2) IMPACT OF BROADBAND ON ECONOMY

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Access to information, broadband connectivity and financing of virtual accessibility are key components necessary for the development, adoption and use of Information and Communication Technologies (ICT) in the economy and society. Inadequacies in the telecommunication infrastructure and accessibility to services among the individual countries and regions of the South East Europe (SEE) area hamper significantly competitiveness and cohesion in SEE' countries. Market mechanisms fail to address adequately the low population density and/or rural and remote areas. These problems have been widely acknowledged at European and national policy level. Member states and regions in the SEE area have adopted virtual accessibility strategies, but further work needs to be done particularly in elaborating comprehensive operational plans and mature implementing measures to achieve the objectives set regarding the broadband connectivity and accessibility of services.

However, in order to examine and promote policies to tackle the digital gap emerging between SEE areas and the rest of Europe, and among SEE areas as well, large investments are required for infrastructures, operational costs and other subsequent expenditures. This raises the question if there is a repayment and how much this is, in terms of local economy development, employment increase and other possible cost savings that will justify the significant initial investments.

Unfortunately, measuring broadband's impact is a quite difficult task. Broadband is a general purpose technology, which means there is no specific output, that it would be easy to measure. Instead, it affects multiple aspects of our professional and personal lives, in multiple ways. Moreover, in the countries under investigation, broadband large-scale penetration is recent or even expected in the near future. This means that the actual effects have not been either expressed or documented. Another consequence of broadband's general purpose nature, is that the effects become visible a long period of time after its ignition cause. This means that investments in infrastructure or a significant increase in broadband penetration may influence the economy of the area the next two or three years making the identification of the correlation difficult. Changes in employment are also difficult to trace since demand in one area may create a migration (or outsourcing) trend from other areas, or vice-versa.

The biggest problem however, in calculating accurately broadband's effects is the severe lack of data for many countries related to broadband and inter-sector economic dependencies that would allow for reliable investigation of the subject. Few countries have the means and the motivation to collect and analyze the data needed for the task, since it requires data for many variables and for an extended period of time.

Due to this problem, the largest portion of the bibliography has focused on high developed countries. The report in (Katz, 2012) was conducted under the provision of International Telecommunication Union (ITU) and constitutes a collective presentation of the research to date and policy issues on the subject highlighting the general conclusions of the past and ongoing research. The report discusses the parameters each study was based on, and compares the results of each study attempting to justify the diversification between the papers' results. The study in (Katz, Vaterlaus, Zenhausern and Suter, 2010) investigates the macroeconomic impact of investment in broadband technology on employment and output of Germanys economy, showcasing the longer term externalities of infrastructure investments, such as accelerated innovation and new business creation, as well as their possible role as economic stimuli in the present times of economic crisis. The effect on employment is also investigated, including direct positions that are created for construction and maintenance of the network (engineers, technicians, workers, etc.), indirect jobs created in sectors connected to the infrastructure, like electronic equipment manufacturing and induced employment that reflects the increased household income.

The work in (Qiang and Rossotto, 2009) applied regression analysis on data collected for a period of time starting from 1980 and onwards, separating high with low income countries. The analysis concluded that the empirical findings confirm that broadband's benefits in growth are major and robust for both developed and developing countries, although the significance is higher for the former, which have a longer track record of broadband diffusion. Similar results were obtained by (Koutroumpis, 2009) investigating 22 Organisation for Economic Co-operation and Development (OECD) countries, finding a positive correlation in growth and broadband penetration. The results also showed that the positive impact of broadband was greater when a critical mass of infrastructure was present, thus developed countries harvested the most benefits from broadband. US state-level data were used to estimate direct and indirect benefits on state Gross Domestic Product (GDP) in (Thompson and Garbacz, 2008). The phenomenon called "capital labor substitution" was also studied.

The latter means the loss of jobs because of the efficient utilization of broadband services. This effect varied between different locations and sectors, with the greater impact to be observed in less developed countries and sectors like accommodation. The work in (Fornefeld and Delaunay, 2008) showed that this effect becomes less evident in countries where innovation is encouraged, and new services are quickly embraced. When this is the case, broadband deployment may boost innovation and the creation of new ideas of services, products and applications resulting in the growth of their respective fields, such as e-commerce, social networking etc. This development results in an increase in employment due to broadband which compensates for the reduction of lost jobs because of the capital labor substitution effect. Works Crandall, Lehr and Litan, 2007) and (Gillett, Lehr, Osorio, and Sirbu,2006) studied the effects on USA output and employment as well, showcasing a positive link between broadband and economy.

In this chapter, we investigate the impact of broadband on the growth and employment in SEE countries, namely Austria, Bulgaria, the former Yugoslav Republic of Macedonia (FYROM), Greece, Montenegro, Slovenia. Specifically, we define the macroeconomic evidence required for the analysis. We then enforce regression analysis on data collected by the respective countries in order to find the correlation between broadband, growth and employment. The period of the examination was set to be the last decade in order to obtain an extended amount of data, and take into account possible influences on the results by the economic crisis and the subsequent recession of the last years in the area. We also estimate the cost savings to companies and the state by the usage of broadband-based e-government services. We then forecast these benefits to 2015 when the respective countries are expected to have reached the e-government usage level which is set by the European digital agenda (Digital agenda, 2013).

2.1 Regression analysis

In statistics, regression analysis is a statistical technique for estimating the possible relationships among variables. It includes many techniques for modeling and analyzing several variables, when the focus is on the relationship between a dependent variable and one or more independent variables. More specifically, regression analysis helps one understand how the typical value of the dependent variable changes when any one of the independent variables is varied, while the other independent variables are held fixed. Most commonly, regression analysis estimates the conditional expectation of the dependent variable given the independent variables - that is, the average value of the dependent variable when the independent variables are fixed. In all cases, the estimation target is a function of the independent variables called the regression function. In regression analysis, it is also of interest to characterize the variation of the dependent variable around the regression function, which can be described by a probability distribution (Regression analysis, 2013).

Regression analysis is widely used for prediction and forecasting. Regression analysis is also used to understand which among the independent variables are related to the dependent variable, and to explore the forms of these relationships. In restricted circumstances, regression analysis can be used to infer causal relationships between the independent and dependent variables. In this report, we use the technique with both aforementioned purposes.

At first, we investigate the causality between broadband provision and infrastructure to growth, employment and externalities and then we try to forecast the impact of future scheduled broadband plans to these variables for the next years. However, there is high probability that correlation of two events may not imply causation, instead it may suggest that both events are associated to and caused by a third event. This can lead to illusions or false relationships, so caution is important. As we have stated, another problem is the bi-directional causality between broadband provision and growth. In the model we consider broadband the independent and growth the dependent variable. However, in reality, a stronger economy affects broadband policies too, thus the bi-directional nature of the variables, which is, unfortunately difficult to model.

The performance of regression analysis methods in practice depends on the form of the data generating process, and how it relates to the regression approach being used. Since the true form of the data- generating process is generally not known, regression analysis often depends to some extent on making assumptions about this process. Classical assumptions for regression analysis include:

- The sample is representative of the population.
- The error is a random variable with a mean of zero conditional on the explanatory variables.
- The independent variables are measured with no error.
- The predictors are linearly independent.
- The errors are uncorrelated.
- The variance of the error is constant across observations.

These assumptions are sometimes testable if many data are available. Regression models for prediction are often useful even when the assumptions are moderately violated, although they may not perform optimally.

Regression models predict a value of the variable *Y* given known values of the variables *X*. Prediction within the range of values in the dataset used for model-fitting is known informally as interpolation. Prediction outside this range of the data is known as extrapolation. Performing extrapolation relies strongly on the regression assumptions. The further the extrapolation goes outside the data, the more room there is for the model to fail due to differences between the assumptions and the sample data or the true values.

2.2 Methodology

Due to the lack of known inter-sector dependencies that would allow calculating multipliers to measure the impact, we considered regression analysis as explained above. In our study, we considered linear regression, for two reasons. The amount of data was insufficient to examine correlation with high complexity. The second reason is that based on the past research works, effects on broadband seems to saturate and are neglected for very high levels of penetration in developed countries. This situation is not representative of the SEE area that we investigate in this report, thus the linear model was rated adequate. The impact on growth was determined based on data collected for the period of 2001-2011 when available. The dependent variable was chosen to be the GDP per capita, and the independent the number of broadband internet subscribers per 100 people ($Broad_{pen}$). Our analysis was based on the model followed by (Qiang and Rossotto, 2009) and (Koutroumpis, 2009). Specifically, *Eq. 1* was used:

$$\log (GDP_{pc})P = \alpha_0 + \alpha_1 * \log(Broad_{pen}) + \alpha_2 * \log(Edu) + \alpha_3 * \log(Invest) \quad (1)$$

where GDP_{pc} denotes the GDP per capita, *Edu* is the percentage of school enrolment in primary education, and *Invest* is expressed through the Gross fixed capital formation (as a percentage of GDP).

Our goal is to estimate the coefficient of the “broadband internet subscribers per 100 people”, i.e. the coefficient a_1. This estimation will allow us to track changes in GDP when broadband penetration changes; while the remaining parameters remain the same. Specifically, if $Broad'_{pen}$ and GDP'_{pc} are the new values of broadband penetration and GDP per capita respectively, the corresponding change in GDP would be:

$$\frac{GDP'_{pc}}{GDP_{pc}} = \left(\frac{Broad'_{pen}}{Broad_{pen}}^{\alpha^1}\right) \quad (2)$$

To calculate the impact on employment, the dependent variable was chosen to be the total employment of the country expressed as a percentage of the total labour force (*EMP*) and the independent variable was the number of broadband internet subscribers per 100 people ($Broad_{pen}$). Our analysis was based on the model in (Crandall, Lehr and Litan, 2007), and is shown in the following equation:

$$EMP = b_0 + b_1 * Broad_{pen} + b_2 * Edu + b_3 * Wage + b_4 * TAX \quad (3)$$

where *Wage* denotes the average wage in the country, *TAX* expresses the taxes on income, profits and capital gains (as a percentage of revenue), and *Edu* denotes again the percentage of school enrolment in primary education.

Here, our goal is to estimate the coefficient b_1 that will allow us to track changes in employment when broadband penetration changes; while the value of the remaining parameters stays the same. In this case, if $Broad'_{pen}$ and *EMP'* are the new values of broadband penetration and employment respectively, the corresponding change in employment would be:

$$EMP' - EMP = b_1 * (Broad'_{pen} - Broadpen) \quad (4)$$

Finally, we evaluated the positive externalities derived by the utilization of broadband-based e-government services. Indirect benefits of broadband are difficult to measure. As already stated, broadband is a general purpose technology, affecting many economic aspects. Probably, the most important externality is the cost reduction to end-users, companies and state, through broadband facilitated services. These include saving work hours, reducing travel costs etc.

E-government allows for effective, fast and most importantly cost-effective method of public administration and user-government and business-government interaction. Saving work hours through e-government services is a large portion of the cost reduction that is attributed to broadband. Companies save millions of work hours, the state reduces the cost relative to traditional methods of transactions, and citizens both harvest the above benefits, plus save money through postage burdens, travel reduction, working hours etc.

To estimate the money each country may save by increased e-government, we followed the process defined in (E. D. I. Society, 2004) and (L. Frontier Economics Ltd, 2010). Specifically, we evaluated the costs that are saved by each country when three of the most common transactions i.e. income tax, VAT and business registration are conducted online, instead of the traditional way. At first we estimated the total number of these transactions that were conducted in a year. Since, those statistics were not available for the countries under investigation, we used the number of transactions that were available for other European countries and adjusted the number to the population of the countries of the consortium. We multiplied the total number of transactions ($\#Trans_{tot}$) with the percentage of e- government usage of each country ($egov_{per}$), to estimate the total number of transactions that were conducted online within a year ($\#Trans_{online}$), i.e.:

$$\#Trans_{online} = egov_{per} * \#Trans_{tot} \quad (5)$$

We then calculated the total time saved using e-government services per year, by multiplying the number of online transactions within a year with the time save by each one of them (61 minutes per transaction, according to (E. D. I. Society, 2004) and (L. Frontier Economics Ltd, 2010):

$$TimeSaved(min)=61 * \#Trans_{online} \quad (6)$$

The next step in our analysis was to express the time saved in equal working years. To this direction, we considered a working year to contain 240 working days, and each working day of 8 working hours (*Eq. 7*). Finally, we evaluated the total money saved per year based on the average annual wage in the country examined and the time saved (*Eq. 8*).

$$TimeSaved(yrs)=TimeSaved(min)/(240 * 8 * 60) \quad (7)$$

$$Money_{saved} = TimeSaved(yrs) * Wage_{annual} \quad (8)$$

After our evaluation, we forecast the potential savings due to e-government when the goals set by the European digital agenda on e-government services are reached. That is, 50% of the population will be using e-government services by 2015. It is noted that our estimations were based on a fraction of the total transactions possible, and our final cost reduction did not include the money saved by the reduction of travelling or postage requirements due to e-government. Thus, the estimation should be considered a conservative estimate of the resulting cost savings.

2.3 Experimental results

2.3.1 Impact on Growth

Below we present the findings of the regression analysis, regarding the impact of broadband on the countries' GDP. The analysis yielded the dependencies depicted in Table V. The positive link between broadband and growth is reflected through the broadband coefficient a_1 which was found positive for all countries. Parameter R^2 denotes how well the calculated line by the regression fits the measured data. Values of R^2 close to 1, as is the case in our results, show very good fitting.

Table V. Regression Statistics on Growth.

Country	a_0	a_1	a_2	a_3	R^2 stat
Austria	2.5816	0.0768	0.9427	0.0123	0.8931
Bulgaria	-1.6938	0.0561	2.4604	0.0642	0.9321
FYROM	0.3753	0.1554	1.1710	0.6472	0.9848
Greece	0.3934	0.0259	1.6583	0.3084	0.9291
Montenegro	6.4629	0.0487	-1.7419	0.2815	0.9174
Slovenia	1.3640	0.1985	-0.4105	0.3836	0.8940
Italy	0.6101	0.1193	1.7306	0.2264	0.6281

The practical meaning of the findings is depicted in Figure 2 where we calculate the impact on growth when broadband penetration is assumed to increase by 10% (and all other parameters are assumed constant). The impact ranges from 0.2 to almost 1.9% increase in GDP and GDP per capita. Slovenia exhibits the greatest benefit of all countries. It also has the biggest penetration, which implies that there may indeed be a link between the level of penetration and the severity of broadband impact. However, several other parameters play their role, since FYROM being the second in growth impact, has a penetration rate of just 8.5%.

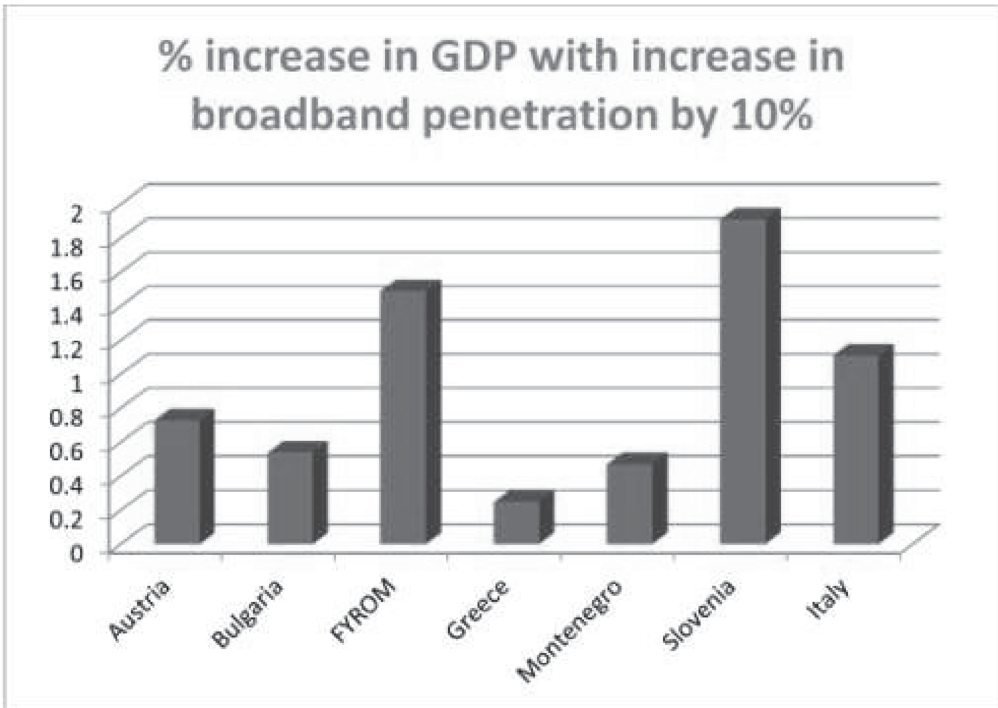

Figure 2. Percentage of GDP increase for 10% broadband penetration increase

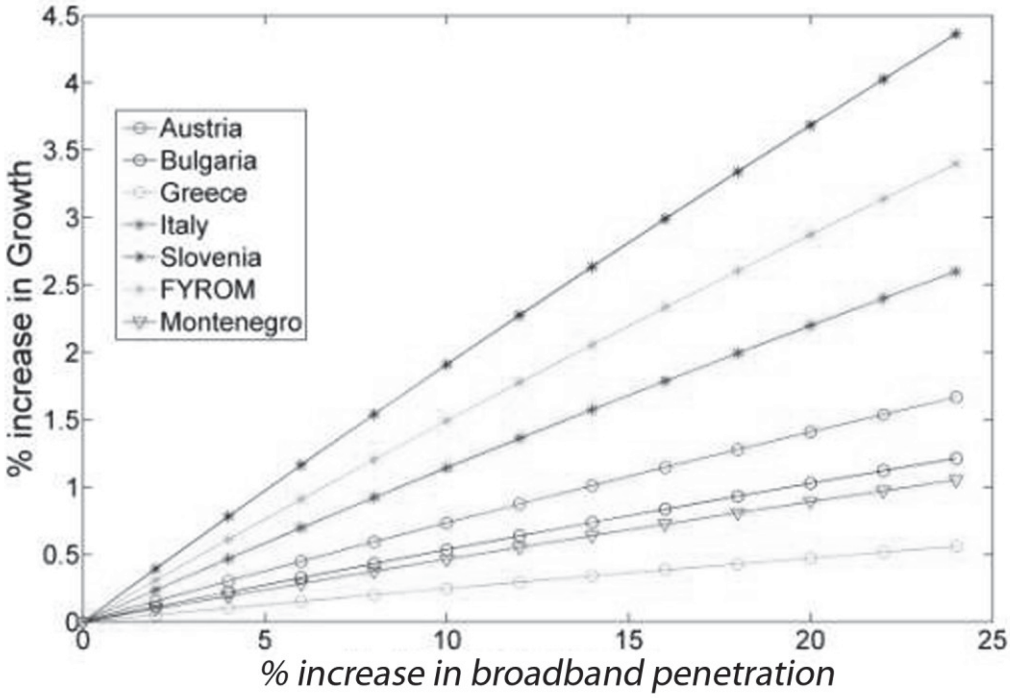

Figure 3. % increase in GDP as a result of the corresponding % increase in broadband penetration, when all the other variables are considered constant

Using Eq. 2 to depict GDP growth versus broadband penetration when all other variables are considered constant, results to Figure 3. In the figure we show the % increase of growth for different percentage increase in broadband penetration. The slope of the curves correspond to the $(Broad_{incr})^{a1}$ value for each country, where $Broad_{incr}$ denotes the % increase of broadband penetration. Besides the adequate time needed to fully reveal its impact and the complex dependencies that broadband exhibits in the economy, the positive stimulation of broadband on growth of SEE areas is evident, and it should be considered as an attractive candidate for boosting economic development.

2.3.2 Impact on Employment

In this section we present the findings yielded by the regression analysis on employment. Table VI shows the factors obtained by the analysis where possible. As the table suggests, the results were inconclusive. Three of seven countries examined, showed positive overall correlation between broadband and rise of employment (positive broadband penetration coefficient), though the findings and the parameters of the research (i.e. data availability) were not adequate for safe results. This is more evident in Figure 4, where we substitute coefficient b_1 found for each country in *Eq. 4*. The figure depicts the theoretical connection between broadband increase and the corresponding change in employment, when all other variables are considered constant.

Table VI. Regression Statistics on Employment.

Country	b_0	b_1	b_2	b_3	b_4	R^2 stat
Austria	11.5979	0.0101	-0.0371	0.0010	0.4415	0.8368
Bulgaria	100.3273	-0.5312	-0.8837	0.0022	2.0397	0.9268
FYROM	0	0.3006	0.2481	0.0004	0.4915	-
Greece	71.8160	-0.3014	-0.3982	0.0013	-0.3502	0.9842
Montenegro	-	-	-	-	-	-
Slovenia	40.3993	0.0596	0.0072	0.0004	0.3453	0.8570
Italy	76.6873	0.0915	0.3155	-0.0020	0.1341	0.6282

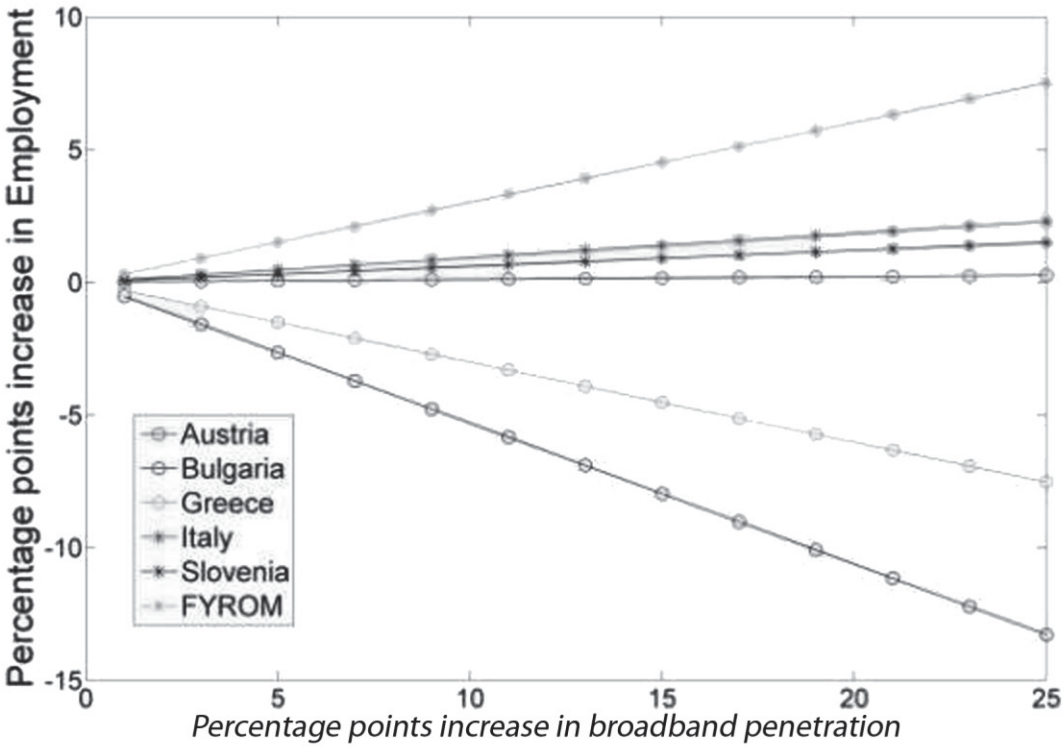

Figure 4. Percentage points increase in employment as a result of the corresponding percentage point's increase in broadband penetration, when all the other variables are considered constant

Besides the insufficient amount of data that did not allow us to cover every country, the analysis did not reveal a common trend between employment and broadband provision. Apart from the immediate creation of jobs for infrastructure building and maintenance, several phenomena such as outsourcing, tele-working and the capital labour substitution effect make long-term impact on employment rather indefinite and did not allow for a safe conclusion.

2.3.3 Cost Savings

In this section we present our findings on the externalities of broadband expressed as cost-savings to the end-user and to businesses, by incorporating e-government services. Table VII presents all the variables calculated in our analysis. As the table shows, the cost savings calculated were significant for every country, of the order of million Euros.

Figure 5 displays the current as well as the expected savings if countries reach the levels of e-services utilization set for 2015 by Europe's digital agenda. Further incorporation of broadband-facilitated services is shown to be highly beneficial for end-users, firms and public administration finances. In our analysis we do not take into account all transactions conducted through e-services, and we do not include the savings originating by travel or post fees reduction. Thus, we consider our estimations to be conservative and the actual savings to be greater.

Table VII. Cost Savings due to e-Government Services.

Country	Num. of transactions (thous.)	Num. of online transactions (thous.)	Time of transactions (yrs.)	Total savings (mill. euros)	Potential savings (mill. euros)
Austria	-	-	-	-	-
Bulgaria	5263	1402	742.48	5.5983	10.507
FYROM	1450	159	84.4945	2.5858	11.754
Greece	7965	820	434.452	8.878	43
Montenegro	444	52	27.5424	0.02076	0.08874
Slovenia	1435	775	410.585	9.0518	(Already reached 50% of e-government usage)
Italy	42122	4212	2230.4	62.694	313.470

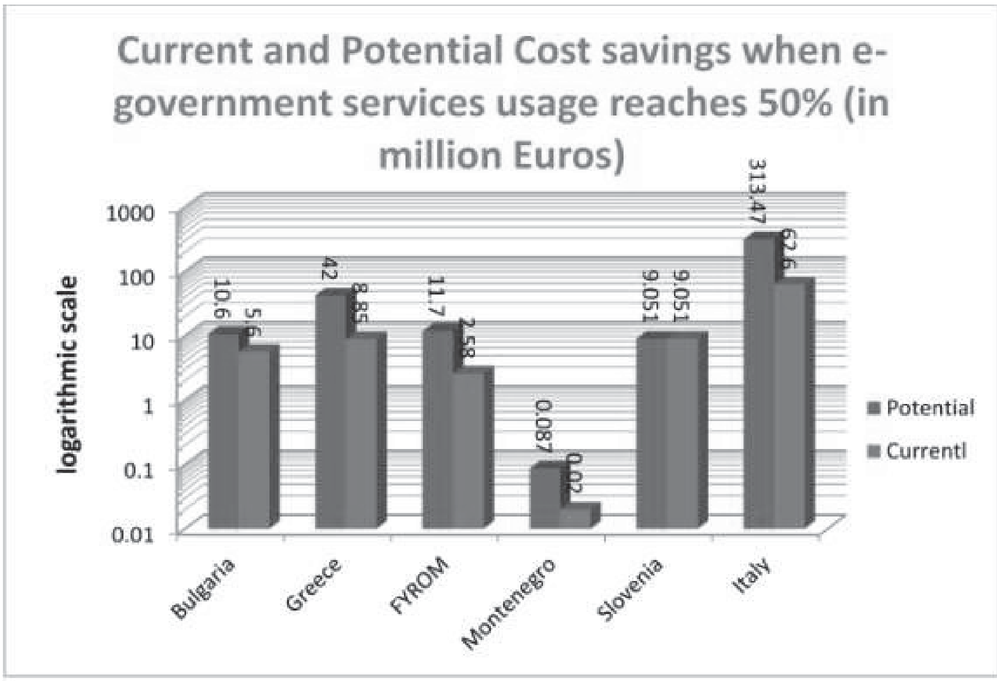

Figure 5. Cost savings through e-government services if broadband penetration reaches 50% (in million Euros)

The theoretical connection between total savings per year and e-services usage yields to Figure 6. While there are deviations between the countries, the amounts relative to their GDP are significant for all.

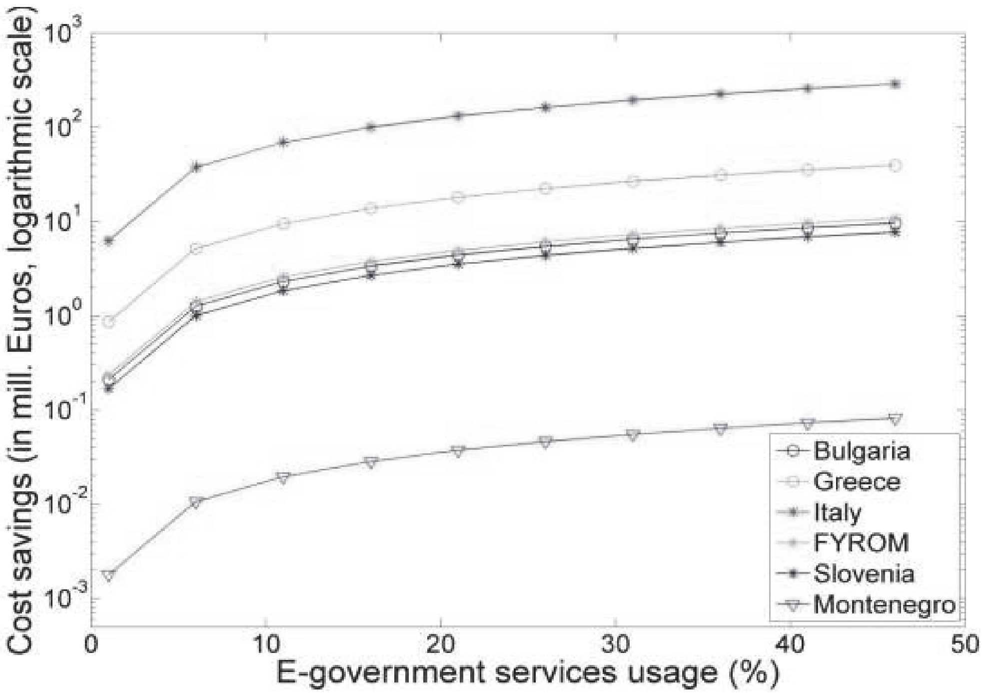

Figure 6. Expected total savings per year vs. the e-government services usage

2.4 Conclusions

This chapter examined the impact and effectiveness of virtual accessibility public infrastructures and services in selected SEE areas on employment and growth. First we presented the econometric analysis that led us to specific conclusions regarding the impact of broadband on growth and employment. While the estimation is considered conservative, the benefits of broadband provision have been found significant. When the amount of data permits reliable analysis, our conclusions suggest that broadband affects positively the economy growth of a country. Besides the adequate time needed to fully reveal its impact and the complex dependencies that broadband exhibits in the economy, the positive stimulation of broadband on growth of SEE areas is evident, and it should be considered as an attractive candidate for boosting economic development.

Specifically, growth was found to benefit greatly from increased broadband provision, showcasing GDP increase that ranged from 0.2% to 2% (depending on the country) with increase in broadband penetration by 10%.

As far as employment is concerned, findings were inconclusive as expected. As expected the difficulties of measuring the impact on employment are substantial. The amount of available data was not sufficient for some countries, thus calculations were unsafe or not conducted at all. Overall, employment is expected to rise initially due to manpower required to support the construction and maintenance of broadband needed infrastructures (i.e. technicians, engineers, architects, electronic manufacturers etc.). The subsequent effects, though, are inconclusive depending on the production substitution effect and tendency of its country to new services and practices to compensate for possible loss of jobs.

Finally, cost reduction through e-government services to companies, end-users and the state were found quite considerable and beneficial, especially for countries exhibiting high broadband penetration rate. Projecting the findings in 2015 where e-services are expected to increase significantly according to the European directives, the corresponding benefits were found extremely large.

In times where the economy of many countries is in recession, broadband related investments prove to be an overall significant way of boosting the economy providing both economy stimulation in industries, and significant cost savings. Thus, policies that pursuit or facilitate the increase of virtual infrastructure and broadband provision should be considered a strong candidate solution by authorities for a positive impact on the economy.

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2.6 Abbreviations

FTTH	Fiber to the Home
GDP	Gross Domestic Product
ICT	Information and Communication Technologies
ITU	International Telecommunication Union
OECD	Organisation for Economic Co-operation and Development
SEE	South East Europe
SIVA project	South East Europe improved virtual accessibility through joint initiatives facilitating the rollout of broadband networks