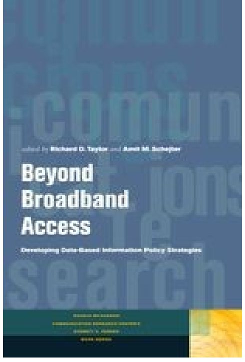

Beyond Broadband Access: Developing Data-Based Information Policy Strategies
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CHAPTER

11 European Broadband Spending: Implications of Input-Output Analysis and Opportunity Costs

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Abstract

This chapter considers the opportunity costs involved in using government funds for broadband in the context of a future European proposal to publicly finance broadband infrastructures. Using the input-output (IO) table methodology, it analyzes whether European investments in broadband infrastructures would improve welfare. The chapter begins with a literature review of previous studies on the relationship between broadband and information and communication technology (ICT) before turning to a discussion of the opportunity cost concept from a macroeconomic point of view. It then presents the macro perspective of the opportunity cost using the IO methodology and performs cost-benefit analysis based on the value of the economic multiplier, using the 59-sector IO table of European countries.

Keywords: opportunity costs, government funds, broadband, Europe, broadband infrastructures, input-output table, investments, welfare, information and communication technology, cost-benefit analysis

Subject: Museums, Libraries, and Information Sciences

Currently, many advanced countries have proposed broadband as part of the government's responsibility to combat the digital divide. The idea is that government should increase the accessibility of broadband to people who have not yet been able to access it, especially in rural areas. A prime example has been the so-called Obama Package, a $787 billion stimulus bill signed into law on February 17, 2009, as the American Recovery and Reinvestment Act of 2009. This act included $7.2 billion to support a variety of broadband-related programs, including $4.7 billion for the build-out of broadband in unserved and underserved areas.

Moreover, in Europe there have been initiatives to fund broadband as part of the European Economic Recovery Package. Decisions have been taken toward this end by the European Council, including the goal of 100 percent broadband coverage in Europe within the period 2010–2013 by spending 1 billion euro to stimulate broadband in rural areas in the European Recovery Plan.

While these programs have received considerable public attention, several issues come to the fore. The immediate one is whether government is spending money wisely. More precisely, a recommendation for using government funds should consider the *opportunity cost*, that is, whether other alternatives for spending the available money will create greater or less benefit to society. This chapter will present a methodology to evaluate the opportunity cost of using government funds for broadband, with particular attention to the European proposal to publicly fund broadband infrastructures, and ask ↳ (p. 190) whether such investments would be justified as improving welfare. More generally, the methodology will address whether any investment, private or public, improves welfare.

In particular, this study will consider the opportunity costs of broadband policy using the input-output (IO) table methodology, especially the output multipliers derived from the IO table as a basis for the opportunity cost assessment. Applying the IO methodology in this way provides a counter-factual, as-if analysis to the question of investment impacts due to broadband. Therefore, this study is conducted as an exploratory as-if study based on the IO literature without necessarily striving to provide implications for decision makers. Despite IO having strong theoretical background, the IO method has to be treated carefully due to its limitations and simplifications.

The chapter is structured as follows. First, a literature review of previous studies on the relationship between broadband and Information and Communication Technology (ICT) as well as the discussion on IO method will be presented. It will be followed by the opportunity cost concept from a macroeconomic point of view as a tool providing a common point of departure on this concept even though this study will not discuss the micro approach in a more detailed way. The next section will present the macro perspective of the opportunity cost using the IO methodology. Following this, an application of the method to selected European countries is conducted. Conclusions and implications for research follow.

Literature Review

This chapter investigates the impact of broadband represented by the ICT sectors, where the definition is derived from Organisation for Economic Cooperation and Development (OECD)[1]. The analysis makes the assumption that there is a close relationship between the broadband and ICT sectors. This link can be seen from many previous studies which refer to the Internet—where broadband itself serves always-on and faster Internet connections—to exemplify the terminology of ICT for instance in Hollenstein,[2] Bozinis[3], Franklin et al.,[4] Martin,[5] Cortés and Navarro,[6] and Haller and Siedschlag.[7]

As other ICT products, broadband is also embedded with the general purpose technology (GPT). The pervasive use of broadband technology in a wide range of sectors, therefore, will generalize productivity gains transferred to the rest of economy. In this view, Majumdar[8] identifies a greater impact of broadband to wages as the sector is associated with the need for a higher skill of labor. In a later study, Majumdar et al.[9] find a positive relationship between broadband deployment and the carriers' productivity and suggest to
p. 191 encourage the deployment of broadband technologies. Other studies also ↳ support the importance of broadband technology increasing employment and productivity level, for instance in Van Gaasbeck[10] and Grimes et al.[11]

Despite the tight link with ICT, broadband is very distinctive in comparison to other ICT devices since it brought a much wider impact on the economy. Previous studies predominantly identified the impact of ICT on the services sector as shown in Baily and Lawrence,[12] Armistead and Meakins,[13] and Antonelli,[14] denoted by a growing and greater ratio of services to the world's gross domestic product (GDP). But, recent studies show the impact of broadband moves beyond the service sector, for instance in agriculture (in the study by Ha et al.[15] and Kandilov and Renkow[16]). Moreover, there is also a growing interest to investigate the impact of broadband on small and medium-sized enterprises (SMEs) and rural and local economic development (Lindskog and Johansson,[17] Arbore and Ordanini,[18] Howick and Whalley,[19] and Glass and Stefanova[20]).

Not only does broadband directly affect economic and productivity as GPT, it also contributes a greater impact on socio-economic development, for instance, health and education (Savage et al.,[21] Sivakumar and Robertson,[22] Lindsay et al.,[23] Collins and Wellman,[24] Hale et al.,[25] and Ward and Prosser[26]). With regards to supporting public administration, recent studies found that broadband is a major catalyst for the implementation of e-government, for instance, in Italy (Arduini et al.[27]), and Estonia (Kalja et al.[28]).

In terms of methodology, the IO table has been largely used to estimate economic impact both solely as the measurement of traditional cost-benefit analysis or in relation to the opportunity cost concepts. The calculation of economic multipliers using an IO table is one of the alternative methods to measure cost-benefit analysis, especially in dealing with public policy choices. Fuguitt and Wilcox also argue that by implementing an IO table, one can derive induced income changes by linkages and for consumption expenditure, thus the contribution of a particular sector can be identified.[29] Therefore, the evaluation of public policy choices will consider not only the direct effect of a project or program but also the indirect effect induced by interconnection among economic sectors.

As an example, the use of an input-output table as the framework to analyze the opportunity cost concept can be found in Hughes et al. In this study they investigated the net effect of a farmers' market in West Virginia making alternative spending using the same amount of money as the second alternative. The opportunity cost impact in this study is concerned with the question of what would have occurred had the consumer spending at the farmers' market was compared to the spending at West Virginia grocery stores. This scenario assumes that expenditure made at the farmer markets is the same as what would have been spent at grocery stores.

p. 192 The gross impact on the economy is measured by calculating the job and income creation from the farmers' market activity, especially when local and regional economies benefit from an enhanced retention of local dollars. The impact is then compared with the alternatives of spending of money at the grocery level. The study reveals that the gross economic impacts of the farmers' market sales are to a small degree offset by losses in agriculture from reduced grocery store sales of similar products produced in West Virginia, confirming the positive opportunity cost of farmers' market development in the near future.[30]

Another study related to the opportunity concept can be found in Cho and Hooker's study, in which they build a model based on microeconomics analysis to measure the effects of a food safety program. The study calculates an opportunity cost, which is defined as the shadow value of productive resources used to enhance food safety that could alternatively be used to increase revenue through the sale of a larger volume of output. In other words, the study tries to estimate the effect of regulation on firm behavior. That is, loss in efficiency due to regulation that reduces a firm's choice of behavior which, at the same time, has a potential impact on economic revenue. To operationalize such a method, Cho and Hooker formulated the output directional distance function which was replaced by the use of IO data.[31] Hence, when the IO method is used to evaluate the opportunity cost concept, it will be dealing with alternative outcomes, which can be produced by using the same amount of resources as the alternative choice.

Nevertheless, as presented earlier, the use of the IO method to measure economic impact needs to be treated carefully. For instance, there is a choice between closed and open IO tables. A previous study by Grady and Muller suggested that the use of a closed IO table usually creates a misleading result since it yields exaggerated estimates of the impact of program expenditures on the economy.[32] This is the case because closed IO models do not take into account the macroeconomic feedback that tends to cause the multiplier to decrease over time. In the end, the use of open IO tables that put all final demand categories, including consumption, as exogenous variables is recommended. In addition, the study by Elder and Butcher shows that when the IO is used to measure the benefit of the project or program, it is also essential to look at the cost induced by the program at the same time.[33] Hence it will carry out the net effect of a particular project giving the balanced calculation from the cost and benefit side from both direct and indirect effects.

Related to studies on broadband, the ubiquitous adoption of broadband and the current generation of technologies will generate $63.6 billion of capital expenditures in the US economy, according to Crandall et al. This will result in a cumulative increase of the GDP of $179.7 billion and sustain 61,000 jobs per year.
p. 193 Moreover, the identification of consumer benefits from ↳ universal broadband deployment can be separated into various sources including shopping, entertainment, telecommuting, telephone services, and telemedicine. Thus, the cumulative $63.6 billion residential broadband capital expenditure will result in $179.7 billion between 2003 and 2021, or $9.5 billion annual impact.[34]

An empirical study conducted by Kelly on the impact of fiber deployment, found that a city in Iowa that invested in a fiber network at an earlier stage was able to attract 140 companies with 4,250 incremental jobs, while a city that invested later attracted only 9 companies.[35] Ford and Koutsky found that the impact of broadband on economic growth is reaching 28 percent.[36] Lehr et al. found that technology, based on data since 1999, had an impact on employment growth of 1.5 percent.[37] In addition, these studies frame the economic impact of broadband as the benefits listed in Table 11-1.

Table 11-1 Framework for Measuring Economic Impact of Broadband

Impact area	Benefit
Productivity	Labor productivity in ICT intensive and nonintensive sectors Productivity in supply chain and distribution functions
Firm relocation	Relocation of firm for labor pool search
	Relocation of functions resulting from value chain decomposition
	Enhancement of the quality of life, which attracts educated labor force
Employment	Enhancement of self-labor force enabled by telecommunications infrastructure
	Enhancement of the radius of tele-commuting allowing for tapping into additional labor pools
	Creation of new firms/services requiring additional labor force
Economic growth	Strengthening of industries by lowering transaction costs (trade, finance, etc.)
	Consumer surplus derived from telecommunications services, saving of transportation time, etc.

SOURCE: Crandall, Jackson and Singer (2003).

As depicted earlier, the strength of the IO method is its ability to capture both the direct and indirect impact of a certain project.[38] Katz explains that the first impact relates to the jobs created from the deployment of the infrastructure (e.g., construction), while the second impact is generated by the network externalities from other sectors of the economy.[39]

p. 194 The study by Katz also synthesizes previous analyses of the calculation of the multiplier effect in the broadband sector, with studies conducted at the regional level (e.g., Strategic Network Group, 2003) and country level (Crandall et al., 2003; Katz et al., 2008; Atkinson et al., 2009; Katz et al., 2009.a; Katz et al., 2009.b and Liebenau, 2009).[40] An overview is presented in Table 11-2.

Table 11-2 The Multiplier Effect of Broadband

Author	Location	Type I	Type II
Crandall et al. (2003)	United States	NA	2.17
Strategic network group	A Canadian County	2.03	3.42
Katz et al. (2008)	Switzerland	1.4	NA
Atkinson et al. (2009)	United States	NA	3.6
Katz et al. (2009.a)	United States	1.83	3.43
Libenau et al. (2009)	United Kingdom	NA	2.76
Katz et al. (2009.b)	Germany	1.45	1.93

Regarding Table 11-2, the Type I effect measures the impact as the ratio of the total of direct and indirect, divided by direct (direct+indirect/direct), while the Type II effect estimates the impact as the ratio of the sum of direct, indirect and induced, divided by direct (direct+indirect+induced/direct).[41] It has been found in previous studies that the multiplier of broadband varies between 1.43 to 3.60 depending upon the region investigated and the type of multiplier, confirming the study by Grady and Muller, which suggested that the Type II multiplier exhibits a greater value than the Type I multiplier.[42]

Katz and Suter assert that the expenditures for providing broadband service in the United States create employment as a result of network externalities. The study estimates that, due to the employment multiplier, providing of broadband services created 32,000 jobs per year for the four years of the project.[43]

In addition, the Strategic Network Group estimated that the impact of the investment in fiber optic networks in a small city in Ontario can be investigated through the effect of new job creation, expansion of commercial facilities, increased revenue and decreased cost. That study calculates that between June 2001 and April 2003, there was a $2.8 million industry expansion and $140,000 in increased revenue and decreased costs.[44]

In addition there is a correlation between the use of broadband technology and job growth: 50 percent of businesses using broadband experienced job growth; 27 percent of businesses with dial-up Internet access experienced job growth; 5.6 percent of businesses with no Internet access experienced job growth.

p. 195 The above results, which indicate the gradation of the level of Internet technology, were discovered by interviewing business entities after the project's implementation in the United Kingdom. Liebenau et al. provide a more detailed study in the case of the UK economy. Their study estimates that the impact will be significant in contributing immediate direct and indirect job growth in the UK economy, creating a network effect throughout the economy which will support additional jobs, providing a foundation for longer-term benefits including government cost saving, economy-wide productivity, and improved quality of life. Liebenau et al. summarize the impact in the United Kingdom as creating around 280,500 new jobs following a GBP 5 billion investment in broadband deployment.[45]

In addition to the calculation of the economic impact of broadband, broadband policy focusing on spreading out the technology needs to be studied. According to the OECD, the information society is a phenomenon that results from the role of ICTs in every aspect of life, especially its economic and social implications. In economic respects, businesses are transforming their supply and demand chains, as well as their internal organization, to fully exploit ICTs. In addition, ICTs have greatly contributed to the process of creative destruction through the birth of new firms with resulting implications for productivity improvement and economic growth. Therefore, ICTs are called *general purpose technologies* that can be used for a broad range of everyday activities. Thus, it should be taken into account as an alternative view, that amid possible lower multiplier effects, broadband policy should be implemented because broadband and the ICT sectors play important roles as GPTs for the rest of economy.[46]

In summary, in comparison to previous studies, this study will seek to adopt previous analyses in using IO tables as the basis of calculation, especially comparing countries within the European region. The use of an open IO table is implemented to avoid overestimation of the multiplier effect. In addition, the opportunity cost concept is introduced by taking other alternatives of spending broadband funds on non-ICT sectors by assuming that all sectors have similar probability ratios of success. Furthermore, this study only investigates the benefit side of the program, assuming that the cost structure of the ICT and non-ICT sectors investigated do not change before and after the implementation of the project. Hence, the cost side is assumed to remain the same.

The IO Model

The flow of transaction on the IO table, which is used as the main method in this study, can be explained in
p. 196 the following system equation (Equation 1). Suppose we have four sectors in the economy. ↳

$$
\begin{aligned}
x_{11}+x_{12}+x_{13}+x_{14}+c_1&=x_1\\
x_{21}+x_{22}+x_{23}+x_{24}+c_2&=x_2\\
x_{31}+x_{32}+x_{33}+x_{34}+c_3&=x_3\\
x_{41}+x_{42}+x_{43}+x_{44}+c_4&=x_4
\end{aligned}
$$

From Equation 1, x_{ij} denotes the output from sector *i* which is used by sector *j* as an intermediate input (or in the other words, it reflects the input from sector *i* which is used for further production process in sector *j*). On the IO quadrant, these values are located in quadrant 1. Moreover, c_i refers to total final demand of sector *i* whereas x_i refers to total output of sector *i*. c_i is put in quadrant 2.

Introducing the matrix notation, equation 1 can be modified to obtain the following matrix column:

$$x = \begin{pmatrix} x_1 \\ \vdots \\ x_4 \end{pmatrix}; c = \begin{pmatrix} c_1 \\ \vdots \\ c_4 \end{pmatrix}$$

Equation 2 consists of two matrixes that show the other representation of total output and total final demand. Thus, from equation 2, *x* denotes the column matrix of output and *c* is the column matrix of the final demand. The following matrixes I and A are the identity matrix and technology matrix respectively.

$$I = \begin{pmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{pmatrix}; A = \begin{bmatrix} a_{11} & \cdots & a_{14} \\ \vdots & \ddots & \vdots \\ a_{41} & \cdots & a_{44} \end{bmatrix}$$

The left-hand side of equation 3 is the identity matrix; a diagonal matrix whose off-diagonals are zero. Furthermore, A is the technology matrix which consists of the ratio of the intermediate demand to the total output, x_{ij}/x. Hence, a_{14}, for instance, explains the ratio of output from sector 1, which is further used by sector 4 to produce their output, divided by total output from sector 1.

Combining equations 1, 2, and 3, the equilibrium of the equation for demand and supply in equation 1 can be modified as follows:

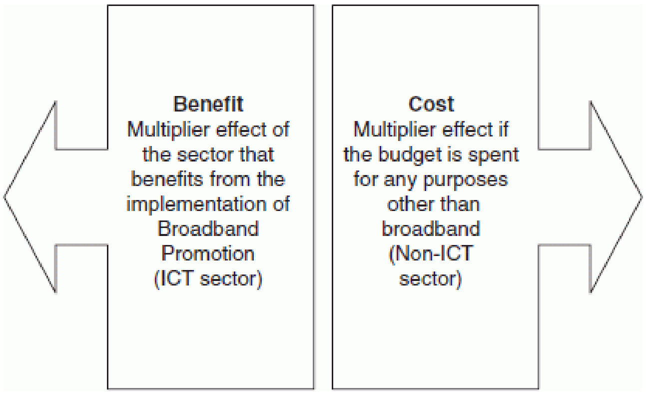
$$\begin{gathered} Ax + c = x \\ (I - A) = c \\ x = \left(I - A\right)^{-1} c \end{gathered}$$

p. 197 The first row of this equation is the general form of equation 1. Then, from equation 4, the multiplier is defined as the inverse Leontief matrix, $(I - A)^{-1}$. The multiplier measures the ratio of output changes in the equilibrium as the result of the change in the final demand. Therefore, the output multiplier measures total change throughout the economy from a unit change in final demand. The change in the final demand might arise from private consumption, government expenditure, investment, and export. As the consequence of production linkages, a change of output will be larger than a change in the final demand. For instance, if the final demand of the ICT sector (e.g., additional purchasing of personal computers) increases by ten unit values of money, the output in the economy will grow by more than ten unit values of money or as much as the multiplier coefficient of this sector. (Additional purchasing of personal computers leads to increased packaging services and transportation services, for instance).

This study employs a simple multiplier that measures the impact both from direct and indirect impacts, thus the matrix $(I - A)^{-1}$ consists of all sectors within the economy putting household exogenous.[47] Hence, the dimension of the matrix is 59 × 59 in the case of the European IO table. In addition, the IO table used in this method is open IO.

Thus, the macroeconomic impact of broadband can be evaluated as shown in Figure 11-1.

Figure 11-1.



Cost and benefit framework.

From Figure 11-1, it is assumed that the budget that is spent for broadband promotion is carried out from a specific pool of funds that actually can be spent for other purposes. Thus, there is a choice for the government in using these funds for public broadband expenditures. The broadband project will be indirectly benefiting the ICT sector, which is identified as the sector utilizing broadband relatively more than other sectors. This explanation describes the "benefit of the broadband package." On the other hand, p. 198 the ↳ (opportunity) cost is the alternative cost of spending. Thus, any alternative sector to invest the money in is considered as the next best alternative. However, it should be noted that there is a weakness in the method: considering current economic development, almost all economic sectors are affected by broadband either directly or indirectly. Therefore, from the calculation of the IO method, benefits are underestimated and costs are overestimated.

Moreover, this study employs the IO table deflated based on the GDP deflator for each country to enable the comparison between years of observation. The more thorough estimation on deflating the IO table is explained, for instance, by Celasun in the case of the Turkish structural change of the economy.[48] The same method using the sectoral producer price index and import price index can be seen in Zakariah and Ahmad on the Malaysian economy.[49] This study only uses the GDP deflator to obtain the constant value of the IO table. A similar method can be found in Akita (1991).[50]

Applying the IO Model to Broadband in the EU

Moving concretely into an application of the IO approach to assess impacts of broadband investment on a selected sample of countries to represent the European economy,[51] the following steps will be taken:

1. Defining the ICT sector.
2. Matching the ICT sector with the 59-sector input-output table.
3. Descriptive analysis of ICT sectors based on the IO table.
4. Multiplier analysis.
5. Evaluation.

These five steps are explained below.

Step 1: Defining the ICT sector. The fact that the ICT sector has contributed to the performance of the economy and other sectors has been proven by many empirical studies. Therefore, the need for statistics and analysis to support and inform policy making has grown alongside the rapid emergence of new ways of communicating, processing, and storing information in a common statistical standard which can be used uniformly to evaluate the information society within the OECD countries.[52]

To give the common understanding of what the ICT sectors are and how the ICT sectors have contributed to the information society, OECD provides details to guide in the measurement of the information society which defines and limits the classification of the ICT sectors. Focusing on the definition, there are two p. 199 categories which are attributed to the ICT sectors: ICT ↳ products and media and content products. The basic principle of identifying the ICT products is adapted from the OECD definition of the ICT sectors: "ICT products must primarily be intended to fulfill or enable the function of information processing and communication by electronic means, including transmission and display."[53]

In addition to that, there is also an OECD definition of the content and media products which is used to determine the content and media sectors: "Content corresponds to an organized message intended for human beings published in mass communication media and related media activities. The value of such a product to the consumer does not lie in its tangible qualities but in its information, educational, cultural or entertainment content."[54]

Step 2: Matching the ICT sector with the 59-sector IO table. Based on the definition of the OECD regarding ICT products and media and content products, the aggregation of ICT sectors based on the European IO table is described below. Table 11-3 shows the detailed classification of the sectors grouped as the ICT sectors based on the IO 59 table. This transformation process is conducted by matching the definition of each ICT and media and content product with the definition of IO sectors.

Table 11-3 Classification of ICT Sectors Based on European 59 Sectors IO Table

No.	Sector Number	Sector Name
1	16	Printed matter and recorded media
2	23	Machinery and equipment
3	24	Office machinery and computers
4	25	Electrical machinery and apparatus
5	26	Radio, television and communication equipment and apparatus
6	27	Medical, precision and optical instruments, watches and clocks
7	36	Wholesale trade and commission trade services, except of motor vehicles and motorcycles
8	43	Post and telecommunications services
9	49	Computer and related services
10	50	Research and development services
11	51	Other business services
12	53	Education services

Table 11-3 shows that there are twelve ICT sectors among the fifty-nine sectors in the European IO table. The classification is also very interesting in ↳ the sense that half the sectors are defined as goods and the rest are service sectors. Here, the economic impact and the contribution of the ICT sectors in this study correspond to these twelve sectors. However, since the aggregation level of the International Standard of Industrial Classification (ISIC) categories are more detailed than the IO categories, some ICT products and media and content products are aggregated in a particular IO sector.

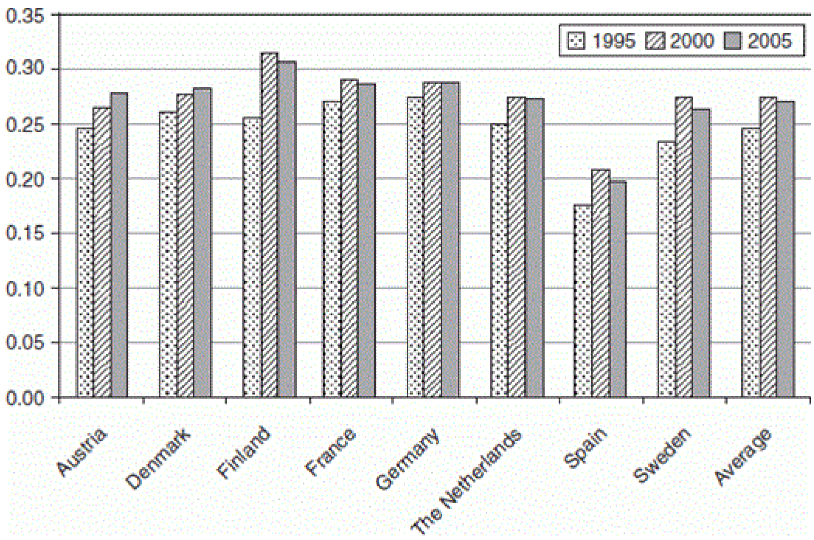
Step 3: Descriptive analysis. The descriptive analysis from the IO table is implemented by directly comparing the value of economic sectors from the table in terms of GDP, output, export and intermediate transactions. In this study the comparison is investigated distinguishing the ICT sectors and the rest of the economy. Table 11-4 shows the growth of output between 1995–2000 and 2000–2005 for a selected sample of European countries.

Table 11-4 Growth of Output

	1995–2000	2000–2005
Economic output	4.89%	2.37%
ICT sectors	7.31%	2.33%

From Table 11-4, it can be inferred that the growth of ICT sectors in the sample of European countries follows a general path of economic growth. While the output growth decreased from 4.89 percent during 1995–2000 to 2.37 percent from 2000–2005, the growth of ICT sectors also dropped from 7.31 percent during the first period to only 2.33 percent in the second subperiod. Thus, from Table 11-4, it can be concluded that, in general, ICT sectors still show a positive output growth for the average European countries. Nevertheless, the growth rate is decreasing compared to the rest of the economy. Figures 11-2 through 11-5 show the contribution of the ICT sector to output, GDP, export and intermediate transaction for each country.[55]

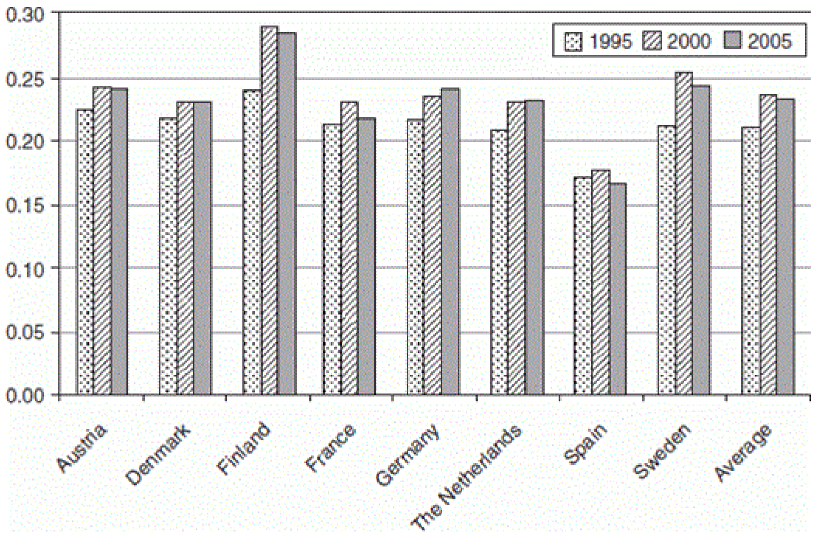
Figure 11-2.



Contribution of ICT sectors to economic output (%).

SOURCE: Author's calculations.

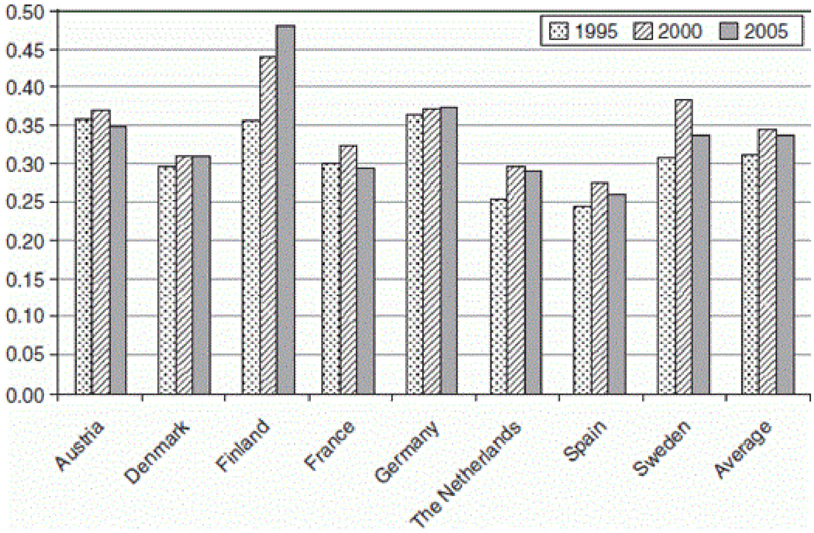
Figure 11-3.



Contribution of ICT sectors to the GDP (%).

SOURCE: Author's calculations.

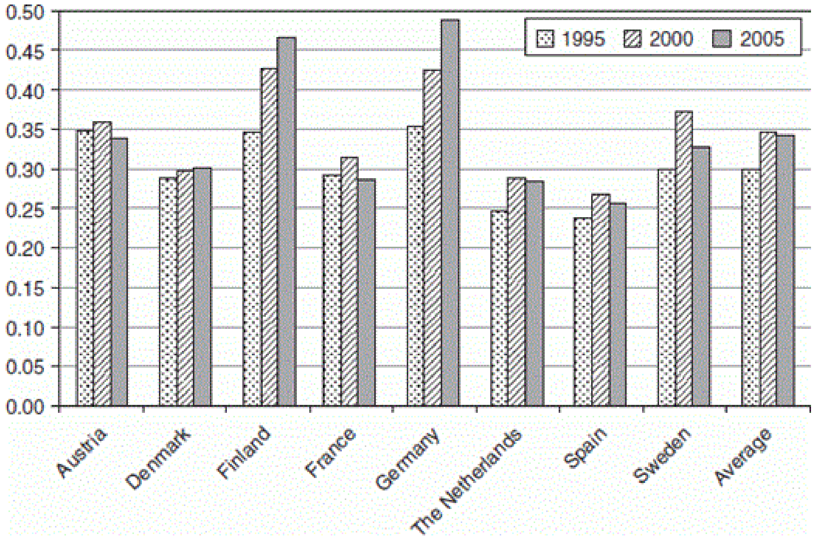
Figure 11-4.



Contribution of ICT sectors to the GDP (%).

SOURCE: Author's calculations.

Figure 11-5.



Contribution of ICT sectors to intermediate transaction (%).

SOURCE: Author's calculations.

While Table 11-4 describes that, in general, the growth rate of the ICT sector is lower than the rest of the economy, Figure 11-2 shows that the contribution of ICT sectors to output varies between countries. Except for Austria and Denmark, which reached a higher contribution during the second period, most of the European countries suffered from lower contribution of the ICT sectors (Finland, France, the Netherlands, Norway, Spain, and Sweden), while Germany was stagnant. The contribution of the ICT sectors on average is 25 percent for the whole European economy in 2005, slightly lower compared to 2000 (26 percent). Figure 11-3 shows the contribution to the GDP.

Since GDP has a proportional relationship to the output, the contribution of the ICT sectors in terms of GDP
p. 201 is similar to those explained earlier ↳ in terms of output. In this case, except for Germany and the Netherlands, all European countries have a smaller contribution by ICT sectors to the GDP. On average, the contribution was 22 percent in 2005 compared to 23 percent in 2000.

p. 202 Figure 11-4 describes the contribution of the ICT sectors to the total export of European countries. The figure also indicates that having reached higher contributions in 1995–2000, the proportion of the ICT sectors declined in most countries except for Finland and Germany.

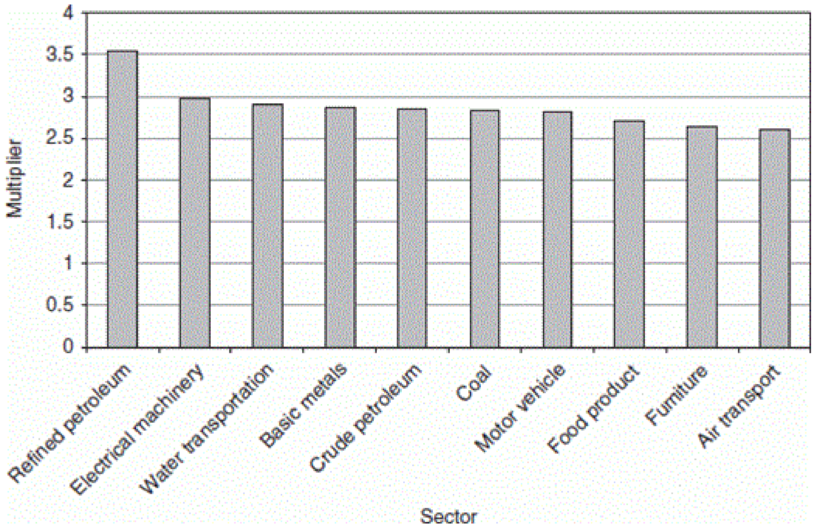
Intermediate transactions measure the output of the economy, which, instead of being consumed in final demand, is used for further production process in the other sectors. Thus this measurement reflects the interrelatedness of ICT sectors to the rest of the economy. Figure 11-5 shows that the contribution of the ICT sectors declined for all countries except for Finland and Germany.

In summary, the output of ICT sectors has declined due both to production level (which is indicated by the lower proportion in intermediate transaction) and to consumption level (both from domestic and export).

Step 4: Multiplier analysis. The most powerful aspect of the input-output model used is the fact that European countries apply the compatible fifty-nine economic sectors; thus they can be compared with each other.

As a detailed example of implementing the IO methodology, the Swedish IO tables—generated for the years 1995, 2000 and 2005—will be examined in more detail as an example. The multiplier effect of the Swedish economy is derived by calculating the inverse of the Leontief matrix and summing each column in order to
p. 203 get a multiplier coefficient for a particular sector.[56] The result in 2000 is shown in Figure 11-6. ↳

Figure 11-6.



Multiplier for Swedish economy, 2000.

Referring to the OECD definition of the ICT sector, the multiplier effect of the ICT sector for Sweden would be as shown in Table 11-5.

Table 11-5 ICT and Non-ICT Sector Multiplier for Sweden Based on IO Table 2005

Year	ICT	Non-ICT
2005	1.89	2.15

As suggested by Table 11-5, an average spending of 1 SEK in the ICT sector will generate accumulated economic output of about 1.89 SEK. It then becomes important to compare it with the impact of the
p. 204 expenditure for the non-ICT sector. Applying the same analysis, the average multiplier for the ↳ non-ICT sector is 2.15. The implication is that investments in the non-ICT sector will create a greater multiplier effect. Hence, the opportunity cost of investing in ICT is higher than investing in non-ICT for Sweden. As the ICT sector is used as an indicator of the broadband sector, the initial results suggest that Sweden would be better off by investing in the nonbroadband sector.

Applying the same analysis, Table 11-6 presents the comparison between two groups (ICT and non-ICT) measured by the average multiplier coefficients for all selected European countries investigated in this study.

Table 11.6 Multiplier Effect

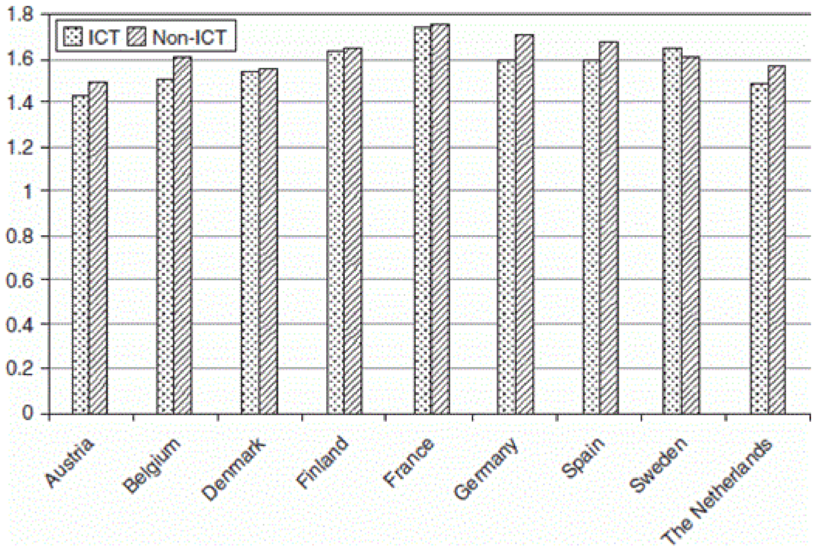
Year	ICT	Non-ICT
1995	1.53	1.58
2000	1.57	1.62
2005	1.57	1.61

SOURCE: Author's calculation.

As has been explained previously, the output multiplier measures a change in output as one unit value change in the final demand. From Table 11-6, 1 euro of spending in the ICT sector's final demand enabled growth of economic output by as much as 1.53 euro in 1995. Table 11-6 also indicates that in general the output multiplier of the ICT sector is smaller than the non-ICT sectors. In other words, based on the multiplier analysis, it demonstrates that the ability of the ICT sectors to contribute to the economy from final demand effect is lower than that of non-ICT sectors.

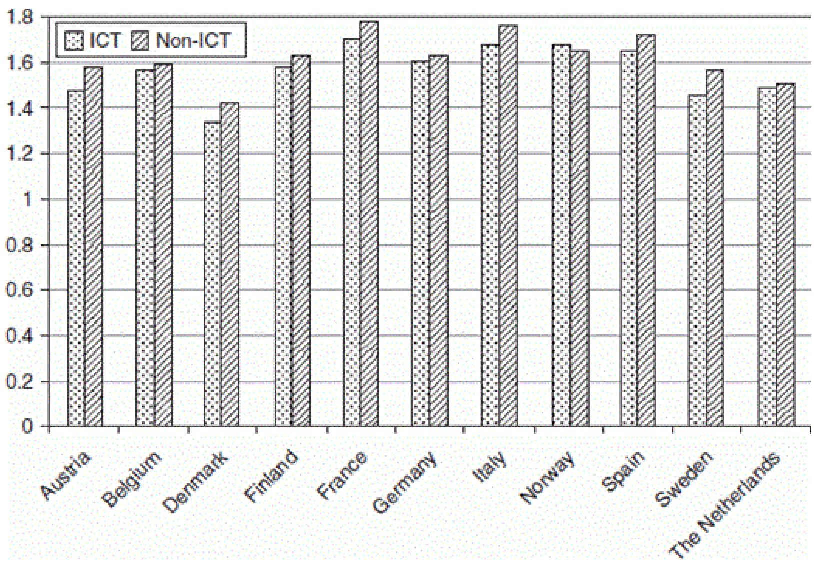
To have a better understanding of the variation between countries, Figures 11-7 through 11-9 compare the multiplier for both ICT and non-ICT sectors from 1995–2000.

Figure 11-7.



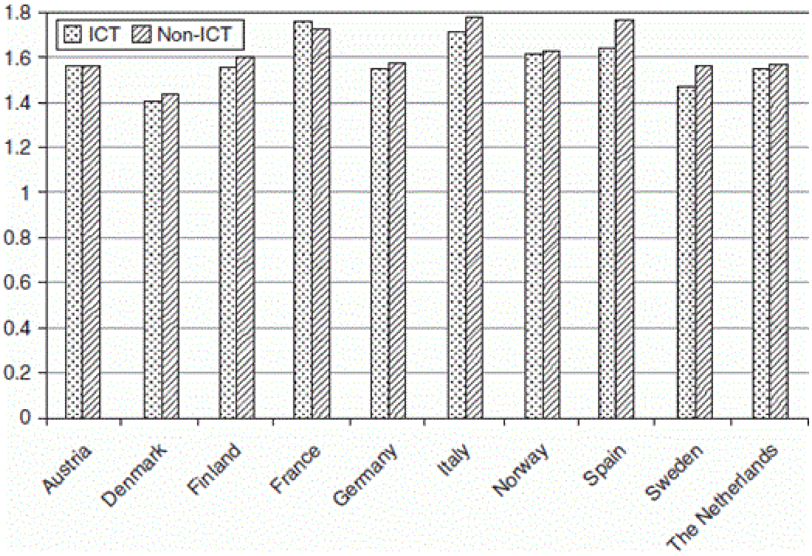
Output multiplier in the European economy (1995).

Figure 11-8.



Output multiplier in the European economy (2000).

Figure 11-9.



Output multiplier in the European economy (2005).

Figure 11-7 shows that except for Sweden, the output multiplier of the ICT sectors was smaller than the non-ICT sectors in 1995. It indicates that the contribution of output generated for every euro spent in ICT sectors product is less than the average sectors. The results for the year 2000 are shown in Figure 11-8. ↳

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As in the 1995 analysis, the performance of the ICT sectors is generally lower in terms of output of multiplier in 2000. Nevertheless, unlike those results in 1995, Sweden has a lower multiplier effect in the ICT sectors. In the other Scandinavian countries, Norway has a higher multiplier effect in the ICT sectors. In addition, there is a significant growth of the ICT multiplier, ↳ even though the numbers are still lower than the non-ICT sectors. Figure 11-9 presents the comparison between the two categories in 2005.

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The last investigation of the multiplier effect demonstrates that the ICT sectors contributed even less in 2005 in comparison to 1995–2000. Figure 11-9 shows that, except France, none of the European countries has ICT sectors with a greater contribution than non-ICT sectors. The range of multiplier is 1.3–1.7, where the ICT sectors have an approximately 15 percent lower multiplier compared to non-ICT sectors.

Step 5: Evaluation. In conclusion, the output of the ICT sectors has declined due both to the production level (which is indicated by the lower proportion in intermediate transaction) and to the consumption level (both from domestic and export). The growth rate of the ICT sectors was greater in the European economy in 1995–2000 but decreased in 2000–2005 compared to the rest of the economic sectors. The contribution of the output of the ICT sectors to the total output generally increased in 1995–2000 and decreased in 2000–2005 except for Austria. The ratio to the total GDP generally increased in 1995–2000 and decreased in 2000–2005 except for Germany. The ratio for export also gives the same sign—that it increased in the first period and decreased in the second period except for Finland. The last ratio is related to the interrelatedness to other sectors through the production side. It leads to the conclusion that except for Finland and Germany, which increased in both periods, the other countries have been experiencing a lower proportion in the second period. In all countries observed in this ↳ study, the ICT sectors contributed lower multiplier effects. On average, these ranged from 1.5 to 1.6, in 1995–2005, while in the non-ICT sectors, the multiplier ranged from 1.6 to 1.7.

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This conclusion brings two important messages:

- If the evaluation of broadband deployment is conducted strictly based on the analysis of sector performance, undoubtedly, the opportunity cost of spending on broadband deployment is large in the sense that choosing to spend the funding on other sectors is believed to achieve a greater economic impact.
- But, as other studies have shown—for instance Rosenberg,[57] Milgrom et al.,[58] Bresnahan and Trajtenberg,[59] and OECD[60]—the technology attached to the ICT sector has the potential for pervasive use in a wide range of sectors and by its technological dynamism enables generalized productivity gains to be transferred to the rest of economy. Accordingly, the role of technology has become more

important as the catalyst in the process of innovation and thus broadband policy is an important agenda to be realized.

Conclusion

The following conclusions can be drawn from the above analysis:

- The implications of a policy, the goal of which is to promote broadband in rural areas in Europe, have to be treated carefully. Does this policy need special funds competing with funding for other purposes? Or is there some free money that has zero opportunity cost?
- In dealing with the possible opportunity cost, this study applies a cost-benefit analysis based on the value of the economic multiplier, using the 59-sector IO table of European countries. The sample of the study covers eleven selected European countries that have a similar technological level to represent the European economy.
- For the basic analysis, it is presumed that any broadband policy will have significant economic impact from the production point of view. Hence, promoting broadband will directly affect the sectors that utilize broadband as the main component of their operation. These sectors are then called the ICT sector. This study adopts the OECD definition related to the classification of the ICT sector based on the International Standard of Industrial Classification (ISIC)
- From the descriptive analysis, in most countries, the ICT sectors contributed a greater proportion during the first half of the p. 208 ↳ observation period (1995–2000) but a lower proportion to the output, GDP, and intermediate input for the rest of the economy during the second part (2000–2005). Moreover the multiplier analysis leads to the conclusion that ICT sectors contributed a lower multiplier during the second part of the observation.
- Two implications of this study suggest that if the evaluation of broadband deployment is conducted based on *ex post* analysis of sector performance, the opportunity cost of spending on broadband deployment is large in the sense that choices to spend the funding for other sectors would create a greater economic impact. However, considering that the technology attached to broadband enables further use by the other sectors (non-ICT sectors), as a general purpose technology, the policy to promote broadband is an important agenda.
- Further research after this study should elaborate the IO method in defining the employment multiplier and wage multiplier. Thus, forecasting the effect of employment generation for the whole economy given an additional job available from the ICT sector would be of interest. The same interpretation is applied for the wage multiplier, which describes additional wages (or income) for the whole economy, given an additional one euro in income from the ICT sector. The employment data is a significant challenge however. Further research can also be applied to carry out the primary survey data to measure additional welfare from consumer or the individual point of view in a more precise way.

The main weaknesses of this study are the weaknesses of the IO model itself, which is based on static analysis, constant price, and a homogeneous product. In the worst case, the method aggregates many dissimilar products into one group. In addition, comparing one country to another is apparently less realistic given the fact that many countries have different economic platforms or even exchange rates as the basis for calculating prices. Therefore, this study is basically an exploratory study based on the IO table as an alternative approach to address broadband investment.

Future research can be implemented by utilizing the ongoing project of interregional input-output (IRIO) table of European countries. Using this table, the study can investigate the impact of the project not only by looking at a single country impact but also at the interconnection between all European countries, which is more sensible in producing a policy recommendation. Another enrichment study can be done by using the computable general equilibrium (CGE) model, which can investigate the change in production, household and factor price simultaneously.

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