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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

$$SS \quad (P_{T0} \quad P_{T1})\, T_1 \tag{1}$$

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

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

$$Y \quad AK\,L^{1} \qquad (2)$$

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

$$Y/Y \quad s_{KO} \; K_O/K_O \quad s_{Ki} \; K_i/K_i \quad s_L \; L/L$$ @ E€È) R …'''—™„V ÂDŸ 5E9(GE`0 p

demand curve for transport services, the equivalent variation consumer surplus is given by (a

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]

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 horizont

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 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

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	

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 estim0tes by extra5

$$S_{true}/S_{zero} = (\ ^{1} \qquad 1)/(1 \qquad)(\qquad 1)$$

Where is the ratio P_{NR}/P_{R} and 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	

Ta

Table 4. ICT

Figure 1

Figure 2

P_T

E

A

D

D_2

T_0 T_1 Transportation

Figure 3

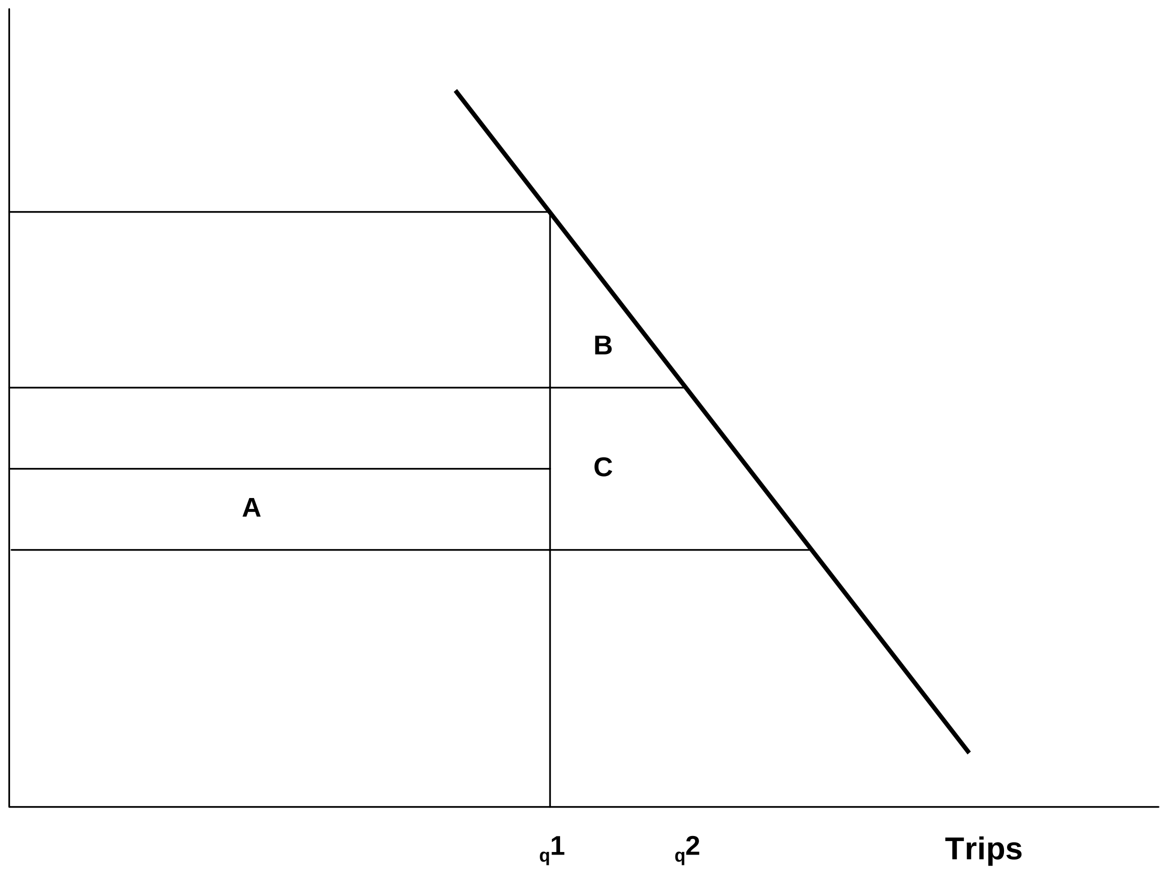

Figure 4

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