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Social Savings as a Measure of The Contribution of a New Technology to Economic Growth

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1. Introduction

The usual way to evaluate the implications of new technology for economic growth is through growth accounting techniques. This methodology has, of course, been widely employed to examine the impact of information and communications technology (ICT) and the results have dominated thinking on the post-1995 growth resurgence in the United States (Oliner and Sichel, 2000) and have been an important ingredient in the debate over Europe's recently disappointing productivity growth (Hurst and Uppenberg, 2001).

One of the most famous episodes in cliometrics concerned a similar question, namely, what was the contribution of the railway to nineteenth century economic growth ? The most famous study was that of Fogel (1964) who pioneered the technique of social savings as a methodology. This is based on estimating the cost-savings of the new technology compared with the next best alternative. This saving in resource costs was also taken to be equal to the gain in real national income (Fogel, 1979, p. 3). Thus for railways the amount of social savings (SS) was calculated as

$$SS = (P_{T0} - P_{T1})\, T_1 \qquad (1)$$

where P_{T0} is the price of the alternative transport mode, water, P_{T1} is the price of rail transport and T_1 is the quantity transported by rail. Fogel deliberately intended this to be an upper-bound measure constructed as if demand for transport was perfectly price inelastic.

Table 1 reports estimates made of the social savings of railways for various countries. If Fogel's interpretation is accepted, these can be regarded as (upper bound) estimates of the gains from this technology and in most cases, of course, this represents technology transfer. Several points worth noting can be taken from the research underlying Table 1. First, the benefits were relatively small initially but grew over time as rail output rose as a share of overall economic activity and as the productivity of railways improved. Second, the benefits depended heavily on the alternative form of transport; where countries had been able already to develop water transport (canals, coastal shipping etc.) the cost advantages of rail were often quite small but where the relevant comparison is with road transport the gains were typically rather large. Third, fares paid by passengers for rail journeys were often higher than for the alternative mode of transport; this reflects willingness to pay for speed and underlines that rail passenger travel should be thought of as a new good.

Another major implication of Table 1 is that transport users took most of the benefits of the new technology. This is true even in Britain where the railway era began. The estimates in Hawke (1970) indicate that the average social rate of return on railway investment was about 15 per cent whereas the private rate of return was about 5 per cent. Supernormal profits were not apparent in British railways. A major reason for this was competition both between rival railways and also between railways and coastal shipping. It is well-known that all major inter-city routes were served by competing companies but it is perhaps not widely recognized that as late as 1910 almost 60 per cent of domestic freight ton-miles in Britain were by sea (Armstrong, 1987).

Although most investigations of the impact of the diffusion of ICT on economic growth have relied on growth accounting, for example, van Ark et al. (2003), a recent paper by Bayoumi and Haacker (2002) has rediscovered the social savings technique and has applied it in this context. This suggests that it may be opportune explicitly to compare the two methodologies. Three questions deserve to be considered:

1) What is the relationship between social savings and growth accounting ?

2) What are the advantages and disadvantages of using the social savings approach as an alternative to growth accounting ?

3) How do the results for ICT compare ?

2. Theory: Growth Accounting and Social Saving Compared

Traditional growth accounting captures the contribution of technological change to growth through total factor productivity (TFP) growth , i.e, the Solow residual. With the standard Cobb-Douglas production function and competitive assumptions

$$Y = AK^{\alpha}L^{1-\alpha} \qquad (2)$$

the Solow residual is computed as

$$\Delta A/A = \Delta Y/Y - s_K\Delta K/K - s_L\Delta L/L \qquad (3)$$

where s_K and s_L are the factor income shares of capital and labour respectively.

A straightforward generalization of this has been used in the growth accounting literature on ICT. This allows for different types of capital and distinguishes separate components of TFP growth. In the variant proposed in the well-known paper by Oliner and Sichel (2000), capital is divided into three types of ICT capital (computer hardware, computer software and telecom equipment) and other capital each of which is weighted by its own factor income share. TFP growth is decomposed into a component based on the production of ICT capital and other TFP growth. Altogether the contribution of the new technology comes partly through embodiment in new capital and partly through conventional TFP growth.

Thus the growth accounting equation is written as

$$\Delta Y/Y = s_{KO}\Delta K_O/K_O + s_{Ki}\Delta K_i/K_i + s_L\Delta L/L + \gamma(\Delta A/A)_{ICTM} + \phi(\Delta A/A)_{NICTM} \quad (4)$$

where the subscript $_O$ indicates other capital, the subscript $_{Ki}$ indicates ICT capital of type i, the subscripts $_{ICTM}$ and $_{NICTM}$ indicate manufacture of ICT equipment and the rest of the economy, respectively, and γ and ϕ are the gross outputs of these sectors as a share of GDP.[1]

This formula can be refined further to take account of (unremunerated) TFP spillovers from ICT investment in the rest of the economy. These might result, for example, from reorganization effects similar to those accruing when factories were redesigned after electricity had replaced steam (David and Wright, 1999). The magnitude (and even the existence) of these spillovers from ICT is controversial and growth accounting studies do not typically seek to quantify them.

Fogel's social saving can be thought of as the resources released by the technological improvement in transportation and is represented

[1] These are so-called Domar weights which sum to greater than 1. For an algebraic justification of this procedure, see Hulten (1978).

graphically by the distance BC in Figure 1. The gain in national income is equal to the sum of the factors of production that can be redeployed in the rest of the economy multiplied by their marginal productivity. Metzer (1977) sets out the argument as follows. For the case depicted in Figure 1 with fixed cost linear transformation curves and constant output of transportation, the following equality holds

$$\frac{C_1 P_{C1} + T_1 P_{T1}}{P_{C1}} = \frac{C_0 P_{C0} + T_1 P_{T0}}{P_{C0}} \qquad (5)$$

where C is other output and P_C is its price.

This is equivalent to

$$C_1 - C_0 = T_1 (P_{To}/P_{C0} - P_{T1}/P_{C1})$$
(6)

and normalizing the price of other output to 1 in each period

$$C_1 - C_0 = SS = (P_{T0} - P_{T1})\, T_1 \qquad (7)$$

Putting this result in terms of utility in Figure 1 by drawing the community indifference curves U_0 and U_1it is apparent that the estimated gain BC = EG is an overestimate of the equivalent variation by the amount FG since U_1 can be reached at point D.

Translating the story into a partial equilibrium consumer surplus diagram in Figure 2 where D_1 and D_2 are compensated demand curves for pre- and post-railroad real income levels and *D* is the uncompensated demand curve for transport services, the equivalent variation consumer surplus is given by (a + b + c + d) and the social saving by (a + b + c + d + e). Clearly, an accurate (as opposed to upper bound) estimate of the real income gain requires information on the price elasticity of demand.

Two more points should be noted about this result. First, as Metzer (1984) points out, the area of increased consumer surplus shown in Figure 2 captures the general equilibrium gains from the shift in the production possibility frontier (PPF) illustrated in Figure 1. Jara-Diaz (1986) derives this result mathematically and shows that the transport benefits will be exactly equal to economic benefits if there are constant returns to scale and perfect competition throughout the rest of the economy. Second, the argument can also be developed for intermediates in terms of a derived demand curve provided that the purchaser operates under conditions of competition and is therefore acting as the agent of final consumers. Bresnahan (1986) shows this in the context of the estimating the value of purchases of computers by the financial services sector.

The natural interpretation of the gain in real income obtained from reducing resource costs in transportation is as an increase in TFP. Harberger (1998) reminded us that TFP growth can be interpreted as real cost reduction and the price dual measure of TFP confirms that the rate of fall over time in the real cost of railroad transport under competitive conditions is also equal to TFP growth. Since railroads will only be introduced at the point where they can offer transport at the same cost as water transportation, if expressed as a contribution to the annual growth rate, the social savings measure should equate to the own TFP growth contribution. Indeed, this equivalence is exactly how Foreman-Peck (1991) extended the social saving estimate for British railways made by Hawke (1970) for 1865 to 1890.

The price dual measure of TFP growth equivalent to (3) is

$$\Delta A/A = s_K \Delta r/r + s_L \Delta w/w - \Delta p/p \qquad (8)$$

where r is the profit rate, w is the wage rate and p is output price. Thus when input prices are constant, TFP growth equals the rate of nominal price decline.

Using this result, the rail social saving in year t compared with the year of introduction, t – 1, expressed as a fraction of rail revenue is

$$(p_{t-1} - p_t)q_t/p_t q_t = p_{t-1}/p_t - 1 = A/A_{t-1} - 1 \qquad (9)$$

or expressed as a fraction of GDP is

$$(A/A_{t-1} - 1)*(p_t q_t/GDP_t) \qquad (10)$$

Rail social savings as a proportion of GDP are revealed to be the percentage change in TFP in the rail industry multiplied by the ratio of rail output to GDP.

The social saving approach is then equivalent to taking only the TFP and not the embodied capital contribution of an innovation. The logic of this is quite clear in terms of Fogel's search for the unique contribution of railroads to economic growth. Railroad capital earned a normal profit equal to its opportunity cost so, in the absence of railroads, another investment would deliver an equal return.[2] The social saving concept

[2] If railroads earned supernormal profits, then it would be appropriate to add just the producer surplus component of profits to find a true estimate of the real income gain, McClelland (1972).

was devised to answer the counterfactual question "how much faster was economic growth than it would have been in the absence of the new technology?" whereas growth accounting simply addresses the ex-post accounting question "how much did the new technology contribute to growth ?" and ignores issues of crowding out.[3]

3. Refinements of the Social Savings Concept

The full economic benefits of a transport improvement will be underestimated by the conventional measurement of consumer surplus if there is imperfect competition elsewhere in the economy. This was ignored by Fogel (1964) and probably does not matter for freight social savings where commodities like grain and coal were being transported. More generally, however, market power in the transport-using sector should be taken into account, as is shown in Figure 3 drawn for a representative firm in the transport-using industry. This shows the benefits of the transport improvement represented by a fall in transport costs from P_{T1} to P_{T2} as the sum of (A + B + C) rather than (A + B), the traditional transport benefits.

The extra area C accrues because of the expansion of output in the transport-using industry for which marginal benefit exceeds marginal cost. The ratio of the economic benefit to the transport benefit will be equal to $\{1 + \eta(m/p)\}$ where η is the price elasticity of demand facing the representative firm and m/p is the mark up of price over marginal cost (SACTRA, 1999, p. 100). A reasonable estimate for the UK economy in the late 1990s suggests that the traditional measure underestimates on average by about 10 per cent (SACTRA, 1999, pp. 101-2).

A more serious problem may be that the social saving approach treats new technology as simply making available a perfect substitute

[3] Growth accounting typically assumes normal returns to investment in the new capital.

more cheaply. More generally, technological change may provide new goods which have 'fundamental novelty' in the form of previously unavailable characteristics, i.e., are close but imperfect substitutes. For example, in terms of passenger travel on railways, hitherto unattainable speeds were now possible. So, there would be a consumer surplus gain even if there was no reduction in the price of travel and it should be added to the conventional social saving. Figure 4 taken from Bresnahan and Gordon (1986) illustrates this by showing the difference between the imperfect substitute where dd is downward sloping and the perfect substitute where dd(–∞) is horizontal. Taking account of such gains can lead to very large estimates for the value of new services to consumers; for example, Hausman (1997) estimates an annual gain of $1.27 billion a year for voice messaging services in the United States[4]. This extra consumer surplus gain is ignored by growth accounting where computations of TFP growth are based on cost of goods indices (COGI). In fact, what would be required are calculations of the addition to real income where deflation of nominal GDP is based on a cost of living index (COLI) which calculates the expenditure necessary to maintain the reference standard of living (stay on the same indifference curve) over time. The difference between the COGI- and COLI-based estimates of growth of real output may be appreciable (Crafts, 2003).

A remaining issue with the social savings measure of the benefits from technological change is, as its proponents acknowledge, that it will not capture externalities or gains from economies of scale (external or internal) in the transport-using sector. This was the essence of the critique by David (1969). The advent of the new economic geography encourages us to believe that these may be more serious omissions than Fogel (1979) was willing to accept. With regard to railroads the burden of

[4] Hausman shows that a reasonable approximation to the compensating variation is that it is equal to 0.5 x current revenue from sales divided by the own price elasticity of

Chandler's (1977) account of the rise of mass consumption and mass distribution in the late nineteenth century American economy is that it was based on the transport cost reductions that railroads entailed and the agglomeration benefits that ensued. Simulations of a new economic geography model in Venables and Gasiorek (1998) suggest that taking account of such considerations could imply that the total economic benefits are as much as 50 per cent greater than the traditional transport benefit. These unrecognized gains are the equivalent of the TFP spillovers that growth accounting studies acknowledge may exist but also fail to quantify.

The preceding discussion has been conducted entirely in terms of a closed economy. This is in fact a serious limitation in the context of a globalized economy where the users and producers of new technologies will often be in different countries. Since the products of the new technology will experience falling prices, the impact of its production on real GDP will not equate to that on real national income. This is shown in Figure 5 which is a modification of Figure 1 now drawn for an economy open to international trade with a conventionally sloped PPF.

In Figure 5 technological progress in computer manufacture shifts out the PPF as shown. At constant relative prices (terms of trade) production shifts from A to B resulting in a rise in utility from U_1 to U_3 with consumption shifting from D to F. If, however, we allow for a decline in the relative price of computers and thus in the net barter terms of trade, the shift in production will be from A to C rather than B and in consumption from D to E rather than F. Instead of reaching U_3 only U_2 can be attained. Measured in terms of the composite commodity on the vertical axis, failure to allow for the change in the purchasing power of exports over imports leads to an exaggeration of the gain in real income of HJ. Thus, the production and consumption gains are different.

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demand.

History tells us that this consideration can be serious and that it may be dangerous to view the contribution of a new technology entirely through a growth accounting methodology focused on domestic production. The best example is probably cotton textiles during the British industrial revolution. Cotton accounted for almost a quarter of the TFP growth contribution to British growth between 1780 and 1860 (Harley, 1999a, p. 184) but about 50 per cent of its output was typically exported and its price compared with other goods fell from a relative of 6.3 in 1770 to 2.7 in 1815 to 1.0 in 1841. Cotton was Britain's most important export and, accordingly, the net barter terms of trade fell from 196 in 1801 to 108 in 1851 (Imlah, 1958, pp. 94-6).

These price changes mean that much of the benefit of technological advances in Britain accrued to consumers in the rest of the world. Allowance can be made for this by taking account of the terms of trade losses through deflating exports by an appropriate import price deflator. Harley (1999b) provides such a calculation and concludes that the welfare gain from the growth of cotton textiles during the industrial revolution was a little over 11 per cent of 1841 income whereas valuing output of the sector with no such terms of trade correction would have shown a gain of 25 per cent. The social saving methodology by valuing gains from domestic use of new technology is a better guide to welfare benefits than the usual growth accounting estimate.

4. Social Savings in Practice

The discussion of the previous section implies that there may be substantial advantages in using the social savings approach to evaluating the contribution of a new technology. Among these are the following. First, there is a clear focus on benefits to users and gains from consumption rather than production. Second, this is particularly appropriate in open economy situations, especially for countries where production of the new good is much larger than consumption, i.e., net exports are substantial relative to GDP. Third, it is not necessary to measure output in the sector which uses the new technology and this is convenient where 'hard-to-measure' activities are concerned. Fourth, the most serious weaknesses identified, namely, the problems arising from inappropriate treatment of new goods and TFP spillovers, are shared with the growth accounting approach.

How great are the practical difficulties of estimating the social saving ? The data required are probably less difficult to obtain than for growth accounting. Indeed, the appeal of the social saving is its simplicity (Bayoumi and Haacker, 2002, p. 12). If the technique is implemented econometrically, the key requirement is to be able to estimate the demand curve for the goods in which the new technology is embodied. For a technology whose price is rapidly declining, identification is unlikely to be a problem and data on expenditures, prices and real incomes are needed. The key here is to measure price declines well. This last is also true of the alternative way to implement the methodology through computing index numbers. Here the aim is to calculate the relative cost of providing second period utility at first period prices. Bresnahan (1986) notes that the requirements are to assume a functional form for the COLI and to obtain budget shares, quality adjusted prices and expenditures.

Some of the data problems of growth accounting are formidable and are obviated by the social saving approach. These include the difficulties associated with measuring flows of capital services such as obtaining rental prices and depreciation. There is also no need to measure output in the using sectors or to assume that factor shares equal output elasticities.

An illustration of the results that can be obtained from the social savings approach as applied to ICT is provided by Table 2 taken from

Bayoumi and Haacker (2002). These authors obtained data on expenditure for 41 countries for various IT goods from World Information Technology Services Alliance (WITSA) and based prices on US hedonic prices adjusted for changes in the exchange rate. Demand elasticities for IT hardware, software and telecoms were estimated using OLS panel regressions. The coverage is quite wide and includes a number of middle income countries.

The results in Table 2 have a number of interesting aspects. These include the fact that, although the United States has the largest social saving, several other countries are not far behind including Australia, New Zealand, and Singapore. It is also notable that there is no close correlation between the share of the economy in ICT production and the social savings gains. Some major ICT producers such as Ireland and Malaysia have much smaller benefits than Australia which has very little ICT production. There is, however, a positive relationship between social savings from ICT and income levels – developed countries have gained more on average.

Table 3 from the same study fleshes out the role of international trade in the lack of correlation between the relative importance of ICT production in GDP and user benefits. The contribution of ICT to domestic demand (column 6) is much more evenly distributed across countries than the gain in real GDP based on productivity gains in the ICT sector (column 5). The countries whose economic activity is most skewed towards ICT production such as Malaysia and Singapore export most of their output and the falling price of this production has been to the benefit of consumers in the rest of the world.

Finally, Table 4 offers a comparison between the growth accounting results in van Ark et al. (2003) and social savings from ICT over part of the same period in Bayoumi and Haacker (2002) for countries which feature in both studies. The following pattern is observed. First, for all but one country (Sweden) the social savings is lower than the total growth accounting contribution. Second, for all but one country (Ireland) the social savings contribution is higher than the TFP component of the growth accounting contribution. This is what we would expect for a set of countries where ICT expenditure is greater than ICT production. Not surprisingly, Ireland emerges as the country in which ICT has made the greatest contribution as measured by growth accounting and by far the largest contribution from TFP growth. On a social saving basis, however, Ireland is only equal sixth and well behind the United States. This illustrates once again the importance of distinguishing welfare benefits from gains in productive potential where small open economies are concerned.

5. Conclusions

In the introduction three questions were posed. In summary, the answers that the paper proposes are as follows.

First, in the case of a closed economy, the social savings measure of the contribution of a technology to economic growth is approximately equal to the own TFP contribution identified by growth accounting.

Second, it is important to recognize that the social saving approach essentially seeks to examine the welfare benefits derived from the technology rather than to measure the contributions to increased production volume. The techniques are essentially complementary. Where domestic consumption and production are fairly similar, computing the social saving may be a short cut method of approximating the TFP growth contribution of the technology. Both techniques have measurement problems. They both need accurate measures of the rate of price decline of the goods and services experiencing technological improvement. On top of that, social savings needs good estimates of the price elasticity of demand and growth accounting needs good measures of capital flows and output to capital elasticities.

Third, comparison of the results of recent studies of ICT shows that the two methodologies can give a very different sense of the growth contribution of ICT, especially in small open economies. These differences are broadly in line with theoretical expectations.

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Table 1. Social Savings from Railways (% GNP)

a) Freight		
Argentina	1913	26.0
England and Wales	1865	4.1
	1890	10.2
USA	1859	3.7
	1890	4.7
Spain	1878	6.5
	1912	18.5
Russia	1907	4.6
India	1900	9.0
Brazil	1913	18.0
Mexico	1895	14.6
	1910	31.5
b) Passengers		
USA	1890	2.6
Russia	1907	1.0
Brazil	1913	1.6
Mexico	1910	0.6

Notes:

Freight:

Spanish estimate for 1878 is corrected from the original to take account of subsequent research on Spanish historical national accounts. Unpublished doctoral research by Herranz-Loncan (2002) finds that the estimates are too high because the gap between road and rail freight rates is considerably less than previously thought. His estimates show a social saving equal to 2.4 per cent of GDP in 1878 and 7.0 per cent of GDP in 1912.

Mexican estimate is average of high and low estimates presented by the author.

US 1890: the 4.7% estimate is from Fogel (1964); this is considerably lower than would be obtained by extrapolating Fishlow's 1859 estimate on the basis of his TFP growth estimates. Fishlow (2000) continues to believe that Fogel's calculation of 1890 freight social savings is flawed and recently reasserted that the true figure is at least 10 per cent of GDP.

O'Brien (1983) contains several other 'guesstimates' which are less thoroughly documented and probably of lower quality; for Belgium: 2.5 per cent of GDP in 1865 and 4.5 per cent in 1912, for France: 5.8 per cent of GDP in 1872, and for Germany: 5.0 per cent of GDP in the 1890s.

All these estimates are "upper bound" and assume a zero price elasticity of demand. They therefore exaggerate the user benefits. Empirical estimates suggest that the true elasticity was probably around –0.5. If so, then as a rule of thumb, these social savings are overestimates by a factor of around 2. The precise ratio between true social savings and the figure obtained assuming zero price elasticity depends on both the price elasticity of demand and the ratio between rail and non-rail costs and is given by the formula (Fogel, 1979):

$$S_{true}/S_{zero} = (\phi^{1-\eta} - 1)/(1-\eta)(\phi - 1)$$

Where ϕ is the ratio P_{NR}/P_R and η is the price elasticity of demand.

Passengers

The table only includes estimates that take account of passenger travel time savings and the estimates are all based on a benchmark price elasticity of demand for rail passenger travel of – 1.

Figure for Mexico is my interpretation of the discussion in Coatsworth (1981, pp. 71-72) rather than an estimate explicitly provided by the author.

Sources:

Freight:

Argentina and Brazil: Summerhill (2003); England and Wales: 1865: Hawke (1970), 1890: Foreman-Peck (1991); USA: 1859: Fishlow (1965), 1890: Fogel (1964); Russia: Metzer (1976); India: Hurd (1983); Spain: Gomez-Mendoza (1983); Mexico: Coatsworth (1981).

Passengers*:*

USA: Boyd and Walton (1972); Russia: Metzer (1976); Brazil: Summerhill (2003); Mexico: Coatsworth (1981).

Table 2. Change in Social Savings of ICT (%GDP)

	1992-99	1985-2001
Argentina	1.3	1.3
Australia	3.6	5.0
Austria	2.0	2.7
Belgium	2.3	3.0
Brazil	1.8	2.1
Canada	2.8	4.0
Chile	2.2	2.7
China	2.0	2.4
Columbia	2.1	2.3
Denmark	2.9	4.0
Egypt	1.1	1.0
Finland	2.7	3.8
France	2.1	2.7
Germany	2.1	2.8
Greece	1.3	1.3
Hong Kong	3.0	3.6
India	1.1	1.1
Indonesia	1.0	0.9
Ireland	2.7	3.6
Israel	3.2	4.2
Italy	1.5	1.9
Japan	2.6	3.4
Korea	3.2	4.4
Malaysia	2.5	3.4
Mexico	1.6	1.8
Netherlands	2.8	3.9
New Zealand	3.9	5.1
Norway	2.7	3.8
Philippines	1.5	1.7
Portugal	1.8	2.1
Singapore	4.0	5.4
South Africa	2.6	3.7
Spain	1.6	2.0
Sweden	3.2	4.7
Switzerland	3.1	4.2
Taiwan	1.9	2.4
Thailand	1.4	1.6
Turkey	1.3	1.4
UK	3.5	4.8
USA	4.1	5.6
Venezuela	2.0	2.3

Source: Bayoumi and Haacker (2002), Table 8.

Table 3. Comparison of the Impact of the IT Sector on Real GDP Growth and Real Domestic Demand, 1996-2000 (% per year)

	Output (%GDP)	Producer Price	Spend (%GDP)	Consumer Price	Growth Effect	Demand Effect
Australia	0.2	–9.0	1.8	–15.6	0.03	0.25
Austria	0.6	–5.7	1.8	–9.7	0.03	0.12
Belgium	1.4	–7.7	2.0	–8.2	0.10	0.13
Brazil	1.1	–14.5	1.2	–11.2	0.17	0.10
Canada	0.8	–12.5	1.6	–17.8	0.10	0.28
Denmark	0.5	3.6	1.8	–13.3	–0.01	0.21
Finland	5.3	2.5	1.6	–12.8	–0.09	0.21
France	1.5	–4.9	1.7	–7.7	0.06	0.11
Germany	1.1	–4.6	1.6	–10.3	0.04	0.12
Greece	0.3	–4.7	1.3	–6.0	0.01	0.05
Hong Kong	1.1	–15.8	1.3	–15.3	0.20	0.20
India	0.2	–11.0	0.4	–16.7	0.04	0.08
Indonesia	2.0	–8.5	0.8	–2.7	0.17	0.01
Ireland	14.2	–18.1	1.4	–12.9	2.10	0.20
Israel	3.2	–10.1	1.3	–16.5	0.27	0.21
Italy	0.8	–10.8	1.3	–10.1	0.09	0.11
Japan	2.6	–12.8	1.2	–13.6	0.37	0.17
Korea	9.7	–10.4	3.0	–9.2	0.85	0.28
Malaysia	31.5	–15.0	1.4	–10.7	3.31	0.21
Netherlands	1.0	–12.2	1.9	–11.3	0.13	0.19
Norway	0.4	–5.9	1.6	–12.9	0.03	0.22
Philippines	11.7	–15.4	1.3	–7.9	1.13	0.09
Portugal	0.5	–13.8	1.3	–10.7	0.07	0.11
Singapore	39.2	–17.6	2.7	–10.3	6.71	0.30
South Africa	0.3	6.4	2.4	–9.8	–0.01	0.19
Spain	0.7	–5.0	1.7	–8.0	0.03	0.09
Sweden	4.3	2.7	2.4	–12.6	–0.10	0.31
Switzerland	0.5	–5.2	2.1	–10.2	0.03	0.18
Taiwan	8.9	–19.2	1.0	–15.4	1.50	0.15
Thailand	8.2	–15.3	1.0	–9.9	0.96	0.10
UK	2.0	–16.2	2.1	–16.3	0.30	0.31
USA	1.8	–15.1	2.4	–16.7	0.28	0.39

Source: Bayoumi and Haacker (2002), Tables 3 and 4.

Table 4. ICT: Growth Accounting and Social Savings Compared

a) Growth Accounting Contribution to GDP (% per year)

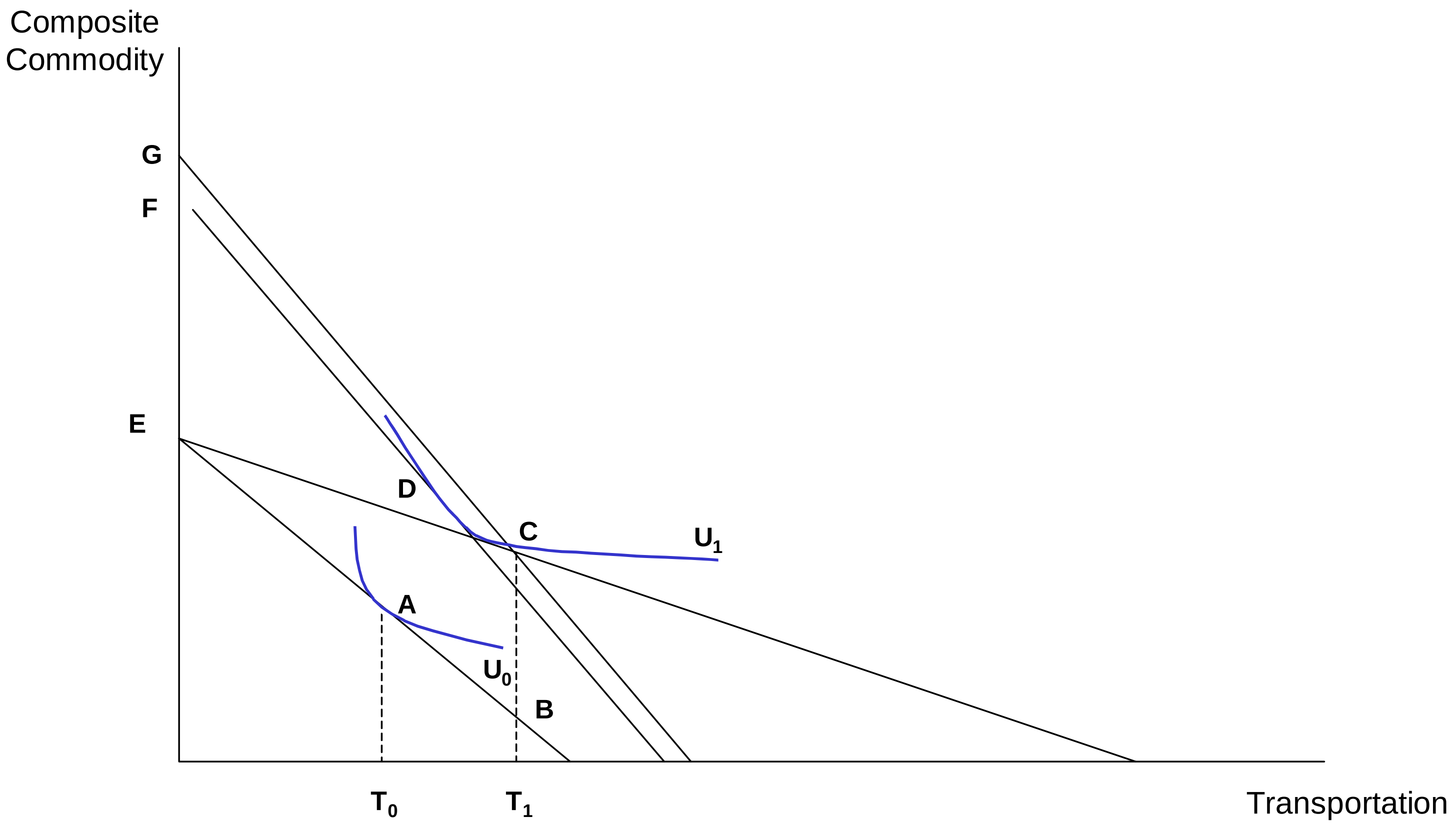
	1990-95			1995-2000		
	Capital	TFP	Total	Capital	TFP	Total
Austria	0.22	0.08	0.30	0.36	0.10	0.46
Denmark	0.24	0.05	0.29	0.44	0.06	0.50
Finland	0.17	0.16	0.33	0.37	0.17	0.54
France	0.20	0.17	0.37	0.35	0.22	0.57
Germany	0.28	0.14	0.42	0.37	0.16	0.53
Ireland	0.24	1.17	1.41	0.80	3.02	3.82
Italy	0.23	0.13	0.36	0.41	0.15	0.56
Netherlands	0.33	0.07	0.40	0.68	0.10	0.78
Portugal	0.23	0.02	0.25	0.34	0.03	0.37
Spain	0.18	0.09	0.27	0.27	0.12	0.39
Sweden	0.22	0.14	0.36	0.53	0.09	0.62
UK	0.34	0.21	0.55	0.69	0.32	1.01
USA	0.46	0.25	0.71	0.86	0.43	1.29

b) Social Savings Contribution to Growth, 1992-99 (% per year)

Austria	0.29
Denmark	0.42
Finland	0.39
France	0.30
Germany	0.30
Ireland	0.39
Italy	0.22
Netherlands	0.40
Portugal	0.26
Spain	0.23
Sweden	0.46
UK	0.50
USA	0.59

Sources: van Ark et al. (2003), Tables 20 and A6 and Bayoumi and Haacker (2002), Table 8.

Figure 1



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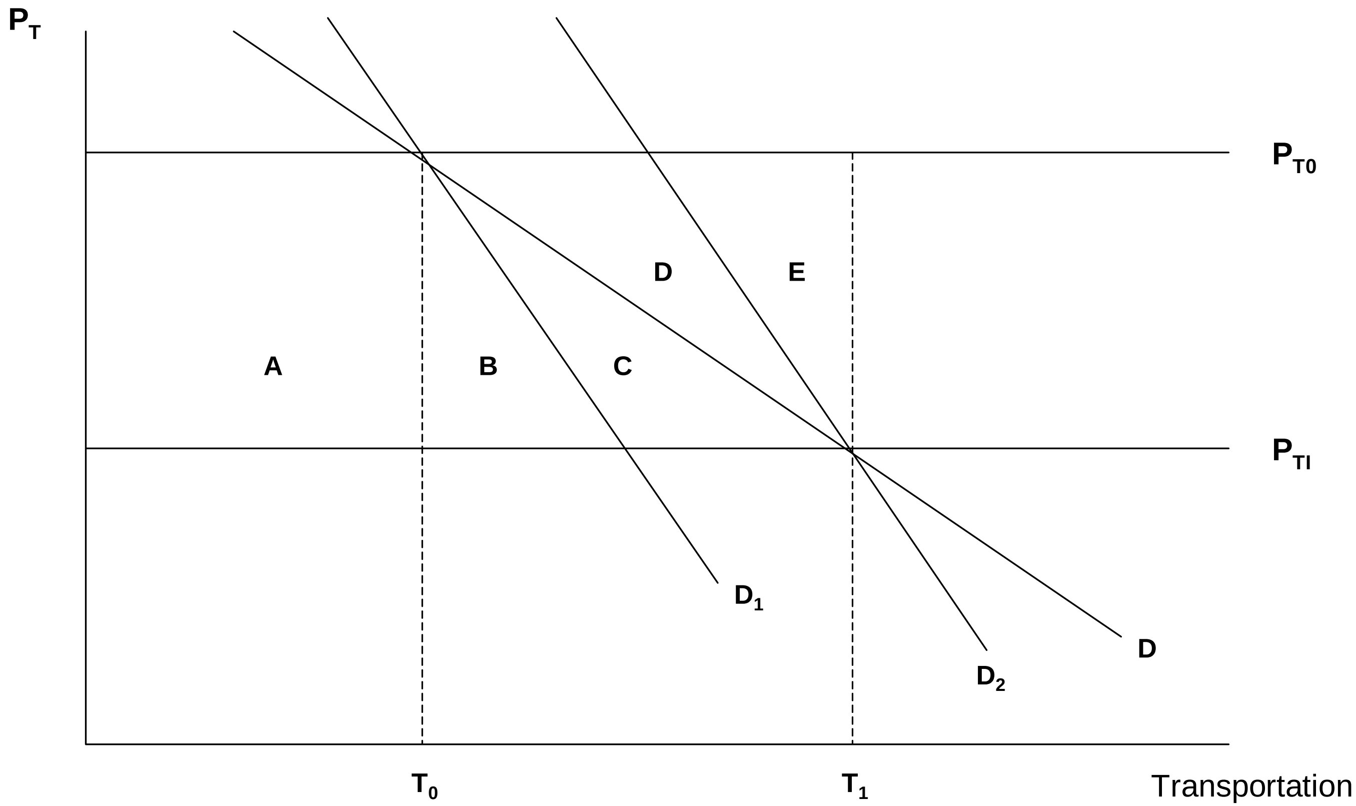


Figure 3

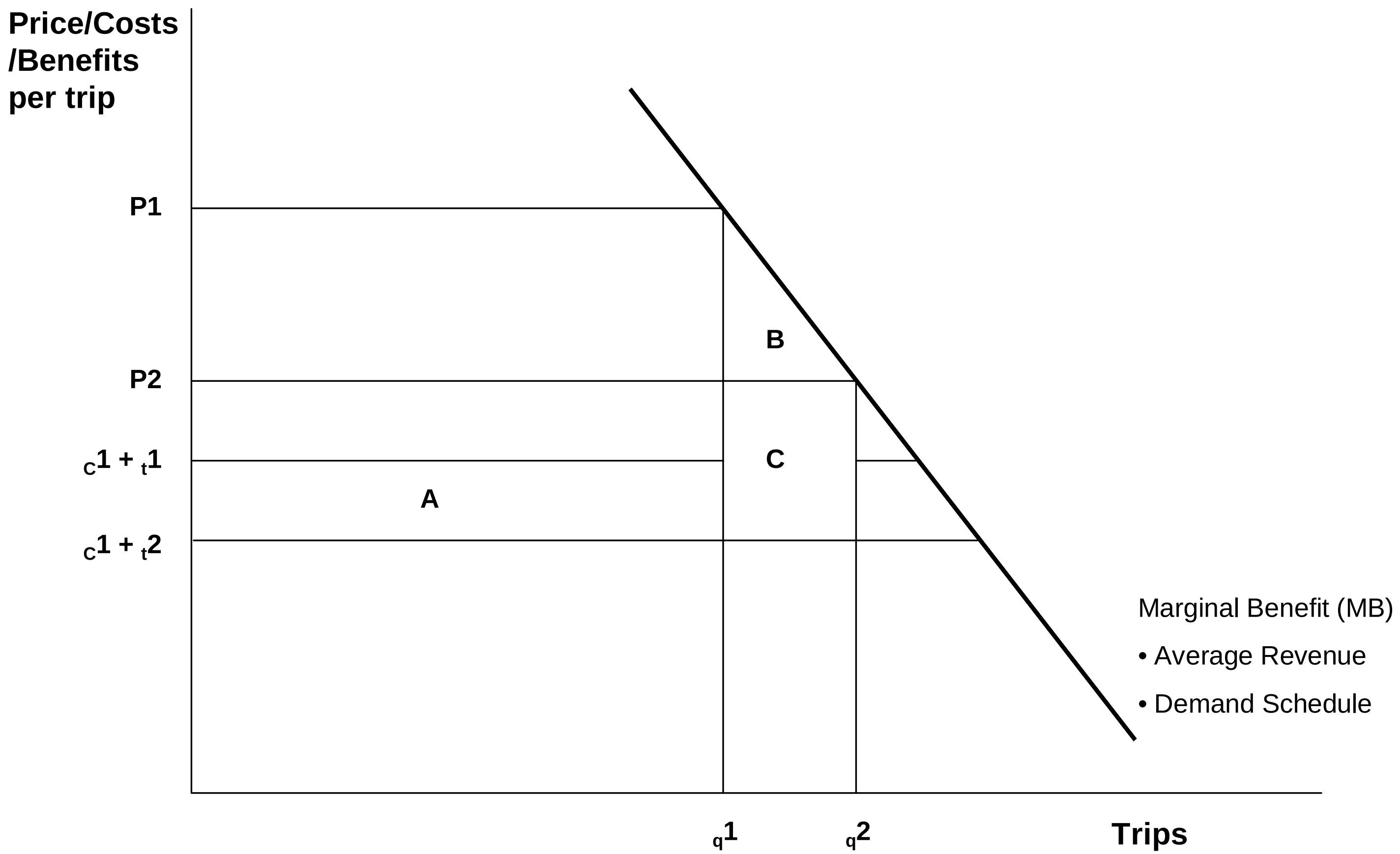

Price/Costs
/Benefits
per trip
P1
P2
c1 + t1
c1 + t2
A
B
C
Marginal Benefit (MB)
• Average Revenue
• Demand Schedule
q1
q2
Trips

Figure 4

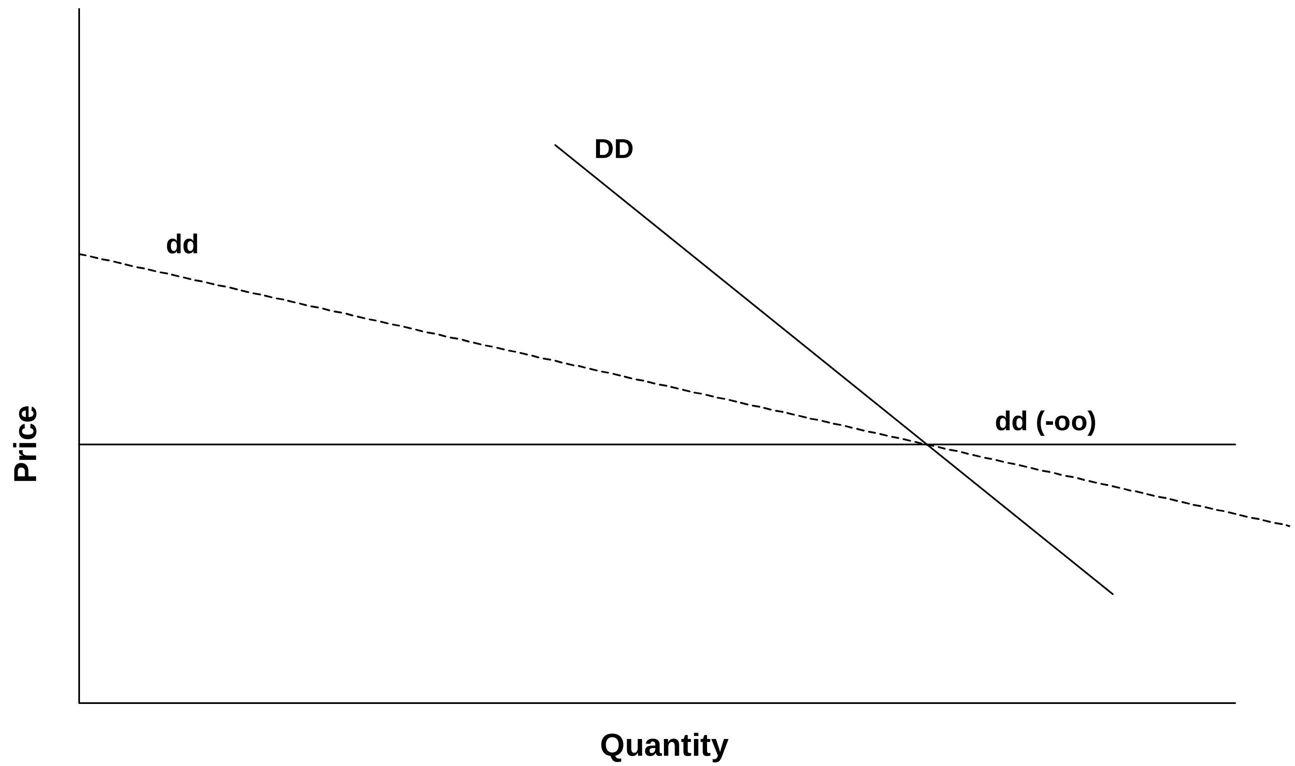
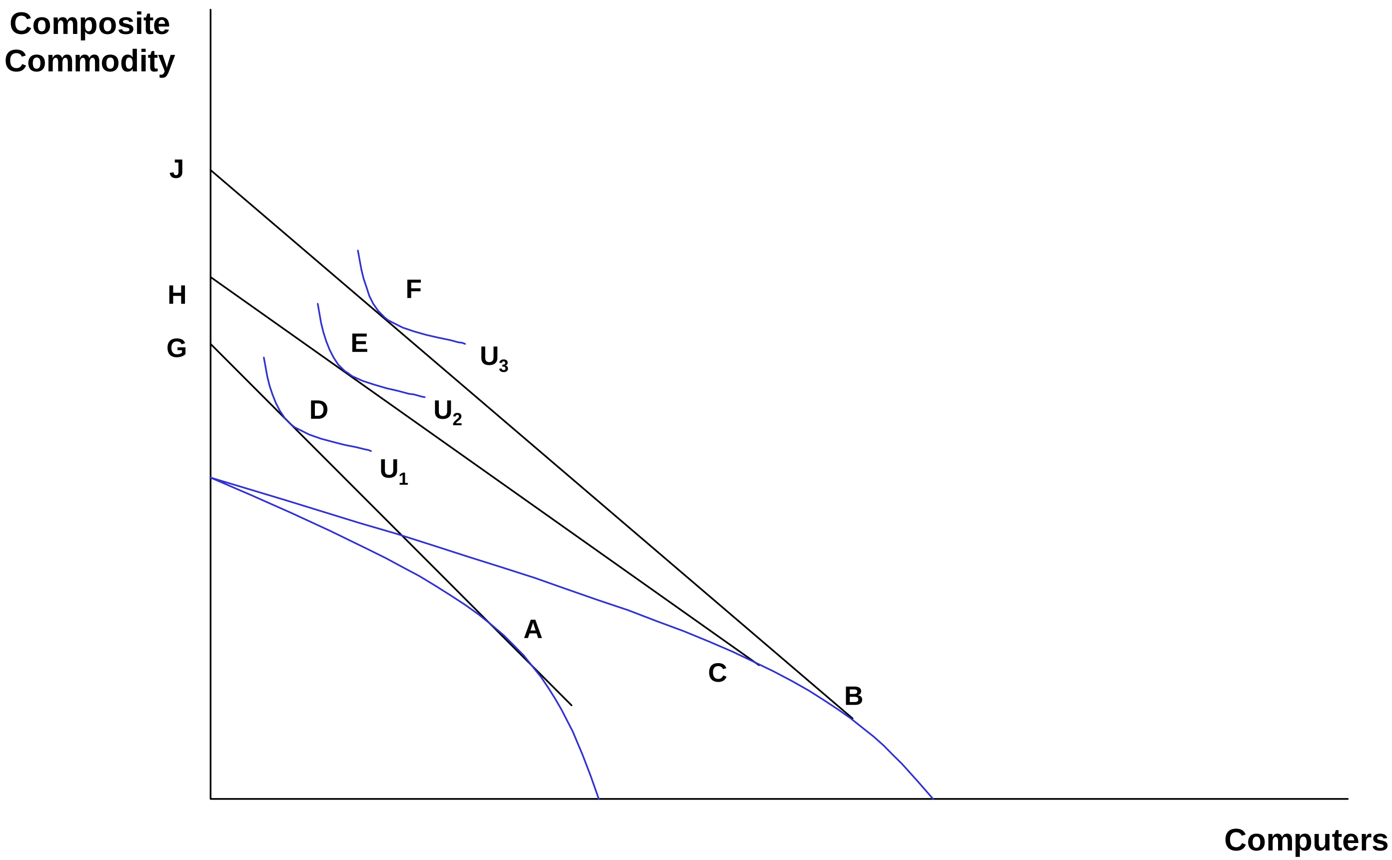


Figure 5



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