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ON THE GROWTH EFFECTS OF 1992

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ABSTRACT

This paper demonstrates that several types of dynamic trade effects can be easily quantified, at least roughly. These dynamic effects on output are found to be much larger than the static effects measured by existing empirical studies of trade liberalizations. The paper exposits and measures the Ricardian dynamic trade effect (the link between trade and steady-state level of productive factors). It also exposits and measures the Grossman-Helpman dynamic trade effect (the link between trade and the steady-state rate of accumulation of productive factors) by calibrating two of the "new" growth theory models.

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The aim of the 1992 program is to eliminate all barriers to the movement of goods, people and capital within the European Community. To this end, it will remove border controls, liberalise financial markets, harmonise VAT rates, standardise industrial regulations, open up government acquisition procedures and generally remove barriers to competition among EC firms. The Cecchini Report estimates that, by allowing a more efficient utilisation of productive resources, the program will lead to a once—off rise in EC income of between 2.5 and 6.5 percent. The mismatch between the radical nature of the liberalisation and the modest size of the estimated gains is striking, even though it is a common feature of all empirical studies of major trade liberalisations. There is a standard reply to this mismatch. The greatest benefits of a liberalisation, economists argue, are to be found not in its one—time effect on the allocation of resources, but rather in its dynamic effects: more innovation, faster productivity gains, and a higher growth rate of output and income. The Cecchini Report and other such studies ignore these dynamic effects for the simple reason that they are poorly understood and supposedly impossible to measure.

This reasoning brings to mind the man who one night loses his wallet in an empty lot but looks for it on the street corner, "because that's where the light is." Undaunted by the lack of empirical illumination, the EC's political leaders have emphasised the dynamic, or growth effects of 1992. Lord Cockfield in his foreword to the Cecchini Report states, "the completion of the internal market will open up: opportunities for growth, for job creation, for economies of scale, of improved productivity ... in short a prospect of significant inflation–free growth and millions of new jobs." This stress on growth is understandable. Small increases in the growth rate soon lead to large increases in the material standard of living. For instance, if 1992 raised Europe's growth rate even a half percentage point, the program would chalk up an extra 5 percent of real income not just once, but every ten years. If it permanently added one percentage point to EC growth, citizens' real income would triple in an average lifetime, instead of doubling as it will at the current growth rate.

Traditional thinking about the growth effects of liberalisations is guided by the neoclassical growth model which explains per capita growth entirely by technological progress. Since the determinants of this technological progress are not addressed, it is easy to see why the Cecchini Report found the growth effects of 1992 impossible to measure. Starting with Romer (1983), a number of economists (Krugman, Grossman and Helpman, Shleifer, Vishney and Murphy among others) have theoretically explored how competition, market sise and trade policy can affect growth rates. This "new" theory stresses the role of economy–wide increasing returns to scale and profit–motivated technological improvements as the primary determinants of productivity gains and growth. At first blush this new theory, with its models of imperfect competition, economies of scale and profit–motivated innovation, seems to be the ideal tool with which to address the growth effects of 1992. However the nascent literature has yet to converge on a consensus model. Nor has it been developed with an eye to empirical testing or implementation. Indeed, although some papers have offered stylised facts in support of the various models, no rigorous empirical tests have been performed. More importantly, no studies have tried to gauge whether policy changes have large or small effects on growth.

This paper is an exploratory attempt to analyse some of the dynamic effects of a market liberalisation, namely the 1992 program. The theoretical part of this is relatively straightforward. The quantitative part is trickier. Many of the key effects in the new theory involve factors which are unobservable, or on which the data are unavailable or unreliable. To get around this, I apply the calibration methodology which has been recently introduced to the trade literature by Dixit (1987), and Baldwin and Krugman (1987). Given the crude nature of this methodology (more on this below), the results should be thought of as rough, back—of—the—envelope calculations. In this sense, Samuel Johnson's quip about a dog walking on its hind legs applies to my empirics: the interest lies not in that it is done well, but rather in that it is done at all.

My analysis suggests two main policy points: (i) The Cecchini Report numbers significantly underestimate the economic benefits of 1992, perhaps by as much as an order of magnitude. (ii) The long term growth effects of 1992 could be very significant, adding between two tenths and nine tenths of one percentage point to the EC's long term GDP growth rate. Academically the key point is that 1992 will lead to easily quantifiable dynamic gains from trade which are independent of the new growth theories. The source of this effect is simple. As Baldwin (1989) shows, a broad—based liberalisation makes investment more profitable and thereby leads to an endogenous rise in the steady—state capital output ratio. As the economy moves to the new steady state, income rises above and beyond the rise due to the initial static gain. It may be useful to think of this indirect effect as a medium term "growth bonus" since its sise is proportional to the sise of the static gain.

Section 2 intuitively explains the link between scale economies and the dynamic effects of 1992. Section 3 presents some formal and informal evidence that scale economies are important in the modern world. Section 4 looks at the policy implications of three types of models in the new growth theory. Section 5 explains how we calibrate the models and Section 6 presents the empirical results. Section 7 contains a summary and concluding remarks.

2. Increasing Returns to Scale and the Growth Effects of 1992

Given the size of an economy's labor force, investing extra capital raises total output. Simple mathematical manipulation shows that in the traditional model (i.e., with no scale economies), the extra output arising from an extra unit of capital depends on the capital labor ratio —— not on the total amount of inputs employed. Moreover with no scale economies, adding more equipment, tools and machines boosts output, but the size of the incremental rise decreases as the amount of capital per worker rises. Of course to come up with an extra unit of capital requires investment which in turn requires someone in the economy to postpone consumption. It is not hard to see that due to the diminishing marginal product of capital, the economy–wide capital labor ratio will eventually reach a point where the extra output stemming from an additional unit of capital is not great enough to induce someone to postpone the necessary amount of consumption. Per capita growth therefore grinds to a halt.

How then does the traditional model account for the growth the world has experienced since the industrial revolution? Simple. It assumes that continual mana–from–heaven technological advances lead to growth in both the capital labor ratio and per capita income. That is, the model makes assumptions which imply that long term growth depends only on technological progress (which is usually modeled as a time trend). Things like trade barriers, market size, and the harmonisation of industrial regulations therefore cannot affect long term growth. Clearly such a framework makes the analysis of the growth effects of 1992 rather difficult. Several notable efforts have been made to account for technological progress in a piecemeal fashion (Maddison 1987, Denison 1985). However policy analysis based on such empirical results is inevitably ad hoc.

By contrast, if there are increasing returns to scale on an economy–wide basis, the marginal product of capital (and therefore the return on investment) depends on the total amount of factors employed as well as on the capital labor ratio. The investment decision, and thereby capital accumulation and growth, depend on the total amount of factors employed. Market size, therefore, matters. Programs like 1992 matter. Furthermore, increasing returns to scale reduces or eliminates the need for an exogenous time trend to explain growth. Three types of models from the new growth theory and their policy implications are discussed in Section 4. The common element shared by all three, however, is the presence of increasing returns to scale at the economy—wide level. It is well understood that the presence of factory—level scale economies has important implications for the once—off increase in the level of GDP due to a market liberalisation. What the new growth theory shows is that economy—wide scale economies imply that a bigger market can result in a higher growth rate of GDP in the medium term and possibly permanently. The goal of this section is to illustrate, as simply as possible, the link between scale economies and the growth effects of a broad—spectrum liberalisation like 1992. As we shall see, this link provides a simple way of illuminating one type of dynamic gains from trade. The following discussion is based on Baldwin (1989).

2.1. An Easily Measurable Dynamic Effect of Market liberalisation

For simplicity, suppose we can view the economy—wide relationship between the capital stock (K) and the labor force (L) and the output of goods per worker (GDP/L) as being governed by a simple formula: $(GDP/L) = \Omega K^{\theta}(K/L)^{\alpha}$. The number θ is a measure of aggregate scale economies (the traditional model sets θ equal to zero; the new growth theory lets θ be positive). Specifying the micro foundations of these scale economies is an important contribution of the new theory. Moreover, the discussion in Section 4 shows that certain policy implications depend upon the source of the increasing returns. For the moment, however, just take θ as given in order to highlight the link between scale economies and growth. The number α comes from the output elasticity of labor (which is $1-\alpha$). The parameter Ω is a measure of overall efficiency which may be changed by things like the 1992 program. Again, to facilitate the exposition we ignore changes in the labor force (L is constant) and any exogenous technological progress. This formula is plotted as YY in Figure 1.

To see how GDP grows, we must determine how the capital stock grows via savings and investment. There are many ways to do this. The simplest is to suppose that the economy saves and invests a constant fraction of GDP (call this fraction s). This assumption enormously simplifies the exposition without fundamentally altering the conclusions. However, since the assumption disobeys a standing order in modern macro theory —— "if it moves, maximise it" —— a more complete model, based on Baldwin (1989), is sketched in Appendix 1. Continuing with the constant savings rate assumption, we see that the supply of investment per worker varies with the capital labor ratio according to SS in Figure 1 (which is simply s times GDP/L).

From the economy–wide perspective, this investment must go either to creating more capital, or to replacing the faction of the existing capital stock that depreciates each year. If there is any investment left over after making up for depreciation, the capital labor ratio rises. The steady–state capital labor ratio is that level where all investment is devoted to replacing last year's depreciation. The investment per worker required to replace depreciation is plotted as DD (this is simply δK/L where δ is the rate of depreciation). Simple algebra shows that as long as $\theta+\alpha$ is less than one, point A in Figure 1 pinpoints the stable levels of the capital labor ratio and the output per worker. That is, the K/L ratio will tend to rise if it starts out less than $(K/L)^A$, and it would tend to fall if for some reason it ended up greater than $(K/L)^A$.

With all this on the drawing board, we are ready to look at one type of dynamic effect of the 1992 program. The first step is simple: the removal of barriers to trade, barriers to competition, and barriers to capital and labor mobility will improve the overall efficiency with which the EC labor force and capital stock are combined to produce output. This will lead to a once–off shift up in the YY and SS schedules (this corresponds to an increase the Ω in the GDP formula). We draw the new curves at YY' and SS'. (The size of the upward shift is estimated to be between 2.5

and 6.5 percent by the Cecchini Report.) What happens next? With the higher SS curve, there is more investment left over after making up for depreciation. Consequently the capital stock rises. If there are no scale economies, the EC output per worker and capital labor ratio eventually converge to point B. However if there are scale economies (θ greater than zero) then the rise in K causes the YY and SS schedules to shift up again (say to YY" and SS"). And the cycle repeats. We have drawn the new stable capital labor ratio and output per worker level as point C.

In a nutshell, in addition to raising per capita income directly, the market liberalisation has the indirect effect of improving the investment climate in Europe. This leads to a higher steady—state capital labor ratio. As the economy moves toward its new steady—state capital labor ratio, income will rise by more, perhaps much more, than the original static efficiency gain.

2.2. A Growth Bonus from Market Liberalization

A useful way of thinking of this indirect, dynamic effect of market liberalisation is as a medium term "growth bonus" since its size is proportional to the size of the direct, static effect. Moreover as long as $\alpha+\theta$ is less than one, the long run growth rate will eventually fall back to its pre—1992 level. That is to say, the rise in the steady—state K/L level leads only to medium term, not long term growth. Graphically it is simple to see the division of output gain between the direct effect and the growth bonus. The direct effect of 1992 on GDP per worker is the difference between $(GDP/L)^{A}$ and $(GDP/L)^{x}$ (regardless of the size of θ). For the traditional model the growth bonus is the difference between $(GDP/L)^{x}$ and $(GDP/L)^{B}$. For the increasing returns case, the bonus is the difference between $(GDP/L)^{x}$ and $(GDP/L)^{C}$. The size of this growth bonus depends on how important economy—wide increasing returns to scale are. In the traditional growth model, the bonus is not negligible. To give a bit of a preview, section 6 shows that even in the traditional model it is equal to about 40 percent of the static gain. Section 6 also shows that the presence of economy—wide scale economies can greatly magnify this.

In the simple Figure 1 model, the growth bonus comes from the fact that the liberalisation directly boosts the amount of savings and investment in the economy. Regardless of whether there are scale effects, this extra savings leads to a rise in the stable level of the capital output ratio. In the more complete model in the appendix we get an identical effect via a different economic channel. The liberalisation raises the marginal return on investment (vis marginal product of capital). Consumers therefore find it optimal to invest more. If $\alpha+\theta$ is less than one the marginal return on investment eventually falls to its pre–liberalisation level as the capital labor ratio approaches $(K/L)^C$.

2.3. The Long Term Growth Bonus in Romer's Model

The growth bonus illustrated in Figure 1 is essentially a medium term rise in the growth rate since the steady–state growth rate eventually returns to its pre–liberalisation level. In terms of Figure 1 this occurs when the economy reaches point C. However, if the scale economies are large enough it is possible that 1992 could lead to a permanent rise in the EC's growth rate. This is certainly one of the most radical, and most contended, implications of the new growth theory.

Simple algebra shows that a liberalisation can have long term (i.e. permanent) growth effects only if $\alpha+\theta$ is greater than or equal to one. As it turns out, if scale effects are large enough so that $\alpha+\theta$ is greater than one, we should observe accelerating growth. Since this is pretty clearly not a fact of life in the modern world, we dismiss this theoretical possibility. On the other hand, if the scale economies are such that $\alpha+\theta$ exactly equals one then a one–time market liberalisation leads to permanently higher growth. It may seem a bit strange to think that $\alpha+\theta$ would be equal exactly to any given number at all, much less one. However Romer has presented a fairly reasonable model (see Romer 1987) where this is true; furthermore he has presented some very crude empirical evidence that $\alpha+\theta$ actually does equal one in the US. Although Romer's empirical methodology is faulty, given the present state of knowledge about economy–wide returns to scale, we cannot rule out conclusively the possibility that $\alpha+\theta$ equals one. Since it has important new policy implications, we exposit what the growth effects of 1992 would be, if $\alpha+\theta$ does indeed equal one. The principal difference between this case and the Figure 1 case is that the K/L ratio never reaches a stable level. In other words even without exogenous technological progress, K/L and per capita output continue to grow. (This should in no way be considered a drawback, since in fact K/L has risen for at least a century in the industrialised nations.) Basically, this is because the marginal product of capital is not diminishing in K/L when $\alpha+\theta$ is one. A consequence of this property is that attempts to find the new stable level of K/L (e.g. point C in Figure 1) are futile. Nevertheless, translating the case of $\alpha+\theta$ equal to one into a formula is straightforward. Doing so gives us a handy portmanteau for our policy discussion.

Again start with the GDP formula, $GDP_t = \Omega K_t^{\alpha+\theta} L_t^{(1-\alpha)}$ and the supply of investment formula, $S_t = sGDP_t$. Combine these formulas with the depreciation of capital (setting $\alpha+\theta$ to one) and we see that next year's capital stock, K_{t+1}, must equal $K_t(1-\delta) + S_t$, i.e., $K_t(1-\delta) + s\Omega K_t L_t^{(1-\alpha)}$. Plugging back into the GDP formula, allowing for labor force growth of η percent per annum and taking the ratio of next year's GDP to this year's gives us:

$$\left(1 + \begin{matrix}\text{growth}\\ \text{rate}\end{matrix}\right) = \left[1 - \left(\begin{matrix}\text{depreciation}\\ \text{rate}\end{matrix}\right) + \left(\begin{matrix}\text{investment}\\ \text{rate}\end{matrix}\right) \times \left(\Omega\, L^{(1-\alpha)}\right)\right] (1+\eta)^{(1-\alpha)} \qquad (1)$$

Let us briefly point out the variables that would result in faster GDP growth: static efficiency gains (increase in Ω), a larger market size (as measured by L), a higher growth rate of the labor force, and a higher savings rate.

Looking at this formula, we see that a once–off efficiency gain would raise Ω and thereby the long term growth rate. This rise, however, is not an independent effect of 1992. Rather it is tied directly to the size of the static efficiency gain. Again it is useful to think of this long term dynamic effect as a growth bonus. Using equation (1) it is simple to see that this long term growth bonus equals:

$$\begin{bmatrix} \text{LT} \\ \text{Growth} \\ \text{bonus} \end{bmatrix} = \left[\frac{s\text{GDP}/K}{1 - \delta + s\text{GDP}/K}\right] \times \begin{bmatrix} \text{Static} \\ \text{effects} \\ \text{of 1992} \end{bmatrix}.$$

Thus the size of the growth bonus depends on the size of the static effect as well as the net and gross rates of investment.

3. The Data versus the Traditional Growth Model

In "A Scandal in Bohemia" Sherlock Holmes tells Watson that it is a capital mistake to theorise before having the facts, since insensibly one juggles facts to fit theories, not theories to fit facts. It would appear that much of the empirical work on the traditional growth model ignored this wisdom. In this section I offer formal and informal evidence that the data has been trying to tell us all along that scale economies are important at the micro and macro levels. This is an essential task. If the neoclassical model is right, the new theory must be wrong. Consequently the static gains from the 1992 program can have no long term growth effects, and will only lead to a modest medium term growth bonus.

Section 3.2 discusses some high—brow econometric results that tend to reject the traditional model's crucial assumption of constant returns to scale. However, to many analysts the more intricate the econometric methodology is, the less convincing are the results. I therefore first present some evidence against constant returns which does not rely on advanced econometric reasoning. The advantage of this type of evidence is its transparency. The drawback is that it is only suggestive, not conclusive.

3.1. Traditional Growth Theory and Growth

The crucial assumption of the traditional theory is constant returns to scale. Taken literally, this assumption implies that each of us could have a personal economy in our garden producing all the goods and services we consume each year. Moreover, constant returns implies that such an arrangement would be as efficient as the industrial structure that actually exists. Obviously in this unadulterated form, the assumption does not pass the laugh—test, much less any sort of econometric test. Nevertheless, rejecting firm—level constant returns does not let us reject the traditional model. What the model actually requires is that the aggregate economy act as if there are constant returns.

For instance, suppose the average cost of making and selling an automobile follows the classic U—shape depicted in Figure 2. If the market is quite competitive, car producers will be forced to operate at the minimum—cost level of output (otherwise competitors would under cut their price). This level is shown as point A (N cars at an average cost of C). Now at point A, but at no other point, returns to scale are constant. That is the average cost of making the $N+1^{th}$ car is essentially the same as making the N^{th} car. Thus despite the fact that firms face increasing returns, competition (vis contestability) forces them to operate at the point where returns are locally constant. Thus with this add—on story, the fact of ubiquitous firm—level scale economies can be made to be consistent with approximately constant returns to scale at the aggregate level. In other words, the GDP formula of the traditional model is a reduced form relationship that takes competition as well as technology into account.

This add—on story points out why it is so difficult to actually test whether there are constant returns to scale at the economy—wide level. Ubiquitous firm—level scale economies need not imply aggregate scale economies. Moreover, the absence of firm—level scale economies does not imply an absence of economy—wide increasing returns. For instance, there may be technological spillovers between firms, or economies of agglomeration. Or as Adam Smith argued, it is possible that larger markets can support finer divisions of labor (more on this in Section 4).

The next strike against constant returns can be found in the world pattern of trade. Much of the world's trade is two—way trade in similar products between similar countries (i.e., industrialised countries tend to import approximately the same types of goods that they export). The most plausible explanation for this is that there are economies of scale at the firm level. More importantly, the scale economies are large enough so that they are not exhausted by the output that domestic sales alone would support. In other words, the U—shaped cost curves typically bottom out at a point that exceeds domestic sales. What this says is that market size might matter. If the market a producer faces is not large enough, there will be unexhausted economies of scale at the aggregate level. However again the case against constant returns is not airtight. Trade among OECD nations is relatively free, thus it still may be that firms typically operate at the bottom of their cost curves.

3.1.1. Some Aggregate Evidence Against the Traditional Model Now let's look at the assumption of aggregate constant returns from another angle. Recall that the traditional model predicts that per capita output growth would grind to a halt without continual mana—from—heaven technological advances. In other words, according to the traditional theory we need a time trend to explain the growth in per capita output. It is simple to write down a formula for the traditional theory's explanation for growth. The formula divides growth into two parts: a part that can be explained by the growth in the K/L ratio (which itself is driven by the technological advances), and a part that is explained by a time trend which is labelled technological progress. In terms of percent changes, this says:

$$\begin{bmatrix}\text{\% change in}\\ \text{output per}\\ \text{worker}\end{bmatrix} = \begin{bmatrix}\text{Technological}\\ \text{progress}\end{bmatrix} + \alpha \begin{bmatrix}\text{\% change in}\\ \text{capital per}\\ \text{worker}\end{bmatrix},$$

where the value of α is taken as something like 0.25 or 0.3. The received wisdom of the traditional model is that, of the two parts, technological progress is by far the most important, accounting for 50 to 80 percent of growth. By contrast, some of the new growth models (for example when $\alpha+\theta$ equals one) predicts that per capita growth can be fully explained by growth in the capital labor ratio without appeal to a time trend.

Let's see whether the data likes the traditional theory's idea that per capita growth is mostly explained by a time trend and not by the rise in the K/L ratio. Unfortunately it is impossible to get data on technological progress (indeed it is hard to be exactly sure how to define it). Data on the capital labor ratio and output per worker, however, are readily available for the past 75 or 100 years. Figures 3a through 3f plot an index of GDP over a measure of the labor force against an index of the capital stock over the same index of the labor force for France, Germany, Italy, Japan, the UK and the US. (The index measures hours worked instead of employment to improve international comparability.) 1913 is the base year for all indices. It is immediately obvious from the figures that if the data had its way, the value of α would be pretty close to one, not one third. Moreover, if α was allowed to be close to one, there would be no need for a time trend to explain growth. Consequently the technological progress term would be largely extraneous.

Clearly, these figures suggest that it was not the facts that told us we had to juggle the theory to account for a time trend. Rather it was the traditional theory that told us we had to juggle the facts to get a time trend into the data. And it is pretty clear how the traditional theory accomplished this. Output per worker and the capital labor ratio move one–for–one with each other in the real world. Since traditional theory dictates that α be a fraction like 0.3, there will be a lot of "unexplained" growth leftover to assign to the conveniently unobservable technological progress. To graphically demonstrate this point I have plotted what α times K/L looks like, taking α equal to 0.3. The difference between GDP/L and 0.3(K/L) is exactly the amount of growth that the traditional model explains with unobservable technological progress.

Now obviously others have looked at these graphs before. How is it that they continued to assume constant returns? Explaining the history of economic thought is not the task at hand, but perhaps Sherlock Holmes' observation offers an insight. Until Arrow (1962) no one really knew how to deal mathematically with increasing returns at a macro level (and even then there were serious questions about the micro foundations of the Arrow model). Perfect competition and constant returns to scale were the assumptions of choice. Moreover these assumptions are extremely convenient from a mathematical point of view not just for growth theory but for all types of economics. Evidence of scale economies meant that these elegant models were all wrong.

Keeping the great sleuth's adage in mind, if one looked at the facts first one would think that the task at hand would be to juggle the theory into explaining: (i) how the rise in the capital labor ratio accounts for all of the per capita growth (not one third of it as in the traditional model) and (ii) how the rise in the K/L has no tendency to grind to a halt. Again, figures 3a–3f are merely suggestive. However one thing they do suggest is that the traditional model's empirics (so–called growth accounting) were an exercise in juggling facts to fit theories, not theories to fit facts. Next we turn to the traditional theory's explanation of these figures.

3.1.2. The Traditional Model's Rejoinder A traditional growth theorist would point out that these figures can be made to be consistent with constant returns to scale. Figures 3a through 3f reflect the well–established fact that the capital output ratio has been roughly constant for a century. While at first glance this seems to fly in the face of the traditional model's assumption, there is a tidy explanation which makes the traditional theory consistent with the observed constancy of the capital output ratio. Once again the unobservable time trend provides the solution. In most reasonable models of savings and investment behavior, the steady–state real rate of interest is determined by things like savers' preferences and the growth rate of consumption. If consumption growth equals output growth and both are approximately constant (due to constant technological progress) then the real rate of interest should be approximately constant. Next, with constant returns to scale, profit maximising firms will choose an output capital ratio that is proportional to the real rate of interest. Thus these two points account for the approximate constancy of the capital output ratio. Lastly simple algebra shows that in this model the change in the output capital ratio equals the sum of the time trend and (α—1) times the growth in the capital labor ratio. Plainly then, a positive time trend forces growth in the K/L ratio. In a nutshell, the traditional theory asserts that technological progress drives growth in both GDP/L and K/L, and that the capital output ratio is constant because the real interest rate is constant.

Plainly, we have two competing explanations for the same set of facts. So far we have no formal basis on which to choose between them. Next we present some high—brow econometric results that tend to reject the traditional model's crucial assumption of constant returns to scale.

3.2. Econometric Evidence Against Constant Returns to Scale

Caballero and Lyons (1989a, b), and Hall (1988) have addressed the question of scale economies using industry—level data on manufacturing. The Caballero and Lyons model encompasses the Hall model, so we focus on theirs. Suppose output per firm (call this Y_i for firm i) is related to K_i and L_i as well as the state of technical know—how (denoted as A). Additionally suppose that there are external economies of scale in the economy. That is, we allow for the fact that a firm might be more efficient when there is a lot of industrial activity in the country. This might be due to Adam Smith's idea that the division of labor is limited by the extent of the market, or to things like infrastructure and technological spillovers. In the end this means the assumed output formula is: $Y_i = (K_i^{\alpha\gamma})(L_i^{(1-\alpha)\gamma})(Y)^{\beta}(A)$, where Y is total output of manufactured goods. The number γ (which will be estimated) is a measure of internal scale economies, β (also estimated) is a measure of external economies of scale. A is a random productivity shock. Hall's model assumes that β is zero. Adding up this relationship across all firms, the relationship between output in manufacturing, the aggregate capital stock, aggregate labor force and the unobservable $\mathcal{A}$ becomes:

$$\begin{bmatrix} \% \\ \text{change} \\ \text{in Y} \end{bmatrix} = \left(\frac{\lambda\alpha}{1-\beta}\right) \begin{bmatrix} \% \\ \text{change} \\ \text{in K} \end{bmatrix} + \left(\frac{\lambda(1-\alpha)}{1-\beta}\right) \begin{bmatrix} \% \\ \text{change} \\ \text{in L} \end{bmatrix} + \left(\frac{1}{1-\beta}\right) \begin{bmatrix} \% \\ \text{change} \\ \text{in } \mathcal{A} \end{bmatrix} \qquad (2)$$

Now with data on K_i, L_i, Y_i and manufacturing output as well as capital and labor's cost shares, one can estimate the size of internal and external scales economies, γ and β. $\gamma/(1-\beta)$ is a measure of overall economies of scale. There are a number of technical questions as to the correct estimation procedure. Caballero and Lyons, and Hall adopt different approaches.

The Caballero and Lyons get industry-level estimates as well as an aggregate manufacturing estimate of $\gamma/(1-\beta)$ for France, Germany, the UK, Belgium and the US. The former are reproduced in Table 1. To interpret these estimates, note that constant return to scale implies that all the $(\frac{\gamma}{1-\beta})$'s should be equal to one. In fact they are all greater than one. That is to say that according to this data, the best guess is that there are unexhausted economies of scale in aggregate manufacturing. Nonetheless the estimates are rather imprecise. For instance we cannot reject the hypothesis that $(\frac{\gamma}{1-\beta})$ actually equals 1.40 for all the countries. If $(\frac{\gamma}{1-\beta})$ does equal 1.40, a 10 percent increase in K and L would lead to a 14 percent increase in output. Likewise, we can reject the hypothesis that $(\frac{\gamma}{1-\beta})$ actually equals one only in the cases of France and the US. The Hall (1988) results for particular US industries are summarised in the next row of Table 1. Caballero and Lyons show that Hall's estimate is in fact an estimate of the inverse of $(\frac{\gamma}{1-\beta})$. Thus it is still true that Hall's estimates should all be equal to one if there are constant returns to scale. However, now we have evidence of increasing returns if the numbers are below one. As it turns out all the estimates are below one. Indeed, in five out of the six industries he handily rejects constant returns to scale.

Due to the methodology Caballero and Lyons adopt, we must multiply the overall $(\frac{\gamma}{1-\beta})$ by capital's share in costs to recover the crucial $\alpha+\theta$ from these estimates. This may very well underestimate the true $\alpha+\theta$. Essentially by imposing that external effect be related to Y rather than K and L independently, they may well have underestimated the economy-wide capital output elasticity. Romer (1987), for instance, argues that all external economies come through the capital stock.

In summary, the jury is still out on how important scale economies are at the economy-wide level. This formal and informal evidence is a long way from an air tight case against constant returns to scale. However, my task here was simply to raise a reasonable doubt about the traditional theory's key assumption of constant returns. I hope that case is strong enough to prevent the analysis from being dismissed as empirically empty theorising.

4. Policy Implications of Three Different Sources of Scale Economies

Increasing returns to scale arise at the level of the factory, the firm, the industry, the region, the country, and the world. The level at which the scale economies occur is critical to policy implications. This section discusses three standard sources and their implications for the 1992 program.

4.1. Specialized Inputs

Adam Smith long ago stated that the division of labor is limited by the extent of the market. Since a finer division of labor presumably allows each type of labor to do its job more efficiently, a larger market may lead to a higher level of output. Romer (1986), and Allen (1926) have shown that the same sort of mechanism implies that a larger market can lead to a higher growth rate of output. Suppose the development of a new specialised input (think of this as a finer division of labor) makes the production of goods more efficient. If the production of the specialised inputs is subject to scale economies then the profitability of introducing new ones may increase with market size. If the profitability increases, it is likely that the rate at which new productivity—boosting inputs are developed will also increase. The faster productivity growth would lead to faster GDP growth.

The EC's one—time income rise due to the liberalisations in the 1992 program will have the effect of expanding the market for any given specialised input. It is possible that this would lead to faster introduction of new specialised inputs and therefore an increase in the rate of productivity and output growth. However, on average about 15 percent of EC output is exported to non—EC countries whose GDPs will presumably not be substantially affected by 1992. This dampens the market expanding effects of the program. Moreover, growth from this source depends on growth in the number of specialised inputs available to EC firm. It does not require that the specialised input be produced in the EC. For instance, specialised industrial robots and advanced microprocessors boost EC productivity but are not made in the EC. Clearly the rest of the world accounts for a large fraction of the growth in new inputs. Thus 1992's impact on worldwide growth of new specialised intermediate inputs will be further dampened by the fact that it will not significantly affect the profitability for the large fraction of developers outside the EC.

4.2. Technology Spillovers

A second source of scale economies is technology spillovers. The idea can be seen by thinking about why firms cluster in places like Silicon Valley or the high tech area outside Cambridge, England. The advancement of knowledge is not an easy process to tie down, but often it is facilitated by the presence of many innovators concerned with similar problems. This way a technological advance by one firm spills over onto other firms. Taking this as a given, it is clear that doubling the number of innovators will more than double the amount of innovation as the productivity of each is aided by the presence of the others. Consequently a larger, more open market can lead to faster growth.

But how should one define market size here? Information can be exchanged and informal contacts maintained among innovators that are geographically dispersed. Thus maybe the overall size of the world industrial economy is the relevant market size. Using this definition, the rate at which new knowledge disseminates to each country would be an important determinant of growth, as emphasised by Grossman and Helpman (1989). Presumably the completion of the internal market would boost the rate at which technological advances would disseminate among EC members. This would tend to lift the growth rate of each member's productivity and therefore growth. However with this definition, EC productivity advancement depends in a large part on knowledge created outside of the EC. The growth effects of 1992 will therefore be dampened unless 1992 significantly affects the rate of knowledge creation in non—EC countries (especially the US and Japan). Moreover, any move toward Fortress Europe might hinder the dissemination of knowledge from non—members.

4.2.1. Euro Rust Belts Alternatively, face—to—face interaction, or a buyer—seller relationship may be the key to technology spillovers. In this case the relevant market size seems to be the amount of activity in a city or region (like Lyon or the Ruhr Valley). If this region—size definition of scale economies is correct, the completion of the internal market may lead to "Euro Rust Belts". Without national borders to restrict them, EC firms may find it worthwhile to concentrate geographically at the EC level rather than just at the national level. Thus instead of having 12 separate industrial regions (Germany's Ruhr valley, Italy's Pianura Padana, England's Spaghetti Junction, etc.) after 1992 there may be only a handful of such regions as in the US and

Japan. Good news for the locals in the expanding regions; bad news for those in the contracting regions.

4.3. Profit–Motivated Innovation, Growth and 1992

Of the three commonly cited sources of economy–wide scale economies, the most concrete and intuitively appealing is that of endogenous technological change (typically associated with the names of Schmookler and Schumpeter). The basic idea is straightforward. The effectiveness with which capital, labor, land, etc. are combined to create value is constrained by technical and managerial know–how. The state of such know–how, however, is largely the product of profit motivated firms. Many basic scientific advances may be insensitive to commercial motives (e.g. CERN's finding the Z–particle, or the discovery of room temperature superconductors). Yet their application in an effort to get more value out of fewer inputs is a task inevitably undertaken by firms. An innovation (in product or process) usually gives the innovator a temporary edge over competitors and thereby boosts profits. From the macro perspective, the effect of these profit–motivated technological improvements is growth (see Grossman and Helpman 1988). Schematically the Schumpeterian logic is:

Profitability of innovation → Investment in fixed costs of developing innovations → Productivity growth → GDP growth

Given this, it is easy to see how the 1992 program might lead to faster growth. The removal of the hundreds of small trade barriers could allow a potential innovator to spread the R&D costs over more units. This would make innovation more profitable. Consequently more of it would occur and the pace of productivity and GDP growth would quicken.

Obviously this is not a new idea. The contribution of the new growth literature has been to crystalise it into mathematical relationships. This allows us to check it for subtle logical inconsistencies and, more importantly, provides a hope that the effect can be quantified.

Grossman and Helpman (1988) have studied endogenous product innovations; Shleifer (1986) and Krugman (1988) have studied process innovations. The model discussed below is an extension of Krugman's model.[1]

4.3.1. A Model of Endogenous Innovation and Growth Growth models of endogenous innovation view R&D spending on innovation as investment. In a nutshell, the amount of innovation done each period depends on two things: the profitability of innovating and the willingness of people to invest, i.e., postpone consumption. The equilibrium rate of innovation (or more precisely spending on R&D) is the level at which the profitability of an extra innovation is just high enough to prompt the necessary amount of consumption postponement. To be more precise we examine the two aspects separately, starting with the savings—investment decision.

If the economy is to innovate and grow faster, more investment in R&D is required. This of course means more consumption must be postponed. To induce people to postpone the extra consumption requires a higher rate of return on their savings (savings of course is just postponed consumption). The allocation of consumption across time is crucial in many economic models. One standard approach to this question is to assume that the elasticity of substitution between consumption this year and consumption next year is constant. We refer to this elasticity as σ. Given this, the percent growth in real consumption equals σ times the difference between the rate of return on foregone consumption and the rate of pure time preference. (Essentially postponing consumption means that next year's consumption is higher than this year's. The amount of consumption that people choose to postpone depends positively on the rate of return and the degree to which next year's consumption is a substitute for this year's.)

There is a good deal of evidence that growth is balanced in the long run. Balanced in the sense that real consumption grows at the same rate as real output. Here we focus only on such long run, balanced growth paths. Since the growth of consumption is directly related to σ and the rate of return, on a balanced growth path the growth rate of output is related in the same way to the same variables. In the simple model we consider here, innovation is the only form of investment. The rate of return on R&D spending is therefore what we turn to next.

In general it is not a simple matter to measure, or even define, an innovation. The extensive empirical literature on the links between innovation and market structure, firm size, concentration ratios, appropriability, etc, employs a wide range of proxies, none of which are fully satisfactory. Here we abstract from such problems by dealing with a stylised, or average, innovation. We simply assume that a cost–reducing innovation can be developed by investing F units of resources this period. The investment enables the innovator next period to manufacture a given product at a fraction of the pre–innovation cost (call this fraction γ). In other words if the unit resource requirement to produce good i was a_{it} in period t, then by investing F units of resources in R&D, the innovator can produce good i at a constant marginal cost of γa_{it} in period t+1. Again to keep things simple we suppose that the patent on the innovation lasts one period. After that it becomes public knowledge.

The innovation gives the innovator a clear advantage during its patent life. The profit corresponding to this advantage is worked out explicitly by Krugman (1988). The key results are that in absence of trade barriers and regulations, the profit margin and expenditure per innovation are constant. However due to trade barriers, in addition to producing the good, the firm must devote resources to overcoming these barriers. A convenient way to capture the effect of frictional trade barriers is to employ Samuelson's "iceberg" transport costs. To wit, the whole gamut of small trade barriers are modeled as having the effect of "melting" a certain fraction of output. For notational simplicity we refer to the profit margin including trade barriers as $(1-\Gamma)$. Lastly to capture the costs of non–Europe other than trade barriers, we suppose that these costs are proportional to the production costs. We call this factor μ. Thus profits are the profit margin, $1-\Gamma$, times the total expenditure on the product divided by $1+\mu$.

Recall that the equilibrium rate of innovation is where the profitability of an extra innovation is just high enough to prompt the necessary amount of consumption postponement. From the discussion above, we have that the relationship between the rate of growth of output and the various factors affecting the profitability of innovation is:

$$\begin{bmatrix} \text{long term} \\ 1+\text{growth rate} \\ \text{of output} \end{bmatrix} = \begin{bmatrix} (\frac{1}{1+\rho}) \begin{matrix} \text{profitability} \\ \text{of} \\ \text{innovation} \end{matrix} \end{bmatrix}^{(\frac{\sigma}{1-\sigma})} \qquad (3)$$

where

$$\begin{bmatrix} \text{profitability} \\ \text{of} \\ \text{innovation} \end{bmatrix} = \begin{bmatrix} \left(\frac{(1-\Gamma) \times \begin{matrix} \text{resource} \\ \text{expenditure} \\ \text{per good} \end{matrix}}{1+\mu} \right) / F \end{bmatrix} \quad \text{and}$$

$1-\Gamma$ = profit margin net of trade barriers,
μ = costs of non-Europe other than trade barriers,
σ = intertemporal elasticity of substitution in consumption,
ρ = pure time discount (equal to something like 0.95),
F = fixed cost of developing an innovation.

This relationship permits analysis of many of the long term growth effects of the 1992 program. First it is obvious that any aspect of 1992 that affects the profitability of innovation can affect the long term growth rate. To mention a number of important ones:

(i) Trade Opening. The removal of the hundreds of small non-tariff barriers boosts profits by effectively increasing the size of the market over which R&D costs can be spread. In (3) this corresponds to an increases in $1-\Gamma$.

(ii) Fortress Europe. Any increase in external protection that leads to retaliation against EC exports would tend to offset the liberalisation of the internal market. Since EC exports are split roughly 50–50 between EC and non-EC countries, a tit-for-tat retaliation against moves toward Fortress Europe could entirely negate the market expansion effects of the trade opening aspect of the 1992 program. These effects would show up in $1-\Gamma$.

(iii) Pro–Competitive Effects. The Schumpeterian trade–off between static and dynamic efficiency is clear in this relationship. The pro–competitive effects of 1992, which are judged to be quite substantial by the European Commission, would tend to offset the growth effects of the market expansion. In equation (3) this corresponds to a fall in $(1-\Gamma)$. Note that in this model extra competition has no effect on innovation. There are sensible theories showing that competition promotes innovation, and sensible theories that tell us that competition hinders innovation. Empirical efforts have been unable to identify whether competition helps or hinders innovation.

(iv) Regulation Standardisation. The setting of EC–wide health, safety and technical regulations, or the implementation of the mutual recognition principal might lower the fixed cost of innovation. This point is most obvious in the innovation of new products. In (3) this would show up as a reduction in F and therefore as an increase in profitability.

(v) Clearly subsidies to R&D will raise profitability and therefore the rate of innovation and growth. This suggests that EC programs to promote research could lead to faster growth.

(vi) Lastly, it is worth pointing out that since innovations eventually become public knowledge, 1992 could lead to faster growth for non–EC countries as well.

5. Calibrating the Growth Effects of 1992

Empirical evaluation of the new growth models is inherently difficult for two general reasons. First, there is no general agreement on which model to use. The tractable models focus only on one aspect of the scale economies–growth link. There are more complete models, such as Grossman and Helpman (1989), however I was not able to calibrate these. Secondly, for a variety of reasons, data on technological progress, profit margins, prices, R&D costs, capital stocks, innovations, etc. are unavailable, incomplete, or unreliable. Moreover many of the key parameters, such as the rate of dissemination of technology, the appropriability of innovation, technological spillovers, etc. are intrinsically unobservable.

I have no answer for the first problem. The calibration methodology helps with the second. This technique involves specifying a simple model, borrowing some parameters from the work of other researchers and then imputing the remaining parameters so that the theoretical relationships just match the base case set of data. Using these borrowed and imputed parameter values, the relevant policy changes are simulated. Clearly this approach is far from fully satisfactory, but at the present state of knowledge it appears to be the only option. Chief among the drawbacks is the lack of standard errors for the results. This absence means that it is impossible to judge formally the precision of the results. As it turns out, we can judge the magnitude of the medium term growth bonus without calibrating any parameters. Calibration, however, is necessary to gauge the long term growth bonus and to quantify the endogenous innovations model.

5.1. Quantifying the Medium Term Growth Bonus

Figure 1 illustrated how a once–off efficiency gain has an indirect, dynamic effect on the steady–state output per worker. To translate the Figure 1 story into a formula we focus on the level of GDP/L to which the economy will converge after the liberalisation, e.g., $(GDP/L)^{C}$. Start with the GDP formula, $GDP = \Omega K^{\theta} K^{\alpha} L^{1-\alpha}$. Simple mathematics shows that the percent increase in GDP equals the percent increase in Ω (the direct effect) plus $\alpha+\theta$ times the percent increase in the steady–state capital stock (the indirect effect).

To find the percent increase in the steady–state K, we ask how high must K be so that all investment is needed to replace depreciation (since this is the new stable level of K). The answer is the K (and corresponding GDP) where δK equals sGDP. Using the GDP formula, it is easy to show that the percent change in the steady–state K equals $1-\alpha-\theta$ times the percent change in Ω. Thus the formula for the total change is:

$$\begin{bmatrix} \text{\% change} \\ \text{in GDP} \end{bmatrix} = \begin{bmatrix} \text{\% change} \\ \text{in } \Omega \end{bmatrix} \times \begin{bmatrix} 1 + \begin{matrix} \text{Medium term} \\ \text{growth bonus} \\ \text{multiplier} \end{matrix} \end{bmatrix}, \tag{4}$$

$$\text{where,} \quad \begin{bmatrix} \text{Medium term} \\ \text{growth bonus} \\ \text{multiplier} \end{bmatrix} = \left(\frac{1}{\left(\frac{1}{\alpha+\theta}\right) - 1} \right).$$

Equation 4 shows how much output will increase by the time the economy reaches its new steady–state capital labor ratio. This could take a very long time. To get a handle on approximately how long, consider a linear approximation of the adjustment path around the final steady state. Taking the rate of depreciation as 12 percent and $\alpha+\theta$ between 0.3 and 0.5, the half life of the adjustment is between 8 and 12 years.[2] Thus this medium–term growth effect would look very much like a rise in the long term rate.

Plainly, the sise of the medium term growth bonus depends on the importance of scale economies. Indeed, to quantify the growth bonus we only need two estimates: $\alpha+\theta$ (in words, $\alpha+\theta$ is the percent increase in GDP that would result from a one percent rise in the capital stock), and an estimate of the static effect of 1992 on the EC's GDP. We turn first to $\alpha+\theta$.

Table 2 lists a variety of estimates of the true capital output elasticity of GDP with respect to capital, i.e., $\alpha+\theta$. The first row lists the smallest number. This corresponds to the assumption of no scale economies. As argued in section 3, this is probably an underestimate since scale economies are probably important at the aggregate level. However, regardless of one's stance on the scale economies question, this estimate is useful since it provides a non–controversial <u>lower bound</u> on Europe's true $\alpha+\theta$. The second row presents the number derived from Caballero and

Lyons (1989), assuming that capital's average share in value added is 0.3. This number is probably an underestimate of the true $\alpha+\theta$, as discussed in Section 3. Row three presents a rough estimate of my own.[3] As explained in the appendix, we can be pretty sure that this number overestimates the scale effects. Thus it should not be taken at face value (notice I did not cite it as evidence against constant returns). Nonetheless it provides some information on the upper bound of Europe's actual $\alpha+\theta$. Next, we need an estimate of the static gain (percent increase in Ω) due to completion of the internal market.

There are several sources of estimates for 1992's once–off effect on the EC's GDP. First consider those contained in the Cecchini Report. The EC Commission's estimate puts the one–time increase in the EC's GDP due to 1992 as between 2.5 and 6.5 percent. The Commission's range is far from precise so we consider for a moment which end of the range is more plausible. First, let us check the high side of this range for plausibility by comparing it to the numbers obtained for major trade liberalisations. The Tokyo Round tariff cuts reduced *ad valorem* tariff rates by about 7 percentage points (according to Harris and Cox 1982). Since most intra–EC trade barriers have already been removed, the removal of hundreds of small NTBs by the 1992 program would probably have a trade liberalisation effect roughly on this order —— certainly not much greater than this. Moreover the Tokyo Round reduced tariffs with all trading partners, not just within Europe. Deardorff and Stern (1979, 1981) estimate that the Tokyo Rounds cuts increased world GNP by about one tenth of one percent. Brown and Whalley (1980) estimates the total gains of these cuts as 1.6 percent of world GNP. Thus the high side of the Commission's estimate is between four and 65 times larger than these estimates. Simulating the effects of a very different trade liberalisation, Magee (1972) estimated that the cost to the US of all trade restrictions on its manufactured goods trade (on imports and exports) was less than 2 percent of US GNP. Of course these studies did not allow for static gains due to industry–level economies of scale which are the source of much of the Commission's estimated gains. These effects, however, are included in the seminal work by Harris and Cox (1982). They estimate that the move to free trade with all trading partners would lift Canadian GNP by 8.6 percent and require that 6 percent of the work force change industries. The large size of this gain is due partially to the static scale effects and partially to the fact that Canadian's trade barriers are higher than the OECD average.

In summary, if one made the mistake of viewing 1992 merely as a trade liberalisation, the high side of the Commission's range would appear unjustified. The basic point is that intra-EC trade accounts for only half of total EC trade, and this trade is already substantially liberalised. Nevertheless, the readily observable behavior of EC and non-EC firms indicates that those at the cutting face believe that 1992 will have large effects. More importantly, it is probably more realistic to view 1992 as a massive market liberalisation and deregulation rather than as a mere trade liberalisation. From this perspective, the Cecchini Report's range seems more plausible.

Another revealing source of market expansion estimates comes from the survey data reported in the "Economics of 1992." This vast survey asked EC firms to estimate the likely effects of the 1992 program. In particular, firms were asked to quantify the overall effects that the 1992 program would have on the total unit cost for the firm's main product line. On average firms felt that completion of the internal market would lower their total unit cost by 2 percent. It is immediately obvious that if the current output of the EC could be produced with 2 percent fewer inputs, and full employment is maintained, then the static effect on output and income would rise by something like two percent (maybe a little more allowing for economies of scale). It is interesting to contrast this rather small 2 percent with the readily observable economic fragmentation of the EC along national lines. Clearly one possibility is that firms are myopic and failed to realise the grandiose impact of the completion of the internal market. The other is simply that the fragmentation is not due to economic barriers, but instead is due to deep-seated cultural, historical, institutional and linguistic barriers.

Another question posed by the same survey queried firms on how much they thought sales would expand as a result of the 1992 program. The answer on average was 5 percent. Now if all firms expand sales and output by 5 percent GDP should rise by something like 5 percent. Thus the survey data gives us a range that is not far from the Cecchini Report's range. The section 6 simulations consider the dynamic effects of static gains of between 2 and 6.5 percent.

5.2. Calibrating the Long Term Growth Bonus

The growth rate in Romer's model (equation (1)) involves four parameters: the depreciation rate δ, the labor output elasticity $1-\alpha$, the savings rate s, and Ω. We also require the growth rate of hours worked η, the growth of the EC's GDP and the labor force (recall that it was necessary to assume $\alpha+\theta$ equal to one simply to derive equation (1)). From Maddison (1987) we borrow δ (12 percent is the average of the depreciation rates listed for France, Germany, the Netherlands, Italy and the UK). From the OECD Employment Outlook we calculate the growth rate of hours worked in the EC (minus 0.77 percent per annum). Suspending reservations about his empirics, we take $(1-\alpha)$ equal to 0.32 from Romer (1987). The growth of the EC's GDP for the 1980—1987 period is taken from the OECD's Main Economic Indicators; it is 1.8 percent per annum. In principle it is possible to get or estimate figures for L and s. However since we must calibrate Ω in any case this is not a useful exercise. Essentially we choose $(s\Omega L^{1-\alpha})$ to make (1) hold for the borrowed values of δ, g, α and η.

5.3. Calibrating the Endogenous Innovation Model

The large number of unknowns in equation (3) prevent us from calibrating the level version of this equation. However since market size (measured by expenditure in terms of resource units) enters proportionally, we only need σ to determine how 1992 will change the growth rate. That is, a one percent rise in the profitability of innovation will lead to an extra $\sigma/(1-\sigma)$ percentage points of growth. The intertemporally separable preferences we used are quite standard. This allows us to draw on the substantial body of literature that has estimated the intertemporal elasticity of substitution. Hall (1988) provides a critical survey and extension of the estimates of this number and concludes that this number ranges from a small negative number like −0.03, to small positive numbers like 0.3. We adopt the consensus which seems to be something on the order of 0.1. The small magnitude of this number reflects the basic stylised fact that aggregate savings is quite unresponsive to changes in real rates of return.

In addition to the static efficiency effects of 1992 discussed above, the harmonisation of industrial regulations may affect the profitability of innovation by reducing the cost of developing new products. Again the data on this are sketchy at best. Indeed the only direct estimate I could find on this effect was for the European pharmaceutical industry in the EC's report "The Economics of 1992". The study estimates that by avoiding duplication of testing, new drugs could be introduced at a slightly lower cost; between one half and eight tenths of one percent. We add this to the direct GDP boosting effect of 1992 to obtain an overall estimate (admittedly a very crude one) of 1992's impact of the profitability of innovating.

6. Quantifying of the Growth Effects of 1992

Given the models discussed and the parameters we have borrowed, estimated or calibrated, it is a straightforward exercise to quantify the various dynamic effects of 1992. It is important to stress the tentative nature of these results. Both the models and parameter estimates are rudimentary at best. Indeed, in the end this exercise may tell us more about the shortcomings of the models and data than it does about the likely effects of 1992.

6.1 Increase in EC GDP Stemming From the Medium Term Growth Effect

With the Table 2 estimates of $\alpha+\theta$ and the static effect of 1992 on GDP, we calculate the size of the medium term growth bonus illustrated in Figure 1. Table 3 presents the size of this growth bonus for a number of possible combinations of these two inputs. The first column of numbers lists the value of the medium term growth bonus multiplier for the various estimates of $\alpha+\theta$. (The multiplier is defined in equation (4)). This multiplier provides a good summary of how important this type of dynamic effect is in general because it reflects the extent to which the static effects underestimate the impact of 1992 on the Community's GDP.

The smallest multiplier, 0.429, comes from the assumption of constant returns to scale. Thus even if scale economies are unimportant at the aggregate level, the Cecchini Report numbers underestimate the impact of 1992 on GDP by something like 40 percent. The second row contains those from Caballero and Lyons's estimates of increasing returns in aggregate manufacturing. The third row constitutes an upper bound on the multiplier since it uses the upward biased estimate of $\alpha+\theta$ presented in the appendix. The third column lists the estimated percent increase in GDP due to the indirect rise in the steady–state capital labor ratio (i.e., the medium term growth bonus). These are derived by multiplying the range of static effects lists in column 2 by the multipliers in column 1. The fourth column of numbers is simply the sum of the direct and indirect effects (i.e., the second and third columns). Clearly these estimates vary enormously, ranging from a lower limit of 0.858 percent to more than two hundred and fifty percent.

The most important point made by Table 3 is that all estimates of the medium term growth effect are considerable compared to the static effect. That is to say by ignoring the indirect effect of 1992 on the steady–state capital labor ratio, the Commission's figures significantly underestimate the total impact of 1992. We cannot determine the exact extent of this underestimation without knowing $\alpha+\theta$ exactly. However as argued above, the first row in Table 3 represents a lower bound on the size of this indirect effect. Consequently we can conclude that the Commission's estimates of the economic benefits of 1992 are <u>at least</u> 42.9 percent too low.

The high side of the multiplier range, 39.00, is enormous. If we take the high side of the Cecchini Report estimates and mark them up by the high side of the multiplier range we get that the total effect of 1992 will be to eventually raise EC income by 253.5 percent. Obviously such an estimate is implausibly at first sight. After all, as radical as 1992 may be, it seems hard to believe that it would be directly responsible for a tripling of GDP. Nonetheless this is what is implied by a $\alpha+\theta$ that is close to one. Essentially, if the capital output elasticity is close to one, it takes an enormous increase in the K/L ratio to return the marginal product of capital to its pre–liberalisation level.

6.2. Long Term Growth Effects of 1992

Perhaps the most profound dynamic effect is a permanent rise in the growth rate of GDP. As mentioned in the introduction, even very small changes in the growth rate can lead to very large changes in output. To get a more concrete idea of how important long term growth effects are, compare the effect of a once–and–forever rise in the level of GDP (this is what the Cecchini Report numbers capture) with a once–and–forever increase in the growth rate. As they stand the static and growth effects are not directly comparable. One way to compare them is to contrast their effect on the level of GDP a number of years in the future. However by putting the year of comparison further into the future, we could make the growth effect look as large as we want. This is true, but misleading. Higher income in 50 years is not worth as much as extra income today. A better way to compare them is to use the present discounted value of real income as a measuring stick. Thus we ask: How much will a once–and–forever rise in the level of GDP (i.e., the static effect) increase the discounted value of income? And: How much will a once–and–forever rise in the growth rate of GDP increase the same measure?

Simple calculations show that a once–and–forever GDP rise of 1 percent raises discounted income by 1 percent. By contrast, a once–and–forever increase in the growth rate by 1 percentage point boosts discounted income by $(\frac{1}{\rho-g})$ percent, where ρ is the discount rate and g is the initial growth rate. Taking the discount rate as 5 percent and the initial growth rate as 1.8 percent, we find that an extra percentage point of growth would raise the discounted sum of real income by 31.25 percent. To frame the comparison in another way, a rise in the growth rate of 16 hundredths of one percentage point would have the same impact as a five percent static gain.[4] It is essential, however, to keep in mind the fact that discounted income is not a measure of welfare.

6.2.1. Romer model ($\alpha+\theta$ Equals One) Equation (1) together with the borrowed and calibrated parameters discussed in section 5 allow us to calculate the long term growth bonus corresponding to 1992's static efficiency gains. Table 4 presents the results. The first column shows the calibrated sise of the long term growth bonus multiplier that was presented in section 2.3. This is in itself an interesting number. It says that a one percent static efficiency gain will lead to permanent rise in the growth rate of more than one tenth of one percent (0.1422 percent to be exact). The second column reproduces the range of static effects of 1992. The last column presents the corresponding range of increases in the EC long run growth rate. These numbers are in terms of percentage points of growth that would be added to the current growth rate of 1.8 percent. Table 4 indicates that the long term growth effects of 1992 might be quite substantial. The low side of this range indicates that 1992 will permanently add about one quarter of one percent to EC growth. The high side estimates that 1992 would add almost a full percentage point to Europe's growth rate. Recall, however, that the Table 4 results depend crucially on the questionable assumption that $\alpha+\theta$ equals one.

6.2.2. Endogenous Innovations Model Using an entirely different logic, the endogenous innovations model predicts that 1992 will lead to a permanent rise in EC growth. The second row in Table 4 presents the results in the form of extra percentage points of growth that will be added to the current 1.8 percent. The first column presents the long term growth multiplier. This number has the same interpretation as the long term growth multiplier in the first row. It is mildly reassuring that these two multipliers are roughly the same sise. Again the second column reproduces the range of static effects of 1992, including the cost lowering effect of harmonising industrial regulations. The third column is simply the multiplier times that range of static effects. Again we find that the long term growth effects of 1992 are predicted to be large — between one third and eight tenths of one percentage point.

At first glance the Table 4 figures may appear to be small. However since they represent permanent additions to the growth rate, they would eventually have a massive effect on the material standard of living in Europe. To be more specific, we combine the calculations presented in Section 6.2 with the Table 4 results. Doing this we see that the long term growth effects of 1992 could increase the value of discounted real income by between 9 and 29 percent according to the Romer model ($\alpha+\theta$ equal to one), or by between 10 and 25 percent according to the endogenous innovations model.

6.3 Adding Up the Output Effects

Lastly, how should we add up these various effects? The direct static effects are at the base of all the numbers so they should always be added in. After this we have to hedge. Not all the effects are consistent (due to the lack of a consensus model). In the end we get three different ranges of the total effect (static plus dynamic). If $\alpha+\theta$ is less than one, we get the medium term growth bonus. We obviously cannot add to this the long term growth bonus predicted by the model when $\alpha+\theta$ equals one. However as note above, if $\alpha+\theta$ is less than one, we need some sort of trend to keep growth going. It is possible that 1992 would affect such a trend, however we have no model of this. The numbers from the endogenous innovations model cannot be put to service here since that model assumes constant returns in everything except R&D. Consequently if $\alpha+\theta$

is actually less than one, the total effect is given in the last column of Table 3. Namely, 1992 is estimated to be directly responsible for a rise in the Community's income of between 2.7 and 260 percent. Phrasing this differently, these estimates suggest that the Cecchini Report numbers are between 40 and 3900 percent too small, due to the fact that the Report estimated only the static effects.[5]

If Romer or the endogenous innovation model is right, 1992 could permanently raise Europe's growth rate. To get both static and growth effects into one number we must focus on 1992's impact on the discounted sum of EC income. (Recall that this has the nice property that a one percent static increase in GDP raises the discounted sum by one percent. Thus we can directly compare our ranges to the Cecchini Report's range.) Using this measure, 1992 is estimated to increase discounted income by between 11 and 35 percent (adding the static 2 to 6.5 percent to the dynamic 9 to 29 percent from the Romer model).[6] Thus according to this model, by ignoring dynamics effects, the Cecchini Report range underestimates the true impact of 1992 by approximately 450 percent.[7] Finally, if the endogenous innovations model is right the range is 13 to 33 percent, so the EC numbers are about 350 percent too low.

These numbers from the long term growth effects are certainly bigger than the Cecchini Report's range of 2.5 to 6.5 percent. Are they believable? The answer must certainly be yes, if 1992 does indeed change the long term growth rate of Europe. Uncontroversial algebra shows us that even tiny growth effects easily dwarf static effects. However, the estimates of the long term growth effects were based on models that have a long way to go before they become part of the received wisdom of economics. Therefore, the specific numbers may very well prove to be way off the mark. However, even leaving aside these exploratory models, we still have the medium term growth bonus. This rests on well—accepted principals. The only controversy is on the importance of scale economies at the economy—wide level. The low end assumes constant returns. The high end of the range requires substantial economies of scale at the aggregate level. An increasing number of economist agree that these are important, however it should be said that there still are many dissenters.

7. Conclusions

By ignoring the medium term growth effects of 1992, previous studies of the economic impact of 1992 have seriously underestimated the potential effect on the Community's GDP. My analysis suggests that 1992's impact on GDP — including medium term dynamic effects — could be between 40 and 3900 percent greater than the Cecchini Report's numbers. Furthermore, my findings suggest that 1992 could permanently add between one quarter and a full percentage point to the EC growth rate. Certainly the high sides of these ranges seem to require more than the usual suspense of disbelief. Nevertheless, they reflect the solid fact that even small dynamic effects can lead to gains that far outweigh the static gains investigated by the Cecchini Report and other such studies. Given the crude nature of the models, data and methodology behind these estimates, my numbers should be taken with a grain of salt (to say the least). The most important conclusion of this paper, however, lies not in the specific numbers; it lies in the order of magnitude of the high side of the estimated ranges. The standard reply mentioned in the introduction is entirely correct: the biggest effect from liberalisations are likely to be dynamic, not static. This paper shows that it is possible to quantify, at least roughly, several types of dynamic effects of the 1992 liberalisation. Dynamic effects may still be poorly understood. They are not, however, impossible to measure.

Hopefully, the rough estimates I have presented here shed enough light on the quantitative importance of dynamic effects to suggest that it is time to start looking for the wallet where we suspect it is — not where the light is the brightest.

Appendix 1: **A More Complete Model of the Figure 1 Interactions**

The Figure 1 analysis relies on three incorrect assumptions. The first is that a GDP function actually exists. It is well—known that this is only true only under unrealistically restrictive assumptions. Nevertheless we can interprete it as a reasonable approximation. The second is that the investment—GDP ratio is constant. Since consumers are forward—looking in their consumption behavior this is incorrect. However, all we really need is that s is the same in the steady—state before and after the liberalisation. Below we sketch a model in which this is true. Lastly, we assume that the effects of 1992 can be captured by a rise in Ω. This rise lifts the marginal productivity of capital and would therefore induce more savings even in an intertemporal optimising model. Since 1992 is such a broad based liberalisation this is probably not too bad of an approximation. However, in general liberalisations change relative prices and can therefore change factor rewards. If the liberalisation stimulated labor intense sectors, the return on foregone consumption might actually decrease, lead to a reduction in the steady—state capital stock.

The supply side of the economy is fully described by the GDP function $Y = AK^{\alpha+\theta}L^{1-\alpha}$. Here A is the level of technology which is assumed to grow exogenously at a rate of $\dot{A}$. The common, steady—state growth rate, g, is determined by the trend rate of technological progress, $\mathring{A}$, and scale effects:

$$g = \mathring{A} + (\alpha+\theta)\mathring{K} = \mathring{A}\left(1 + \frac{1}{\frac{1}{\alpha+\theta} - 1}\right) = \left(\frac{\mathring{A}}{1-\alpha-\theta}\right). \tag{A1}$$

The savings and investment decision is determined by infinitely lived consumers with the standard intertemporal preferences, $U = \sum_{t=1}^{\infty} \left(\frac{1}{1+\rho}\right)^t \frac{1}{1-(1/\sigma)}\left[C_t\right]^{1-(1/\sigma)}$. On the steady—state balanced growth path, we have:

$$\frac{\partial U/\partial C_t}{\partial U/\partial C_{t+1}} = (1+\rho)\left[\frac{C_{t+1}}{C_t}\right]^{1/\sigma} = (1+\rho)\left[1+g\right]^{1/\sigma} = (1+R) \tag{A2}$$

This ties down the constant real rate of return on capital. Since the steady–state R is constant, the optimal capital output ratio will be constant. This ratio together with the rate of depreciation ties down the endogenous s since in the steady state, $\delta K = sGDP$.

The important point here is that even if we determine s endogenously, it will be the same at point A in Figure 1 (steady state before the liberalisation) and at point C (after the economy reaches it new steady–state K/L ratio). This is all we need to perform the calculations of the medium growth bonus. See Baldwin (1989) for details.

Appendix 2: OLS Estimates of the GDP function and Their Biases

Ordinary least squares on the GDP formula $Y = A\Omega K^{\alpha+\theta}L^{1-\alpha}$ yields an upwardly biased estimate of the capital output elasticity. The basic reason is that firms' choice of K depends positively on unobservable productivity shocks, A. These shocks also affect GDP. Thus K and GDP will tend to move together for two reasons; because more capital leads to more output, and because unobserved productivity shocks cause them to move together. The OLS regression assigns $\alpha+\theta$ according to the extent to which K and GDP move together (controlling for movements in L) without distinguishing between the first reason (which we want it to capture) and the second reason. Annual data on GDP, capital stock and employment for the EC10 for 1960 to 1984 were taken from the EC publication "European Economy". Table A1 reports estimates from the regression: $\ln(GDP)=c + (\alpha+\theta)\ln(K) + (1-\alpha)\ln(L) + \tau(\text{time}) + U$. Rows 1 and 2 strongly suggest that the residuals (which presumably include productivity shocks) are serially correlated even when we include a time trend. Performing an AR(1) correction on levels gives us the row 3 results. These are disturbing since $\alpha+\theta$ is greater than one and the time trend enters negatively. Dropping the time trend we get more sensible results in row 4 (although the labor output elasticity seems too high). Rows 5 and 6 show that first differencing leads to similar results. We use the row 6 estimate of $\alpha+\theta$ in the Section 6 calculation.

FOOTNOTES

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1. Our analysis focuses on steady—state, balance growth paths. Short term adjustment dynamics are of the utmost policy and academic interest. Our understanding of the determinants of aggregate output in the short run, however, is unsettled and not well hooked up to long term growth issues. These issues are side stepped by focusing on long term or steady—state growth.

2. The linear approximation around the new steady—state capital stock, $\overline{K}'$, is: $K(t)-\overline{K}' = (\overline{K}^{o}-\overline{K}')e^{-\delta(1-\alpha-\theta)}$. Taking δ=0.12 and $\alpha+\theta$ as between 0.3 and 0.5 then the rate of convergence is between 6 and 8.4 precent. This implies a half life of between 8.25 and 11.55 year.

3. This number comes from ordinary least squares (OLS) on the EC's GDP, capital stock and employment with various error corrections. The full results are reported in Appendix 2.

4. Static gain raises discounted income proportionally. An extra percentage point added to the long term growth rate raises discounted income by 31.25 percent. Thus a rise in the long term growth rate of 0.032 (inverse of 31.25) percentage points has the same impact on discounted income as a one percent static gain.

5. The medium term growth bonus implies that GDP will rise by one plus the multiplier times the static effect. Therefore the size of the multiplier is the size of the underestimate. 1+0.429 implies about 40 percent. 1+39.00 implies 3900 percent.

6. A one percent static gain leads to a 0.1422 percent rise in the long term growth rate. A one percent rise in the long term growth rate raises the discounted sum of income by $(\frac{1}{\rho-g})$ percent.

Taking $\rho = 0.05$ and $g = 0.018$ this implies that the long term growth effect boosts discounted income by $(31.25) \times (0.1422)$ times the static effect. Multiplying this by the range of static effects yields 8.89 to 28.88 percent.

7. The percent underestimate is derived as follows. A one percent static effect raises the discounted sum of income by $(31.25) \times (0.1422)$. This equals 4.444, which is 444.4 percent. For the endogenous innovation model it is $(31.25) \times (0.1111)$, which corresponds to 347.2 percent.

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Table A1: Upper Bound Estimates of $\alpha+\theta$:
OLS Estimates of GDP Function
(Standard Errors in Parenthesis)

	Constant	Capital Output Elast'y $(\alpha+\theta)$	Labor Output Elast'y $(1-\alpha)$	Trend	DW	S.E.R.
(1) level	−11.6 (1.34)	1.906 (0.11)	0.439 (0.26)	−0.03 (0.004)	1.1	0.01
(2) level	−15.9 (2.67)	0.938 (0.02)	2.14 (0.39)		0.3	0.02
(3) level with AR(1), with trend	−12.3 (1.55)	1.811 (0.15)	0.655 (0.31)	−0.030 (0.005)	1.7	0.01
		rho= 0.48 (0.2)				
(4) level with AR(1), no trend	−11.0 (2.02)	0.962 (0.04)	1.417 (0.29)		1.7	0.01
		rho= 0.89 (0.1)				
(5) 1st Difference with trend		1.602 (0.306)	0.911 (0.341)	−0.020 (0.011)	2.1	0.01
(6) 1st Difference no trend		0.975 (0.059)	1.346 (0.288)		1.8	0.01

Table 1. Econometric Estimates of Scale Economies

Caballero and Lyons (1989), SUR Estimatation

	Germany	France	UK	Belgium	US(OLS)
Aggregate $\gamma/(1-\beta)$	1.22	1.59	1.13	1.42	1.37
standard errors	(0.26)	(0.29)	(0.48)	(0.50)	(0.08)

Hall (1988) US data, Instrumental Variable Estimatation

	Inverse of $\gamma/(1-\beta)$	Standard Error	Implicit $\gamma/(1-\beta)$	Reject Constant Returns?
Construction	0.597	0.277	1.675	YES
Durable Goods	0.543	0.128	1.841	YES
Nondurable Goods	0.322	0.110	3.107	YES
Transportation & public utilities	0.100	0.169	10.030	YES
Trade	0.244	0.178	4.468	YES
Finance insurance & real estate	0.353	1.001	2.830	YES
Services	0.926	0.220	1.080	NO

Table 2. Borrowed and Estimated Parameters

Parameter	Value	Source	Comment
		Medium Term Growth Bonus	
$\alpha+\theta$	0.3	Maddison (1987)	Lower Bound. Assumes no scale economies
$\alpha+\theta$	0.402	Caballero & Lyons (1989)	Average of Reported EC countries. Assumes $\alpha = 0.3$.
$\alpha+\theta$	0.975	See Appendix	Upper Bound. OLS estimate.
Static effect of 1992	2 to 6.5 percent	EC Commission	See Section 5 for discussion.
		Long Term Growth Bonus	
δ	0.12 % per annum	Maddison (1987)	Average for reported EC Countries
$\eta_{EC\ 12}$	−.771	OECD Employment Outlook	Hours worked
$1-\alpha$	0.32	Romer (1987)	
$\alpha+\theta$	1	Romer (1987)	
		Endogenous Innovation Model	
σ	0.1	Hall (1988)	

Table 3. Extra Rise in EC GDP due to Medium Term Growth Bonus of Figure 1

Source of $\alpha+\theta$	Multipler	Static Effect	Percent rise in GDP due to medium term growth bonus	Total Effect: Static + Dynamic
Lower Bound: (No Scale Economies)	0.429	2 to 6.5 %	0.858 to 2.789	2.65 to 9.289
Caballero and Lyons	0.671	2 to 6.5 %	1.342 to 4.362	3.34 to 10.862
Upper Bound: (OLS Estimate)	39.00	2 to 6.5 %	78.0 to 253.5	80.0 to 260.0

Table 4. Long Term Growth Effects of 1992

Romer Model ($\alpha+\theta$ equal to 1)

Long Term growth multiplier	Static effect of 1992 (%)	Percentage points added to growth rate
0.1422	2 to 6.5	0.28 to 0.92

Endogenous Innovation Model

Long Term growth multiplier	Static effect of 1992 (%)	Percentage points added to growth rate
0.1111	2.8 to 7.3	0.31 to 0.81

FIGURE 1

The Medium-Term Growth Bonus

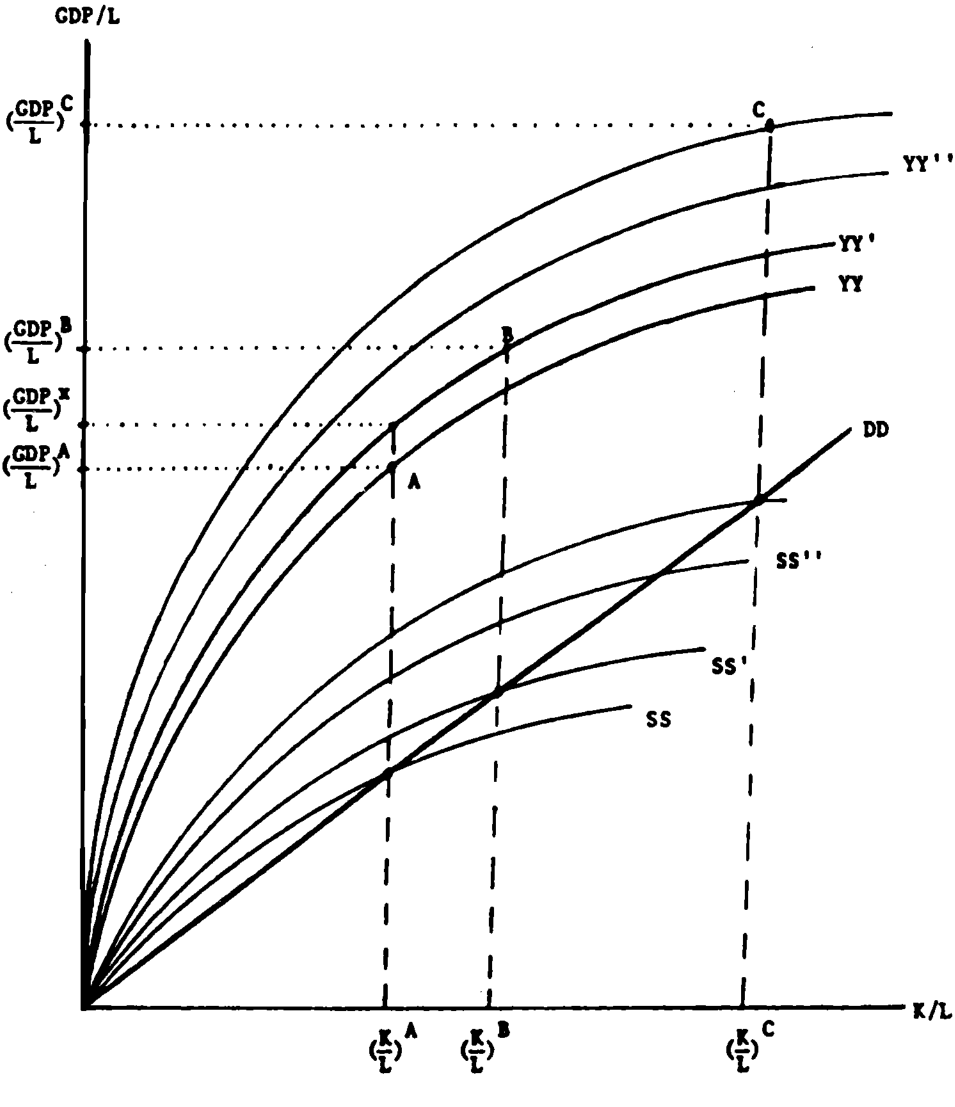

FIGURE 2

Scale Economies at Firm-Level but not Aggregate-Level

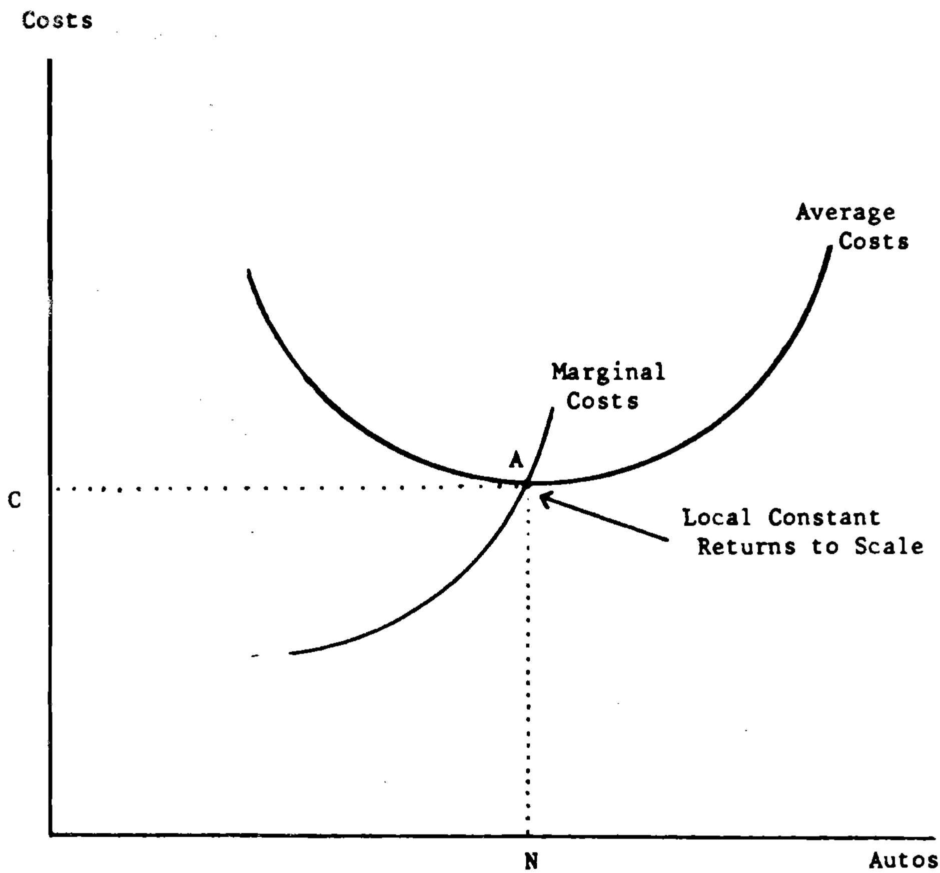

Figure 3a: FRANCE

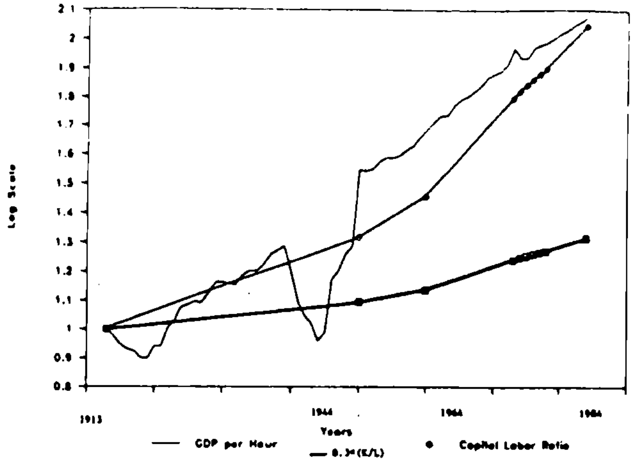

Figure 3b: GERMANY

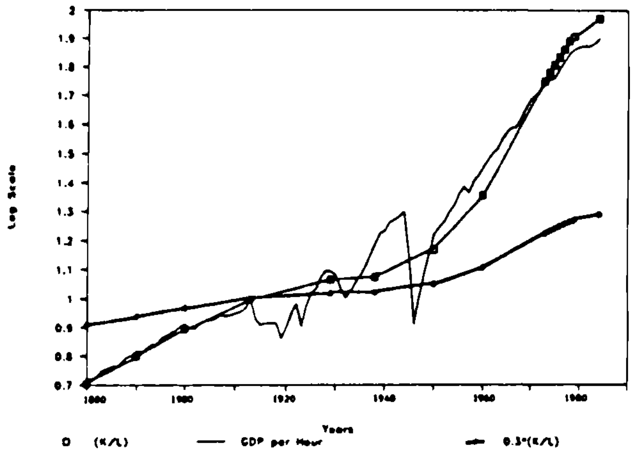

Figure 3c. ITALY

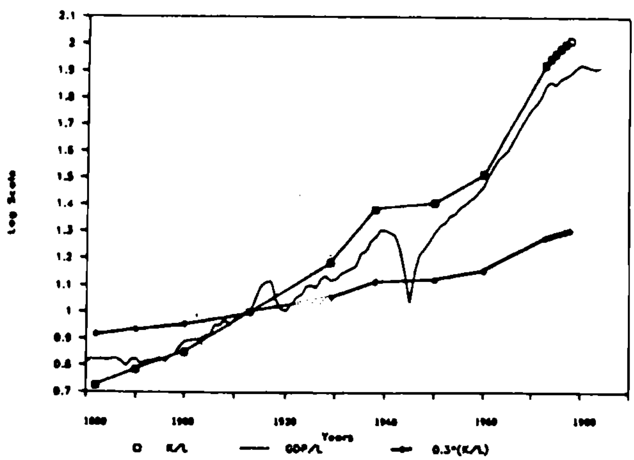

Figure 3d. JAPAN

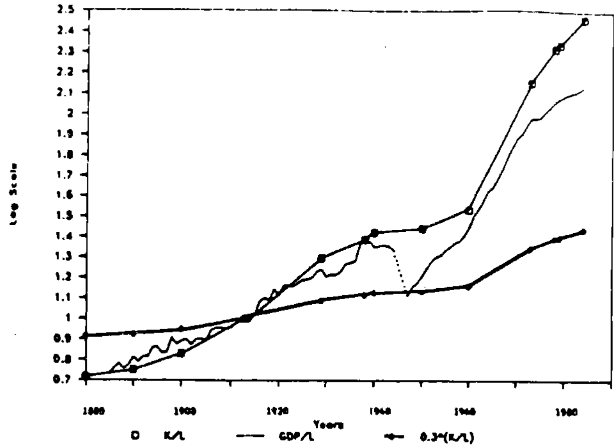

Figure 3e. UK

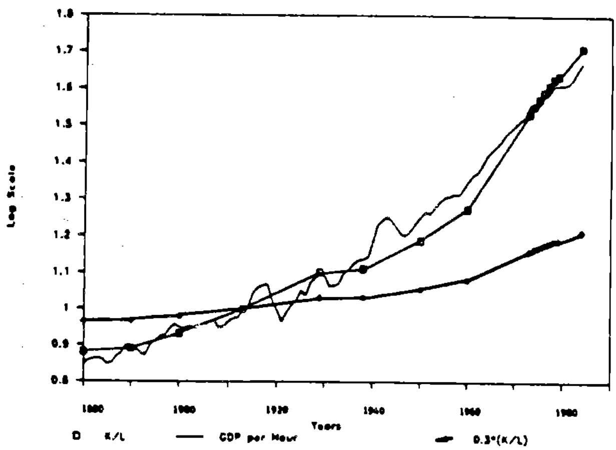

Figure 3f. US