve Keysianism, but all-too-often it is used as a catch-all phrase. More recently, the notion of growth due to 'outward orientation' has added to the confusion.

Given the logic of accumulation and growth, it is natural to identify two broad channels through which European integration affects growth: physical capital formation (integration-induced investment-led growth), and knowledge creation (integration-induced technology-led growth). Instances of integration-induced investment-led growth can be found in the investment booms that Ireland, Portugal and Spain experienced around the time of their accession to the EU. It is much harder to find examples of integration-induced technology-led growth, due, in part, to the fact that technology is very difficult to measure.

This paper begins by presenting a *prima facie* case that European integration has stimulated growth. The evidence is not 'scientific' and indeed no formal tests are presented, but it may serve to convince readers that there is, at least, a phenomenon that deserves further study. The main findings are:

- Several countries experienced investment booms upon accession to the European Union, but others did not. In particular capital formation was boosted in three of the four 'poor' entrants (Ireland, Portugal and Spain), but capital formation was unaffected or fell for the two 'rich' entrants (Denmark and the United Kingdom).

Our *prima facie* evidence on technology-led growth is based on total factor productivity (TFP) data. This data (which has many well-known drawbacks) roughly measures the level of technology in an economy. Studying a 1970–90 panel of TFP data for 20 industrial nations, we find four salient features.

- For three period averages (1971–90, 1971–4 and 1975–90) European nations experienced higher TFP growth than the sample average that includes non-European nations.

There could, of course, be many explanations for this, but it certainly makes it easier to think that European integration has been good for productivity gains in Europe. The picture is only slightly clouded by the fact that European productivity slowed down slightly more than the sample average between the pre-1975 and post-1975 period.

- The original six members of the EU, who participated in deep integration from the very beginning of the sample period (the EU was formed in 1958 as the European Economic Community), seem to have fared even better than the European average. Moreover, we find that roughly speaking, the oldest members of the EU have had the highest productivity growth.

- The major European countries that resisted deep integration – the members of the European Free Trade Association (EFTA) – had systematically worse productivity growth than the EU members. The EFTAns also experienced a bigger drop in productivity growth after 1975.

- The entry of Denmark, Ireland and the United Kingdom into the EU are correlated with a jump in productivity gains. These three had gains that were below the Euro-average prior to accession (1971–4), but above the Euro-average after accession. Of course, North Sea oil muddies the water, but recalculations of the averages with Denmark and Ireland alone leave the results qualitatively unchanged; entrants did worse than average before accession, but better than average after accession.

The paper reviews the general empirical literature on trade and growth, and surveys the literature on European integration and growth. We conclude that there is substantial evidence to support the trade-induced investment-led growth channel, but very little evidence supporting the trade-induced technology-led growth channel. This latter fact may have much to do with the difficulty of measuring technological progress. Nonetheless, more convincing evidence for integration-induced technology-led growth will be difficult to obtain. The fundamental fact is that most measures of productivity indicate that European knowledge creation has proceeded at a steady (or even falling) rate in the post-war period. European integration, by contrast, has steadily deepened. Consequently, the two cannot be linked by a simple linear relationship. We suggest one solution to this conundrum. It may well be that integration would have stimulated technology-led growth, but European governments used the luxury of these incipient pro-growth effects to install anti-growth social programmes. Thus, instead of showing up as steadily higher growth rates, European integration has shown up as a steady expansion of the social welfare state.

The last section presents two econometric tests for integration-induced investment-led and technology-led growth. Using cross-country data (the Barro-Lee dataset) we find that European integration did not affect investment rates except in so far as European integration has lowered trade barriers against European imports and exports. The second set of econometric tests concerns the impact of European integration on technology-led growth, testing for the impact of trade on knowledge flows. Here we estimate the relationship between a country's TFP level and the stock of domestic and foreign R&D inputs, including a dummy for European integration. We find that none of the regressions are cointegrated, so we are formally unable to assess the impact of European integration. Nonetheless, the point estimates on the European dummies are positive, suggesting that further research may be able to substantiate a link between European integration and TFP growth.

Growth and European Integration: Towards an Empirical Assessment

Richard E. Baldwin and Elena Seghezza

1. Introduction

If a nation's labour force is to produce more year after year, the economy must provide the workforce with more 'tools' year after year. Here 'tools' is meant in the broadest possible sense, i.e. of any type of capital, and we must distinguish three categories: Physical capital (machines, etc.), human capital (skills, training, education, etc.) and knowledge capital (technology). While accumulation drives growth, investment by private, profit-motivated firms and individuals is what drives accumulation The rate at which they invest depends on the costs and benefits of doing so. This sequence of rather obvious statements serves the purpose of directing our attention to the only way that government policy can affect growth, namely via its impact on investment in machines, skills and technology. Some policies directly alter the rate of investment, but for the most part, it acts on growth by changing the incentives facing private firms. While all this is quite clear, it is important to make these points given the confusion that the term "export-led growth" has created. At the very best, the notion of export-led growth is a leftover from naive Keysianism, but all-to-often it is used as catch-all phase that substitutes for deeper analysis. More recently, the notion of growth due to "outward orientation" has added to the confusion.

Given the logic of accumulation and growth, it is natural to identify two channels through which European integration affects growth: Physical capital formation (integration-induced investment-led growth) and knowledge creation (integration-induced technology-led growth).[2] Instances of integration-induced investment-led growth can be found in the investment booms that Ireland, Spain and Portugal experienced around the time of their accession to the EU. It is much harder to find examples of integration-induced technology-led growth, due - least in part - to the fact that technology is very difficult to measure.

European Integration and Growth Until fairly recently, the widely-held belief that European integration has promoted European growth was based entirely on causal empiricism. The problem was that until the 1980s, trade economists generally considered the growth effects of trade liberalization to be poorly understood and impossible to measure. The mid-1980s revival of growth theory, changed this. Smith (1984) and Findlay (1984) clarified the role of trade in the neoclassical growth model, but it was the seminal contributions by Romer (1986, 1990), Lucas (1988) and Grossman and Helpman (1991) that rekindled economists' interest in the logic of trade and growth. At first, this understanding was purely theoretical but very early on Baldwin (1989, 1992) showed that growth effects were neither

[2]In principle, integration may also affect the rate of human capital formation. This would be trade induced skills-led growth.

poorly understood nor impossible to quantify. With a few simple assumptions, that article showed that it is trivial to project medium-run and long-run growth effects using the calibration methodology. Fortunately, empirical work on integration and growth has progressed far beyond Baldwin's illustrative calculations.

The aim of this paper is to summarize the existing evidence and to provide some additional empirical support to the widely-held belief that European integration has been good for European growth.

The paper has four sections following this introduction. The next section, Section 2, presents a *prima facie* case that European integration has stimulated growth. The evidence is not "scientific" and indeed no formal tests are presented, but it may serve to convince readers that there is at least a phenomenon that deserves further study. Section 3 briefly reviews the general empirical literature on trade and growth, and exhaustively surveys the literature on European integration and growth. Section 4 presents two tests for integration-induced investment-led and technology-led growth. Section 5 contains our concluding remarks and directions for future research.

2. The Prima Facie Case

This section informally examines some evidence that European integration has promoted European growth. We examine two types of evidence: productivity evidence and investment evidence.

2.1 Productivity Evidence

In the 1950s, Robert Solow taught economists that technological progress is the fundamental source of long run growth. While there is a school of thought that prefers to focus on human capital rather than knowledge capital, Solow's lesson is still valid today. We start, therefore, with some measure of productivity advancement. The most obvious question is: "Have European nations experiences faster productivity growth than non-European nations?" Of course, it will be impossible to draw firm conclusions from the answer since European integration is not the only difference between the two groups. Table 2-1 provides some evidence on total factor productivity (TFP) growth averaged over a variety of periods. There are four salient points.

First, notice that for the three period averages - 1971-1990, 1971-1974 and 1975-1990 - European nations experienced higher TFP growth, than the sample average that includes non-European nations. Plainly, there could be many explanations for this, but it certainly makes it easier to think that European integration has been good for productivity gains in Europe. The picture is only slightly clouded by the fact that European productivity slowed down slightly more than the sample average between the pre-1975 and post-1975 period.

Second, note that the original six members of the EU, who participated in deep integration right from the beginning of the sample period (the EU was formed in 1958 under the name

European Economic Community), seem to have done even better than the European average. Moreover, moving down the rows, we see that on average, the oldest members of the EU had the highest productivity growth.

Third, the major European countries that resisted deep integration - the members of the European Free Trade Association (EFTA) nations - had systematically worse productivity growth than the EU members. The EFTAns also experienced a bigger drop in productivity growth after 1975. The TFP data we are using (from Coe and Helpman 1995) corrects only for physical capital and labour inputs. In particular, it does not correct for the discovery of North Sea oil. This event in the late 1970s has a serious distorting effect on UK and especially Norwegian data. This is important since we have Norway in the EFTA average and the UK in the EU9 and EU12 averages. Since the EFTA average involves only five countries while the EU9 and EU12 data (which include the UK) involves 8 or 11 countries (Luxembourg is excluded on data grounds), and oil was more important for Norway than the UK, we might expect North Sea oil to bias the EFTA average upward. In fact, the EFTA average is above the EU9 and EU12 average in pre-North Sea oil period, but below it afterwards.

Fourth, the entry of the UK, Denmark and Ireland into the EU are correlated with a jump in productivity gains. The Northeast-3 had gains that were below the Euro average prior to accession (1971-1974), but above the average after accession. Of course, the North Sea oil muddies the water, so we recalculated the averages with Denmark and Ireland alone. The results (not shown) are qualitatively unchanged. The entrants did worse than average before accession, but better than average after accession.

There can be many explanations apart from EU membership for these facts, but at least we have established the fact that knowledge accumulated faster in European nations than in non-European OECD nations. Moreover roughly speaking the most integrated European countries grew accumulated knowledge capital faster than the least integrated European countries.

2.2 Investment Rate Evidence

In theory, medium-run growth effects should appear as a transitional rise in the rate of physical capital formation. With standard capital formation assumptions, this requires a rise in the investment-to-GDP ratio. Given this, a very unsophisticated search for medium-run growth effects is to track the behaviour of investment rates for nations that acceded to the EU. There have been three major enlargement episodes: the Northwest enlargement (UK, Denmark and Ireland), the Mediterranean enlargement (Greece in 1981, Spain and Portugal in 1986), and the Northeast enlargement (Austria, Finland and Sweden in 1995). Data for the last is as yet unavailable. Figures 2-1 and 2-2 plot the investment-GDP ratios for the two enlargements. The average EU9 investment rate is plotted for comparison.

The first diagram shows a strong, positive investment response in Spain and Portugal. As always, this could be due to many factors. Note that the accession talks were finalized in 1985 with entry into force in 1986, so it is quite suggestive that 1986 was the first year of the Iberian's investment-led growth. Observe that the EU9 average investment rate declined throughout the 1980s.

The Greek accession, in contrast, does not appear to have sparked an investment response. Greek investment rates trended downward during the entire period at a pace that exceeded that of the EU9 average. If anything, it would appear that EU membership accelerated the decline in Greek investment.

The second diagram shows a similarly mixed picture for the Northwest enlargement. Ireland experienced a particularly sharp pick up in its investment rate. However, the impact on the British and Danish rates seems to be negative.

Taken as a whole, the investment data is decidedly mixed. Half the entrants experienced investment booms just after entry. The other half, however, experienced declining or steady investment rates.

3. A Survey of Empirical Work

3.1 An Organizing Framework for Growth Regressions

Most of the empirical growth literature is marred by a lack of formal theoretical reasoning. The first task, therefore, is to provide a minimal analytic framework with which to interpret the literature's results. Explicitly, or more frequently implicitly, most aggregate growth studies adopt a Cobb-Douglas aggregate GDP function. Log total differentiation of the GDP function yields the per capita growth accounting equation:

$$\hat{Y}_t - \hat{L}_t = \hat{A}_t + \alpha\hat{K}_t + \beta\hat{H}_t - (1-\gamma)\hat{L}_t \qquad \textbf{(3-1)}$$

Y, A, K, H and L are GDP, knowledge capital, physical capital, human capital and unskilled labour respectively, and the "hat" notation indicates annual percent change, i.e., L hat is (dL/dt)/L. This growth accounting equation simply states that all per capita growth is due to the increased application of human capital (H), physical capital (K) or knowledge capital (A). Labour force growth, of course, retards per capita income growth. In equilibrium, all factor markets clear so the growth rate of factors applied to production equals the growth rate of the supply of factors. Thus apart from labour force changes, an economy's growth can be entirely attributed to capital accumulation, where capital is broadly interpreted to included human, physical and knowledge capital.

So far no mention has been made of trade or any international variables. One critical point, which is obvious from the growth accounting equation, is that trade policy or regional integration can affect long run growth <u>only</u> via its impact on the accumulation of human, physical and knowledge capital (taking labour force growth as exogenous to international integration). The system of estimating equations suggested by this is:

$$\hat{Y}_t - \hat{L}_t = \hat{A}_t + \alpha\hat{K}_t + \beta\hat{H}_t - (1-\gamma)\hat{L}_t$$

$$\hat{K} = b_{10} + b_{11}\tau + ZB_1$$

$$\hat{H} = b_{20} + b_{21}\tau + ZB_2 \qquad \textbf{(3-2)}$$

$$\hat{A} = b_{30} + b_{31}\tau + ZB_3$$

where τ is some measure of trade barriers, Z is a matrix of other exogenous parameters and the b's and B's are parameters to be estimated. No study has adopted this full system approach.

Economists generally ignore the impact of trade liberalization on the supply of skilled and unskilled labour. This leaves two major channels for European integration to affect growth: Physical capital formation and knowledge creation. Because independent data on A are unavailable, most studies estimate quasi-reduced forms consisting of the first equation with trade variables included. These are implicitly a test only of trade-induced, technology led growth since capital formation is already included as a regressor. Some of these studies estimate a single equation, while others estimate two of the four equations separately.

Two types of data have been used to estimate these simple growth and factor accumulation regressions: Cross-section data for a range of countries and time series data on individual countries. The cross-country regressions have received by far the most attention.

3.2 Cross-Country Growth Regressions

Since the early 1980s, a vast literature using cross-country regressions has appeared. In many of them, regression analysis is used as the proverbial drunk uses a lamp post - for support rather than illumination. Most studies start by using strong prior beliefs to choose which variables to include in the growth equations. Almost no studies generate the estimating equations from a theoretical model. Regressions are run including only a small number of explanatory variables in an attempt to establish a statistically significant link between growth and a particular variable of interest. Levine and Renelt (1991), which undertakes an exhaustive review, is the basis of the following statement in their study Levine and Renelt (1992):

> Given that over 50 variables have been found to be significantly correlated with growth in at least one regression, readers may be uncertain as to the confidence they should place in the findings of any one study.

The basic problem is that per capita growth is an enormously complex process. When authors include only a handful of variables, even the best fitting regressions have large error terms. It is quite likely that variables are omitted. To the extent that the included variables are correlated with the omitted variables, the size and even the sign of various parameters are affect by the choice of regressors.

Levine and Renelt (1992) Levine and Renelt (1992) perform robustness tests on the two standard cross-country data sets. They start from a "basic" regression,

$$(\hat{Y} - \hat{L})_{\underset{60-89}{avg}} = -0.83 + 17.5^{**} INV_{\underset{60-89}{avg}} - -.38\ GPO_{60}$$

$$- 0.35^{**} RGDP_{60} + 3.17^{**} SEC_{60}, \qquad (3\text{-}3)$$

$$R^2 = 0.46\ ,\ 101\ observations$$

where INV, GPO, SEC, RGDP are the average (1960-1989) physical capital to GDP ratio, the average population growth, the 1960 secondary enrolments rate, and the 1960 GDP per capita respectively. The double asterisk indicates the estimated coefficient is significantly differ from zero at 5% confidence level.

It should be obvious that the error term in such a regression is not white noise. It includes *inter alia* all factors influencing technological progress (A-hat) except those due to the technology catch-up factor captured by $RGDP_{60}$. In other words, all technological progress that is not explained by $RGDP_{60}$ is included in the theoretical error term. Because technology growth typically boosts the marginal benefit of accumulating all factors and may also be spuriously correlated with government policy choices (eg, governments may use the 'luxury' of fast growth to implement various social policies), the technological progress in the error term is likely to be correlated with variables that are included in the basic regression. For instance, in most of the growth models, the rate of knowledge accumulation was exactly proportional to the rate of physical capital formation. Thus since physical capital accumulation is linearly related to INV, the estimated coefficient on the INV variable may be picking the influence of the omitted knowledge creation variable. Support for this omitted-variable reasoning is found in the fact that the estimated coefficient on INV is extraordinarily large.

Robustness Test Their robustness test involves the following procedure. For a variable of interest, call it x_m to be concrete, a regression is run where only the basic variable and x_m are included. The estimate on x_m is labelled the 'base' estimate. Next a series of regressions are run in which other variables (apart from the basic variables and x_m) are added. In particular, all combinations of up to three other variables are regressed. The highest and lowest estimates of the coefficient on x_m are collected from these regressions. A variable is considered 'robust' if the high and low estimates on x_m are of the same sign and both are significant. Otherwise, the variable is considered 'fragile'. Note that all of the basic variables are robust except for population growth.

Levine and Renelt's results are extremely instructive. They consider seven standard measures of trade openness (including export/GDP and import/GDP) and find that all of them are fragile in the per capita GDP growth regressions.

To interpret this results, we see from the organizing framework that their finding does not imply that openness is unrelated to growth. What Levine and Renelt are estimating is a quasi-reduced form of the first equation in (3-2). That is, the accumulation equations for A and H have been substituted into the first equation, but actual data on K-accumulation has included.

Consequently, their results tell us that openness does not seem to have a robust relationship with A or H. Alternatively, it could be that - by chance - the reduced form coefficient on openness, which is equal to $b_{21}+b_{31}$, is zero even thought the two separate b's are non-zero. Since actual data on K-hat is included, it is entirely possible that openness affects growth via its impact on physical capital accumulation.

Another way to say this is that the Levine-Renelt growth regression is testing only for trade-induced, knowledge-led growth. It cannot test for trade-induced, investment-led growth. The authors specify another regression to test for trade-induced, investment-led growth.

In particular, Levine and Renelt note that the informal justifications for including many variables in simple growth regressions are that they may explain the investment ratio INV. To explore this further, and to perform robustness tests on the many factor accumulation regressions that have been done (see for instance Barro 1991), they undertake the same robustness analysis for regression of the average physical capital investment to GDP ratio on various variables. Here they find that none of the other basic variables (RGDP, GPO and SEC) have a robust relationship with INV, nor do any of the standard fiscal policy variables such as government consumption shares or deficit as share of GDP. However, five trade/openness variables do have a robust relationship. These are the exports to GDP ratio, the imports to GDP ratio, the sum of imports and exports to GDP ratio and two openness variables generated by Leamer (1988). The only other variable that has a robust relationship to INV is the average number of coups and revolutions.

In commenting on this pair of results, the authors note:

> "These results suggest an important two-link chain between trade and growth through investment. Interestingly, however, the theoretical ties between growth and trade typically seem to run through improved resource allocation and not through higher physical investment share."

To sum up, the Levine-Renelt findings provide strong support for trade-induced, investment-led growth. They find little evidence of trade-induced, knowledge-led growth.

Lee (1992) This paper estimated what seems to be the first cross-country growth regression that is motivated by a complete theoretical model. In particular, the author presents a theoretical neoclassical growth model of a typical developing country. The country produces a single good under conditions of perfect competition and constant returns to scale. Production of this good requires labour, capital and imported intermediate goods. Capital is formed from foregone consumption (of the single good), so imported intermediates are an essential input into physical capital formation. This is the key mechanism linking trade barriers and growth in his model. Domestic trade barriers raise the price of capital, reducing the rate of return on capital formation and thereby lowering the steady-state capital stock. The model does not allow for the country to be a producer of manufactured goods, so it is not formally applicable to industrialized or industrializing countries.

In his theory, Lee carefully derives his reduced form estimating equation for growth, using a log-linear approximation around the steady state. The independent variables in this equation include only initial per capita income and measures of tariff barriers and the black market premium. In his empirics, however Lee includes the investment share and a proxy for investment in human capital. His rationale for including the endogenous investment variable in a reduced form equation is that this is a way of partially correcting for a potential omitted variable bias.

The main empirical findings are that the black market premium has a statistically significant and negative impact on growth. The point estimate on his tariff variable is negative but not significant at a 5% confidence level (but it is significant at the 10% level) when it appears alone. When it appears with the black market premium, its t-statistic is minus 1.5. Including a dummy for Sub-Saharan Africa makes the tariff variable statistically significant. This result is hard to interpret since the Sub-Saharan countries might be thought of as most closely matching the assumptions of his model.

Lee (1994) Using a simple endogenous growth model, Lee motivates a regression equation that includes the ratio of imported to domestic capital goods in a country's investment. He finds that controlling for the standard Levine-Renelt growth correlates, there is a significant and positive relationship between per capita growth and the ratio of imports in investment.

Baldwin and Seghezza (1996) This paper presents a complete trade and growth model and uses it to derive estimating equations. The core economic mechanism in the model is the link between trade barriers and the derived demand for capital. The model is dynamic, but intuition is boosted by first considering a static trade model. As is well known, domestic and foreign trade barriers alter capital's rental rate by shifting the general equilibrium derived demand for the fixed capital stock. For instance, if the import-competing sector is relative intensive in its use of capital, domestic protection raises the rental rate. If exports are also capital intensive (this is possible with intra industry trade when traded goods - say, manufactures - are capital intensive relative to nontraded goods - say, services), then foreign barriers tend to lower the rental rate. If we relax the fixed factor supply assumption and allow endogenous capital accumulation, trade policy can affect investment and thereby output growth. In a neoclassical growth framework this leads to medium-run investment and growth effects. In an endogenous growth setup, it may have permanent growth effects.

As articulated, however, the model has mercantilist implications. Raising home barriers and lowering foreign barriers unambiguously stimulates the demand for home capital and thereby leads to trade-induced investment-led growth. Since this prediction does not fit the facts, the authors add another element that has long played an important role in the trade and growth literature, namely imported capital goods. When the price of imports and locally produced substitutes affect the cost of new capital, domestic protection acquires an anti-investment aspect that counters the above-mentioned pro-investment effect. Specifically, assuming that traded goods are an input into capital formation, protection raises the cost of new capital goods and thereby tends to lower the rate of return on investment. With intertemporal optimization on consumption, this lowers the steady-state capital stock and slows growth in the transition. The net effect of domestic protection on growth is ambiguous, a matter for empirical investigation.

Note that the Baldwin-Seghezza model provides theoretical solution to the Levine-Renelt assertion that the theoretical ties between growth and trade typically seem to run through improved resource allocation and not through higher physical investment share.

Results Growth and investment equation are derived from the model and estimated with three-stage least squares on a cross-country sample of manufacture exporters. In essence, the system that they estimate is the first two equations in (3-2), with A-accumulation explained by the level of human capital and a catch-up factor (the initial gap between the country's and the US's GDP per capita). H-formation is taken as determined by exogenous government policy.

The authors find that domestic barriers depress investment and thereby growth. This result is fairly robust in that it is present in a variety of sample and for a variety of openness proxies. Foreign trade barriers are also found to depress investment and growth, but the effect is less strong and much less robust to sample and proxy changes.

Furthermore, the authors find no evidence for trade-induced, technology-led growth. In particular, they test for this by including the trade barrier variables in the growth equation as well as in the investment equation. In a variety of samples and for a variety of trade barrier proxies, the trade variables are insignificant in the growth equation, yet they continue to be significant in the investment rate equation. These empirical results are very much in line with what Levine and Renelt obtain with OLS estimation of the individual equations. Finally, the authors run a true reduced-form growth regression -- that is one in which the three last equations in (3-2) have been substituted into the first. Results from this reduced-form regression show that domestic and foreign trade barriers do slow growth.

Baldwin and Seghezza point out that although trade variables are never significant in the growth equation, this cannot be taken as conclusive evidence against the hypothesis that trade can affect the rate of technology progress. Their results are best interpreted as saying that this sort of effect is not strong enough to show up in such a broad cross-section data set. The point is that the error term in the growth equation is almost surely not white noise in reality. It includes *inter alia* all factors influencing technological progress except those due to the technology gap captured by the initial Y/L variable. These omitted factors are likely to be correlated with many of the variables included in the basic regression. For instance, in many growth models, eg Helpman and Grossman (1991) chapter 5, the rate of knowledge accumulation is proportional to the rate of physical capital formation. Thus with physical capital accumulation linearly related to investment, the estimated coefficient on the investment variable may be picking the influence of the omitted knowledge creation variable. In other words, it may be that there is such a close correlation between K investment and technological progress that it is impossible to disentangle the impact of trade on innovation in a growth equation. A superior approach - adopted by Coe and Helpman (1995) would be to work with a measure of technological progress such as total factor productivity growth and use time series data.

De Long and Summers (1991) This study presents a rather exhaustive effort to establish a firm link between equipment investment and GDP per capita growth via its effects on labour productive growth. They argue that most growth regression, which use measures of capital formation that do not distinguish between equipment investment and other forms such as structures and transport equipment, are fundamentally misspecified. They point out the over 30% of the US equipment purchases were imports in 1989, so it is easy to suspect that trade may affect growth especially via its impact on equipment investment. Moreover, they find a strong negative correlation between the equipment prices and growth. This suggests that one important route by which trade affects growth is by reducing the ability of domestic equipment manufactures to charge high prices.

Barro (1991) This study was very important in popularizing the *ad hoc* approach to cross-country growth regressions. Without reference to a formal model. Barro uses data for a broad cross-section of countries (developed and developing countries are included), he uses ordinary least squares to regress average per capita income growth from 1960 to 1985 on the 1960 per capital income level and proxies for the initial level of human capital. In addition to these main right-hand side variables, a handful of other proxies are included, viz. The average (1960-1985) number of revolutions and coups per year, the average (1960-1985) number of assassinations per million people per year, the average (1960-1985) ratio of real government consumption to GDP, and the magnitude of the purchasing power parity correct in 1960. These proxies are intended to be measures of political stability and the degree of government intervention.

Barro's main results are simple to summarize. He finds positive, significant and very large point estimates for the 1960 enrolment rates (human capital) and negative, significant and moderately sized estimates for 1960 income per capita. The point estimates on all of his other proxies are negative and significant. Levine and Renelt (1992) replicate Barro's results and then go on to show that Barro's results are not robust to his list of included variables. This suggests that his findings may have represented spurious correlations between his included variables and the omitted variable in the error term. Presumably a large number of unreported regressions were run in order to select proxies that boosted the goodness-of-fit and produced point estimates on the main variables that conformed to the author's prior beliefs. It is especially suspicious that none of the 14 reported variants on the basic growth equation omits his rather exotic proxies for political instability.

Edwards (1993) Edwards (1993) presents a survey of empirical studies of the link between openness, trade and growth in less developed countries (LDCs). Many of the reviewed studies involved qualitative country-studies. The evidence from these is suggestive of a strong link between trade and growth. The quantitative studies he cites are generally only mildly interesting since they typically revolve around the simple correlation of export growth and GDP growth. Moreover most of these studies fail to provide a formal theoretical framework that motivates the regressions. This makes the results difficult to interpret in a consistent manner.

A classic example is Krueger (1978) in which simple export and growth equations are estimated including dummies that subjectively reflect the openness of various LDCs. It is important to note that these dummies were constructed by researchers who were fully aware of the growth performance of the LDCs and who held very strong priors that trade liberalization was good for growth. Moreover, the possibility that the included variables are strongly correlated with omitted variables raises many doubts. In any case, Krueger's findings are that liberalization is correlated with increased exports and increased exports are correlated with faster growth. When export growth and the liberalization dummies were included in the growth regressions, the dummies were insignificant. Given the fact that both exports and GDP are jointly endogenous, it is difficult to know how much weight to give to Krueger's results. Feder (1983) has the great advantage of motivating his regression with a theoretical model. For this reason, his assumptions are explicit and he is forced to interpret his results in a consistent manner. He finds that export growth is significantly correlated with growth (in 31 semi-industrialized countries) controlling for the investment share and labour growth. This can be viewed as a finding that exports are correlated with the Solow residual.

Backus, Kehoe and Kehoe (1992) The regressions in Backus, Kehoe and Kehoe (1992) are loosely motivated by various endogenous growth theories that depend upon scale effects, but the authors take pains to note that their data work is exploratory. They are looking for statistical regularities rather than performing hypothesis testing. They interpret their results as suggesting directions for future research. Using cross-country data on as wide a sample as possible (usually including both LDCs and developed countries), they find that the growth rates of both GDP per capita and manufacturing labour productivity are significantly related to measures of intra-industry trade, particularly after controlling for the scale of manufacturing. The Backus, Kehoe and Kehoe regressions are marred by the usual possibility of bias due to omitted variables. For instance they regress GDP per capita growth and manufacturing productivity on one level variable (GDP or manufacturing output) and intra-industry trade indices for all goods or only manufactured goods. Clearly, an important number of variables end up in the error term is such a simple specification.

Nonetheless, this link between intra-industry trade and growth is intriguing. The combination of this evidence on the intra-industry trade-growth link and De Long and Summers' evidence on the equipment prices-growth link is highly suggestive, since intra-industry trade is heavily concentrated in manufactured goods - much of which constitutes equipment investment. Backus, Kehoe and Kehoe find little evidence of a simple relation between GDP per capita growth and measures of scale consistent with learning-by-doing, human capital or research and development. They do find a significant correlation between these variables and growth in labour productivity in manufacturing.

3.2.1 Barro Regression Technique Applied to Integration and Growth

The ease of the Barro technique, and the wide acceptance of this highly questionable empirical methodology, led to a large number of follow-on studies. Typically these studies tacked on one or more variables to the original specification of the Barro regression. Conclusions were then drawn from the sign and significance of the estimated coefficients of the add-on variables.

De Melo, Montenegro and Panagariya (1992) One such study is De Melo, Montenegro and Panagariya (1992). Using data for 101 countries from 1960-1985, they tack on dummy variables for various regional integration schemes to a Barro-type regression. They find the only regional integration scheme that influenced growth over this period was the South African Customs Union. When the sample is split into developed and developing countries physical capital investment is significant for both groups but human capital only for developing nations.

The authors interpret this as evidence that regional integration has no effect on economic growth. As is clear from the simple reasoning in the organizing framework, this conclusion is erroneous. Since they run what we call a quasi-reduced form, the authors' regressions test only for integration-induced, technology-led growth. In particular, the specification of their equation rules out consideration of integration-induced, investment-led growth. This is a serious omission since evidence from Levine and Renelt (1992), and Baldwin and Seghezza (1996) strongly suggests that trade opening affects growth via physical capital accumulation.

The authors come tantalizingly close to understanding their own mistake in a separate paper - De Melo, Panagariya and Rodrik (1993). There they note that investment shares in GDP could be higher among participants in integration schemes. Indeed De Melo, Panagariya and Rodrik (1993) actually give evidence that if a properly specified regression had been run, they would have found evidence that integration did boost growth. That is, they state that the investment rate was higher in the West Europe during their integration. Moreover they note that the same increased investment effect also accompanied the announcement of the NAFTA negotiations.

Henrekson, Torstensson and Torstensson (1995) In the spirit of Barro regressions, this paper regresses per capita growth on a proxy for the human capital stock, or human capital formation (depending upon the desired interpretation), the investment ratio, a rough proxy for trade policy (the real exchange rate distortion index from Dollar (1992), and a measure of European integration. The authors' measure of European integration consists of a dummy that equals 1 for members of the EU or EFTA and zero for all other countries in the world. This is, of course, a quasi-reduced form regression that can only test for integration-induced, technology-led growth effects.

Using data from 1976 to 1985, the authors find that the Dollar exchange rate distortion index is always negative and significant and their Euro-dummy is always positive and significant in their growth equation. This is consistent with the Levine-Renelt findings that some openness variables are significant in the growth equation when certain regressors are omitted, but none (including Dollar's index) have a robust relationship with growth. It would have been interesting to see if the authors' Euro-dummy had a robust relationship with growth.

On the basis of their point estimates, the authors go on to calculate that membership in the EU or EFTA has added about one percentage point to members' average growth rates. They also check for integration-induced investment-led growth by running single-equation OLS on an investment rate equation. They find that both their Euro-dummy and the exchange rate distortion proxy are insignificant. Indeed, only the constant and initial period GDP-per-capital are significant. This confirms the Levine-Renelt findings that the Dollar index is not related to investment.

3.3 Time-Series Growth Regressions

To understand the results of this literature, it is imperative to understand the cointegration approach. Fortunately, the basics can be illustrated with a simple example. (The results we discuss hold much more generally, but proving this involves elaborate techniques.)

Consider cointegration techniques for stochastically trended data, i.e. data that follows a random walk with a disturbance term that is normally distributed.[3] Suppose that one stochastically trended variable x (a variable that is "integrated of order one" in cointegration jargon) has a linear, long run relationship with another stochastically trended variable z, in particular assume x = b z + u, where u is an error term that is not stochastically trended. Estimating this relationship on level data for x and z yields a "super-consistent" estimate of b, regardless of any correlations that might exist between z and u due to, say, joint endogeneity of x and z. The idea is very simple. The univariate OLS estimate is:

$$\hat{b} \; = \; b + \frac{\Sigma_{t=1}^{T} \; z_t u_t}{\Sigma_{t=1}^{T} \; z_t z_t} \tag{3-4}$$

The second term is the bias and its denominator is the sum of squared values of a stochastically trended variable. Now the expectation of this denominator gets large as T gets large. For instance since z is a random walk (say without a trend), then for a time series with four observations, we have: $z_0 = 0$, $z_1 = \epsilon_1$, $z_2 = \epsilon_1 + \epsilon_2$, and $z_3 = \epsilon_1 + \epsilon_2 + \epsilon_3$. Now the expectation of $\Sigma_t z_t^2$ is $\sigma^2(3+2+1)$, or more generally $\sigma^2 T(T+1)/2$, where σ^2 is the variance of ϵ. This grows at a quadratic rate of T. The expectation of the numerator, however, only grows at a linear rate of T even if u and z are contemporaneously correlated since u is not a random walk. What all this goes to say is that the second term rapidly becomes negligible as the time series lengthens. Plainly, the formal proof and generalizations are much more complex than this, but the example illustrates the basic issues.

The super-consistency result seems to sweep away all the difficulties of simultaneity in economic data with one fell swoop. There are a few drawbacks, however, including the fact that standard testing of coefficients (the main goal of most econometrics) is not possible. For another, there is no way to figure out the true nature of the long term relationship. The OLS "b" is a transformed correlation coefficient, and correlation does not imply causality. For example, x and z may have a common cause that creates correlation, so the estimated "b" cannot be used to say, if z were x% higher, x would be bx% higher. Cointegration does nothing to help us with this standard problem. The notion of Granger causality can rule out several types of relationships. The common cause relation, however, cannot be tested for unless data for the common cause is available. This is particularly disturbing in growth regressions since unobserved technological progress may very well be the common cause of capital formation, intra-EC trade and output growth.

More technically, measurement errors in the time series may introduce a spurious trend in the error term that leads the research to include variables that are not properly part of the long run relationship but do soak up the measurement error. For instance, suppose that the French capital stock is mis-measured due to poor quality adjustment in the price index of, say, computers. For a growing capital stock, this measurement error is trended. Now suppose, the true relationship is GDP equal alpha times K, but we regress GDP on measured K and some other trended variables such as intra-EC trade as a fraction of GDP. The correlation between

[3]This requirement does, of course, severely limit the types of data we can consider since a random walk has no steady state level.

the measurement error and extra variable may generate a false conclusion that the extra variable has a long run relationship with GDP.

Jones (1995) The simplest result from the cointegration approach is that one cannot explain a nontrended variable with a trended variable. Jones (1995) applies this logic to look at the validity of simple endogenous growth models. First, Jones establishes that the US's growth (and of many other advanced industrial economies) has been essentially flat since the industrial revolution. He then establishes that measures of R&D input - such as the number of scientists and engineers engaged in R&D, or real R&D expenditure - are trended. Consequently, he rejects the simple, linear production functions for knowledge that are at the very heart of the new growth theory. The same is true of European integration and trade more generally. Since WW-II, trade has expanded 1.5 to 2 times faster than output in most countries, and European integration has progressively deepened. Despite this, European growth rates have not risen. Thus on the face of things, neither R&D expenditure, nor European integration can have a simple, linear relationship as suggested by trade and endogenous growth models.

We propose one interpretation could be that governments, especially European governments, have used the luxury of incipient pro-growth effects to install anti-growth social programmes. Thus, instead of showing up as higher growth rates, European integration has shown up in a steady expansion of the social welfare state! It is certainly possible to devise a theoretical growth model with a political economy module that determines the level of anti-growth social policies.

Coe and Moghadam (1993) Using multi-equation cointegration techniques on French time-series data from 1971 to 1991, Coe and Moghadam estimate a linear relationship among the levels of nonfarm GDP, nonfarm hours worked, physical capital, cumulated R&D spending and intra-EC trade as a share of EC GDP. They arrive at some conclusions such as "trade and capital - broadly defined - account for all of the growth in the French economy during the past two decades."

The above diversion into cointegration econometrics may explain the one really striking result in Coe and Moghadam. Unlike Levine and Renelt (1992), they find that an openness variable is significant in an equation that includes physical capital. Mechanically, the most likely explanation is that their cumulated R&D variable which grows at an approximately constant rate, fails to pick up the widely-observed productivity slowdown in the 1970s. Since the intra-EC trade share does dip down in tandem with the slowdown, the positive coefficient is easy to account for. This suggests that Coe and Moghadam should have check for the stability of their parameters. Since they have quarterly data, this should be feasible.

This mechanical explanation does not rule out an economic interpretation. Indeed it might be taken as support for the openness-equipment prices-growth nexus that was suggested by De Long and Summers (1991). Trade in Europe, including France, plays a very different role than it does in most nations. Most EC nations are small and highly industrialized. The other major industrialized nations - Japan and US - are large enough to alleviate the usual trade off between competition and scale economies. In Europe, domestic competition among equipment manufacturers is minimal due to national champions and subtle trade restrictions that foster market segmentation. In Europe trade is necessary to alleviate the scale versus competition trade off. Most of Europe's trade is with itself and most of it is in manufactured goods. That is, intra-EC trade is more like intrastate trade in the United State.

This sort of speculation needs further empirical work. Papers such as Coe and Moghadam are suggestive, but great caution is required in interpreting their results.

Italianer (1994) This study performs a regression using annual time-series data for the GDP growth of the original EC6. The specification of the main regression is more standard than that of Coe and Moghadam in that it regresses annual percent changes in GDP on annual percent changes of physical capital and the labour force. In addition two openness variables are included. The actual regression is:

$$= \ -.2 + 0.67^{**}\hat{K} + 1.03^{**}\hat{L} + 0.84^{**}\hat{W}_6 + 0.76^{**}\hat{W}_{world} \qquad R^2 = 0.78 \tag{3-5}$$

where W_6 is the sum of intra-EC6 imports and exports over total EC6 trade and W_{world} is the sum EC6 import and exports from the world over EC6 GDP. The double asterisks indicate significance at the 5% level. The high r-square is noteworthy given that the regression is on growth rates rather than levels.

In terms of our organizing framework, an important missing variable is some measure of human capital formation. Given that the Romer (1989) results on the importance of education variables was found to be robust by Levine and Renelt (1992), it seems quite likely that the omitted human capital formation variable is important and therefore shows up in the residual. Since OLS was used, one can think of the coefficients on W_6 and W_{world} as having been estimated from the regression of the residuals that would have been generated from the regression of Y hat on L hat and K hat. In terms of our growth accounting framework, this residual should include H hat and A hat. Thus, the estimated coefficients on W_6 and W_{world} reflect correlation with both human capital formation and productivity growth. The fact that both partial correlation coefficients are positive is very much in line with the idea that trade, especially trade with advanced industrialized economies, foster knowledge capital formation. If one accepts the De Long and Summers (1991) results, the most reasonable economic channel is via trade in goods that constitute equipment investment. Since a larger fraction of the EC's trade with itself than its trade with the world consists of equipment, modest support for this can be found in the fact that the estimated coefficient on W_6 is larger than that on W_{world}.

Given Coe and Moghadam's finding of the importance of intra-EC trade for France, and Backus, Kehoe and Kehoe's finding about the important of intra-industry trade in general, it seems likely that the inclusion of education variables would not alter the significance of the intra-EC trade and general openness variables.

Coe and Helpman (1995) Using Solow residuals as proxies for the stock of knowledge, the authors essentially estimate the last of the equations in (3-2) in levels rather than first differences. As such, the paper is a direct test of the trade-induced, technology-led growth hypothesis. The authors note that many endogenous growth models posit a relationship between the growth of the knowledge capital and the amount of resources devoted to knowledge creation. Plainly this implies that the stock of knowledge should be related to the accumulated spending on knowledge creations. Moreover, if international knowledge spillovers are important, accumulated foreign spending should also influence the home stock of knowledge.

To test this, the authors construct a variable for accumulated domestic R&D spending. The foreign accumulated R&D spending is a trade-weighted average of the accumulated R&D variables for each nation's main trading partners. Using OLS on stochastically trended data, the authors find that trade-weighted, accumulated foreign R&D spending does help explain Solow residuals. Note that the regression is cointegrated using critical values generated from Levine and Lin (1992), but not using those of Levine and Lin (1993). From this evidence, Coe and Helpman conclude that international knowledge spillovers are related to trade flows.

4. Testing for Growth Effects of European Integration

This section presents results of empirical tests for the two most likely types of growth effects in the case of European integration: integration-induced technology-led growth and integration-induced investment-led growth. The first is an extension of Coe and Helpman (1995) and the second is an extension of Baldwin and Seghezza (1996).

4.1 Testing for Integration-Induced Technology-led Growth

Grossman and Helpman (1991) identify four mechanisms through which integration may affect technology-led growth. The first involves boosting the international spillovers of knowledge externalities. That is, integration allows scientists in one country to learn more or faster from advances made in other countries. The second is the reduction in the duplication of innovations. The third is market size effect (integration enlarges the market for products but also increases the degree of competition facing domestic innovations). The last is a general equilibrium effect on the reallocation of resources to the R&D sector. If any of these mechanisms are operating in a pro-growth direction, and all else is equal, we should see the knowledge stock of EU members evolving at a faster pace than that of nonmembers. Using the data and cointegration techniques in Coe and Helpman (1995), we can easily test for this in a more formal manner than in Section 2.

The basic Coe-Helpman empirical model suggests that a country's knowledge stock (as proxied by its Solow residual and denoted as TFP for total factor productivity) is linearly related to the value of the cumulated inputs into the country's R&D sector (denoted as S^D for domestic input stock) and a trade-weighted index of the S's corresponding to the country's major trade partners (denoted S^F). The basic hypothesis here is that there are positive but imperfect knowledge spillovers: The extent of the imperfection between any two countries depends negatively on the importance of their bilateral trade. The four openness-and-growth links identified by Grossman and Helpman (1991), suggest that knowledge flows may be influenced by other channels. Since some of these nontrade channels are surely influenced by

European integration, we hypotheses that European Union nations may have benefitted from S^F foreign more than nonEU nations.[4] To test for this, we rerun the Coe-Helpman regression including a multiplicative dummy for EU membership.

The first step in using these cointegration tests is to ascertain that the time series are integrated of order one. This has already been done for us by Coe and Helpman for TFP, S^D and S^F. Since the dummy does not change the time series properties of the underlying S^F, our multiplicative dummy is also trended. The second step is to run the regression and check whether the residuals are stochastically trended. If the residuals are trended, then the extremely handy "super-consistency" vanishes since the numerator and denominator of the bias may grow at the same rate.

The cointegration test statistics and the regression results are reported in Table 4-1. The first column of the table reproduces the main Coe-Helpman regression. There, we see clearly that foreign R&D effort helps explain the domestic TFP level; The G7 variable is a dummy for G7 countries; Its positive sign indicates that these countries rely more heavily than usual on domestic R&D. The last three columns report the same regression, on the same data, including a slope dummy for EU members. That is, we allow EU members to have a systematically different coefficient on the foreign R&D variable. Since the membership of the EU changed over the sample period, we try with the EU9 (France, Germany, Italy, Belgium, Luxembourg, Netherlands, UK, Ireland and Denmark), the EU10 (EU9 plus Greece, which entered in 1981), and the EU12 (EU9 plus Spain and Portugal, who entered in 1986). Unfortunately, the econometrics of stochastically trended panel data is not well-developed. We do, however, have the Levine-Lin test for whether panel data is integrated of order one. Using this test we cannot reject the hypothesis that the errors are integrated of order one. Since this is a necessary condition for cointegration, none of these regressions are cointegrated according to the Levine and Lin (1993) procedure.

To interpret the results, we add the EU dummy coefficient to the S^F coefficient to find out how much EU members' TFP levels depend upon foreign R&D. Note that in all cases, the EU members appear to learn more from foreigners than the average country in the sample. In the case of the EU9 and EU10, the S^F coefficient for EU members is an order of magnitude bigger that of nonEU members. While the lack of cointegration rules out formal inferences, we take this as weak evidence that EU membership allowed member states to enjoy a higher level of TFP than they would have otherwise. In other words, EU membership led to knowledge-led growth effects.

Of course, this test has little power against alternative hypotheses such as physical proximity, not EU membership, is the important factor. In future research, it would be interesting to try other hypothesis. Moreover, we conjecture that inclusion of other macroeconomic variables, such as capacity utilization rates, may result in cointegrated relationships.

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[4] For example, knowledge spillover could be affected by capital market integration, currency stability, mutual recognition of professional credentials, rights of establishment, labour mobility, common standards on competition and state aids policies, etc.

4.2 Testing for Integration-induced, Investment-led Growth

The next set of test looks at the hypothesis that European integration led to higher than expected investment. Most studies, including Barro (1991), Levine and Renelt (1992), and Baldwin and Seghezza (1996) find that lowering domestic trade barriers stimulates the investment-to-GDP ratios in a broad sample of countries. Baldwin and Seghezza (1996) also find that a lowering of foreign barriers also stimulates investment, although this finding is more sensitive to sample and specification changes. Of course, European integration completely eliminated tariffs on intra-EU trade, and eliminated all tariffs in Western Europe on industrial goods (these account for most trade in goods). Because European nations conduct the lion's share of their trade with each other (on average about two-thirds) we can firmly conclude that European integration has had a pro-growth effect via the investment channel.

However, just as the deeper-than-tariff-cutting aspects of European integration was found to stimulate knowledge creation, it might be that such deep integration stimulated physical capital formation. That is, it is possible that European integration stimulated investment above and beyond the amount captured by the tariff measure used by Baldwin and Seghezza. To check for this, we rerun the Baldwin-Seghezza system including an EU dummy.

Table 4-2 reports the results. The first column reports Baldwin and Seghezza's findings for their preferred specification and preferred sample. The next three columns report the result when the system is re-estimated with EU6, EU9, EU10 and EU12 intercept dummies are included in both the growth and investment equations. It is clear that the dummies are always insignificant at any reasonable level of confidence.

5. Summary and Directions for Future Research

This paper looks at the available empirical evidence on the link between European integration and European growth. It started by identifying two key economic channels through which European integration can influence European growth. The first is via investment-led growth, i.e. by affecting the rate of physical capital formation. Obvious examples of integration-induced, investment-led growth are rather easy to find, eg, Spain's accession-induced investment boom in the late 1980s. In addition to this casual empiricism, most econometric estimates find that the reduction of trade barriers promotes a higher investment rate and thereby a higher GDP growth rate. This finding has been confirmed on both time-series and cross-country data. To the extent that European integration has been responsible for the elimination of tariffs on approximately a third of world trade, we can firmly conclude that European integration has produced integration-induced, investment-led growth.

The second channel is via technology-led growth. Obvious examples of this are much harder to find, in part due to intrinsic difficulty of measuring knowledge-creation. Nonetheless, some studies have found a relationship between productivity growth and trade in general, and productivity growth and European integration in particular. More convincing evidence for this type of permanent growth effect of integration will be difficult to obtain. The fundamental fact is that most measures of productivity indicate that European knowledge creation has proceeded at a steady (or even falling) rate in the postwar period. European integration, by contrast, has steadily deepened. Consequently, the two cannot be linked by a simple linear relationship, as predicted by simple trade and endogenous growth models. This paper suggests one solution to this conundrum. It may well be the integration would have stimulated technology-led growth, but European governments used the luxury of these incipient pro-growth effects to install anti-growth social programmes. Thus, instead of showing up as steadily higher growth rates, European integration has shown up as a steady expansion of the social welfare state.

Much empirical work remains undone. In particular, the seminal paper by Coe and Helpman (1995) suggests a methodology for directly testing the long-run growth effect of integration. Another unexploited line of attack is the use of sectoral data. Most models of trade and growth suggest very specific hypothesis concerning the exact mechanisms by which integration affect growth. Thus rather than simply working with macro data, which after all contains only a limited amount of information, test could be performed on sectoral data. For instance, integration-induced, investment-led growth should show up much more in the sectors most directly affected by the integration.

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Table 2-1

Total Factor Productivity Growth Rate Averages

	1971-'90	1971-'74	1975-'90	Drop 1975-'90/1971-'74
EU6 Avg	1.50	2.70	1.23	0.45
EU9 Avg	1.44	2.40	1.21	0.51
EU12 Avg	1.36	2.38	1.13	0.48
EFTA5 Avg	1.30	2.48	1.03	0.41
Euro Avg	1.34	2.41	1.09	0.45
Sample Avg	1.24	2.29	1.01	0.44
UK, DK, IRL	1.33	1.90	1.19	0.62
E, P, GR	1.14	2.33	0.88	0.38

Source: Coe and Helpman (1995).
EFTA5=Austria, Finland, Norway, Sweden, Switzerland (no data on Iceland or Liechtenstein); EU6=Belgium, Netherlands, France, Germany, Italy (no data on Luxembourg); EU9=EU6+UK, Denmark (DK), Ireland (IRL); EU12=EU9+Greece (GR), Spain (E), Portugal (P).
Sample Average includes European nations + US, Japan, Australia, New Zealand, Isreal, Canada.

Table 4-1	Coe & Helpman	EU9 dummy	EU10 dummy	EU12 dummy
log S^D	0.089	0.097	0.88	0.090
G7 log S^D	0.134	0.124	0.130	0.136
log S^F	0.060	0.010	0.026	0.026
EU9 log S^F		0.153		
EU10 log S^F			0.120	
EU12 log S^F				0.089
R-square	0.56	0.67	0.65	.064
Lin & Levin (1993) unit root tests in panel data	1.76	6.6	2.06	1.63

The estimator is fixed effects. The dependent variable is TFP. See Coe and Helpman (1995) for sources and exact data definitions. The Levin-Lin I(1) test statistic follows a standard normal distribution. Note that this is not a formal test of cointegration since there is no correction for the number of included I(1) variables.

Table 4.2	B&S (1995)	EU6	EU9	EU10	EU12
Per Capita Growth	Equation				
Constant	-.02 (-1.5)	-.02 (-1.5)	-.02 (-1.5)	-.02 (-1.5)	-.02 (-1.5)
Initial Y/L	-4E-6 (-3.4)	-4E-6 (-3.3)	-4E-6 (-3.4)	-4E-6 (-3.4)	-4E-6 (-3.4)
Population Growth	.29 (.9)	.29 (0.9)	-.30 (-1.0)	.30 (.8)	.36 (1.0)
H Formation	-.01 (-.8)	-.01 (-0.8)	-.01 (-.7)	-.01 (-.8)	-.01 (-.7)
Initial H	4E-4 (1.8)	4E-4 (1.8)	4E-4 (1.8)	4E-4 (1.8)	4E-4 (1.9)
K Formation	.24 (6.2)	.24 (6.2)	.24 (6.3)	.24 (6.3)	.23 (6.2)
EU-dummy		-2E-4 (-0.0)	4E-4 (0.1)	5E-4 (0.1)	2E-3 (0.4)
R2	.54	.53	.53	.54	.55
Investment	Equation				
Constant	.5 (3.4)	.5 (3.4)	.46 (3.1)	.47 (3.2)	.49 (3.4)
log Initial Y/L	-.02 (-1.1)	-.02 (-1.2)	-.02 (-1.1)	-.02 (-1.2)	-.02 (-1.2)
log Population Growth	-4E-3 (-.3)	-4E-3 (-.2)	-.01 (-.5)	-.01 (-.6)	-.01 (-1.2)
log H Formation	.08 (4.9)	.10 (4.9)	.08 (4.8)	.08 (5.0)	.07 (4.9)
Log Initial H	-2E-3 (-.2)	-1E-3 (-.2)	-1E-3 (-.1)	-1E-3 (-.1)	-2E-3 (-.3)
Home Barriers	-1.05 (-3.8)	-1.06 (-3.8)	-1.0 (-3.8)	-1.1 (-3.9)	-1.09 (-3.9)
Foreign Barriers	-0.82 (-2.0)	-0.82 (-2.0)	-0.81 (-2.0)	-0.84 (-2.1)	-0.87 (-2.1)
EU-dummy		6E-3 (0.3)	-.02 (-0.7)	-.02 (-.9)	-.01 (-.5)
R2	.74	.74	.74	.74	.73

Figure 2-1

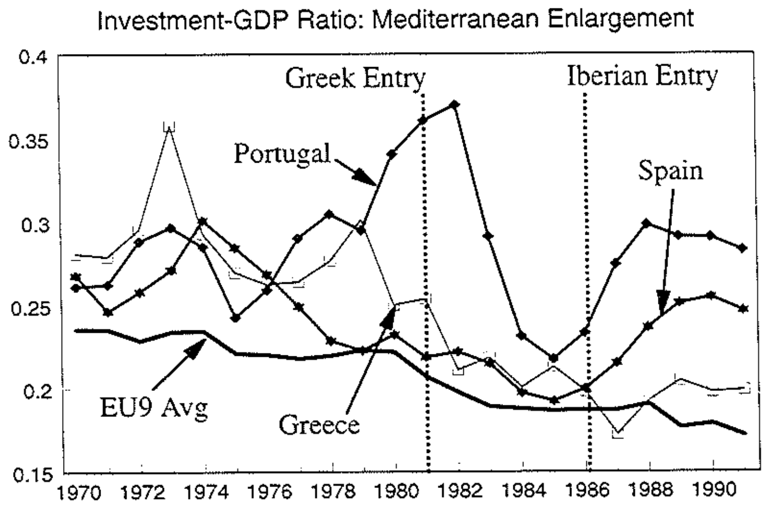
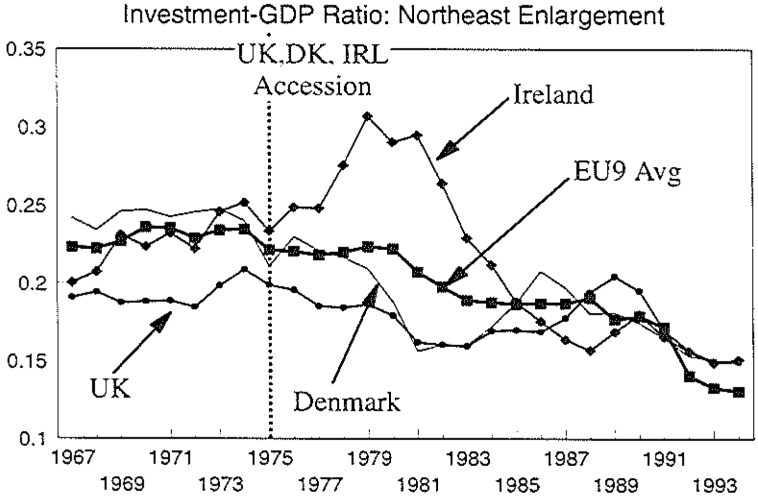

Investment-GDP Ratio: Mediterranean Enlargement
0.4
0.35
0.3
0.25
0.2
0.15
Greek Entry
Iberian Entry
Portugal
Spain
EU9 Avg
Greece
1970
1972
1974
1976
1978
1980
1982
1984
1986
1988
1990

Figure 2-2



Investment-GDP Ratio: Northeast Enlargement
UK,DK, IRL
Accession
Ireland
EU9 Avg
UK
Denmark
0.35
0.3
0.25
0.2
0.15
0.1
1967
1969
1971
1973
1975
1977
1979
1981
1983
1985
1987
1989
1991
1993