

Impact of broadband public infrastructures and services on SEE countries' economy

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Abstract—Broadband is an important tool for increasing productivity and competitiveness. This paper attempts to measure the accumulative impact and effectiveness of broadband public infrastructures and services on the economy of South East Europe (SEE) areas. To this direction, we focus on evaluating the correlation between broadband and each country's growth and employment. Moreover, we estimate the cost savings achieved by the extended usage of e-services, and we evaluate the potential cost savings that will follow the increase of e-services utilization the next years. The results of our analysis show that broadband may have positive impact on growth and employment and that the possible savings are substantial.

Keywords—broadband, growth, employment, regression analysis

I. INTRODUCTION

Access to information, broadband connectivity and financing of virtual accessibility are key components necessary for the development and growth in the economy and society. Inadequacies in the telecommunication infrastructure and accessibility to services in rural and remote areas in South East Europe (SEE) hamper their competitiveness and cohesion. Member states and regions have adopted virtual accessibility strategies for the areas where the market mechanisms failed. However, in order to tackle the digital gap between SEE and the rest of Europe, large investments are required. This raises the question if there is a repayment, in terms of local economy development, employment increase and other possible cost savings. Unfortunately, measuring broadband's impact is a quite difficult task. Broadband is a general purpose technology, with no specific output. Moreover, in SEE countries, broadband large-scale penetration is recent which means that actual effects have not been either expressed or documented. In addition, these effects may become visible one or two years after its ignition cause. 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. On top of that, there is severe lack of data for many countries related to broadband and inter-sector economic dependencies, affecting the capabilities of the relevant research.

The report in [1], was conducted under the provision of International Telecommunication Union (ITU) and constitutes a collective presentation of the research to date. Katz et al in [2] investigates the macroeconomic impact of investment in broadband technology on employment and output of Germany's economy. Qiang et al. [3] concluded that the broadband's benefits in growth are major when applied regression analysis on data collected for developed and developing countries.

Similar results were obtained by Koutroumpis [4] investigating 22 countries, finding a positive correlation in growth and broadband penetration. US state-level data were used to estimate direct and indirect benefits on state Gross Domestic Product (GDP) in [5] and studied the capital labor substitution phenomenon. The work in [6] also studied the effects on USA output and employment, showcasing a positive link between broadband and economy.

In this paper, 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 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 acknowledge possible influences on the results by the recent economic crisis and the subsequent recession 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 set by the European digital agenda [7].

The structure of the paper is as follows: Section II describes the SEE project that ignited the research for this paper. Section III describes the methodology followed in our research. Section IV presents the findings of our analysis and we discuss the results. We conclude the paper in Section V and we make suggestions for future work.

II. SIVA PROJECT

The inception of this paper is attributed to project SIVA. Project SIVA stands for 'South East Europe improved virtual accessibility through joint initiatives facilitating the roll-out of broadband networks'. SIVA aims to contribute to the improvement of the accessibility of SEE territories through broadband services, as substitute for and supplementing physical accessibility and thus to the narrowing the digital gap in SEE.

A significant part of the project's activities is the assessment of current status in broadband related aspects, as well as the investigation of the possible benefits and reflected profits from investments in broadband provision increase. The latter led to the investigation of broadband's impact on the economy of SEE areas, and especially on growth, employment and other positive externalities.

III. METHODOLOGY

In this paper, we considered linear regression analysis for our purposes. The impact on growth was determined based on data collected for the period of 2001-2011 and was based on the model followed in works [3] and [4]. The dependent variable was chosen to be the GDP per capita (GDP_{pc}), and the independent the number of broadband internet subscribers per 100 people ($Broad_{pen}$). Specifically:

$$\log(GDP_{pc}) = a_0 + a_1 * \log(Broad_{pen}) + a_2 * \log(Edu) + a_3 * \log(Invest) \quad (1)$$

Where Edu denotes the school enrolment percentage in primary education, and $Invest$ is expressed through the Gross fixed capital formation (as a % of GDP). Our goal is to estimate a_1 that will allow us to track changes in GDP when broadband penetration changes. Specifically, if $Broad'_{pen}$ and GDP'_{pc} are the new values of broadband penetration and GDP per capita respectively, the change in GDP would be: $GDP'_{pc}/GDP_{pc} = (Broad'_{pen}/Broad_{pen})^{a_1}$.

For the impact on employment, the dependent variable was the total employment of the country as a percentage of the total labor force (EMP). The independent variable was the number of broadband internet subscribers per 100 people ($Broad_{pen}$). Our analysis was based on the model followed in [6]:

$$EMP = b_0 + b_1 * Broad_{pen} + b_2 * Edu + b_3 * Wage + b_3 * TAX \quad (2)$$

Where $Wage$ denotes the average wage in the country and TAX expresses the taxes on income, profits and capital gains (as a percentage of revenue). Here, our goal is to estimate b_1 that will allow us to track changes in employment when broadband penetration changes. In this case, if $Broad'_{pen}$ and EMP' are the new values of broadband penetration and employment respectively, the change in employment would be $EMP' - EMP = b_1 * (Broad'_{pen} - Broad_{pen})$.

Finally, we evaluated the positive externalities derived by the utilization of broadband-based e-government services following the process defined in [8] and [9]. 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 in a year ($\#Trans_{tot}$). We multiplied the total number of transactions 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. Then, we estimated the total time saved by making these online transactions ($TimeSaved(min)$). Specifically:

$$TimeSaved(min) = 61 * \#egov_{per} * \#Trans_{tot} \quad (3)$$

where ($egov_{per}$) is the percentage of e-government usage, the ($\#Trans_{tot}$) the total number of transactions and considering 61 minutes per transaction, according to [8] and [9].

TABLE I. 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 | 0.894 |

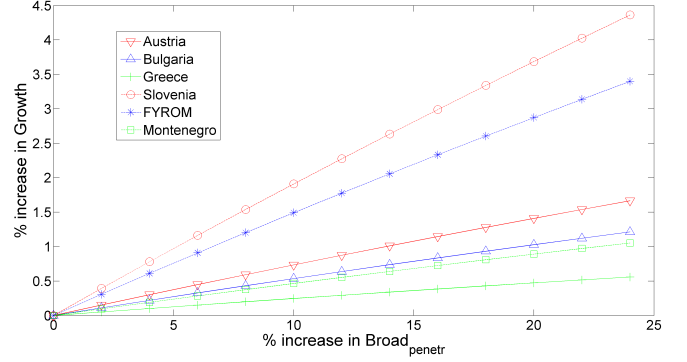


Fig. 1. % increase in GDP as a result of the corresponding % increase in broadband penetration, when all the other variables are considered constant.

Next, we expressed the above saved time in cost reduction by multiplying the annual wage $Wage_{annual}$ with the time saved expressed in working years (consisting of 240 days of 8 working hours):

$$\#Money_{saved} = \frac{TimeSaved(min)}{(240 * 8 * 60)} * Wage_{annual} \quad (4)$$

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.

IV. EXPERIMENTAL RESULTS

The regression analysis, regarding the impact on growth, was performed in MATLAB and yielded the dependencies depicted in Table I. The positive link between broadband and growth is reflected through the broadband coefficient a_1 which was found positive for all countries and expresses 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. Values of R^2 close to 1, as is the case in our results, denotes that the calculated line by the regression fits the measured data. Depicting the % increase of GDP growth versus broadband penetration when all other variables are considered constant, results to Fig. 1. The slope of the curves correspond to the $(Broad_{incr})^{a_1}$ value for each country, where $Broad_{incr}$ denotes the % increase of broadband penetration.

Similarly, Table II shows the factors obtained by the regression analysis on employment where possible. The results were inconclusive, since three of five countries examined, showed positive overall correlation between broadband and employment, but the findings and the parameters of the research (i.e. data availability) were not adequate for safe conclusions. This

TABLE II. 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 |
| Greece | 71.8160 | -0.3014 | -0.3982 | 0.0013 | -0.3502 | 0.9842 |
| FYROM | 0 | 0.3006 | 0.2481 | 0.0004 | 0.4915 | N/A |
| SLOVENIA | 40.3993 | 0.0596 | 0.0072 | 0.0004 | 0.3453 | 0.8570 |

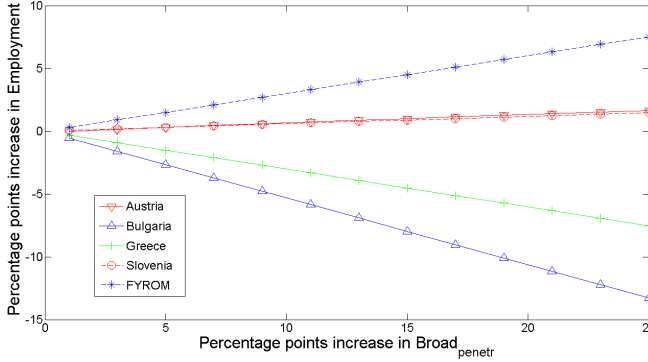


Fig. 2. Percentage points increase in employment as a result of the corresponding percentage points increase in broadband penetration, when all the other variables are considered constant.

is more evident in Fig. 2, where we use the coefficient b_1 found for each country to depict the theoretical connection between broadband increase and the corresponding change in employment, when all other variables are considered constant. Unfortunately, several phenomena such as outsourcing, teleworking and the capital labour substitution effect make long-term impact on employment hard to trace.

Finally, Table III presents the variables of our findings on the externalities by incorporating e-government services calculated in our analysis. As the table shows, the cost savings found, both current and potential were significant for every country. In our analysis we take into account only three transactions, and we do not include other savings (such as travel or post fees reduction), thus our estimations are considered conservative. Expressing the theoretical connection between total savings per year and e-services usage, yields to Fig. 3. While there are deviations between the countries, the amounts relative to their GDP are significant for all.

V. CONCLUSION AND FUTURE WORK

This paper examined the impact and effectiveness of virtual accessibility public infrastructures and services in selected SEE areas on employment and growth through econometric analysis. Growth was found to benefit greatly, showcasing GDP increase that ranged from 0.2% to 2% (depending on the country) with increase in broadband penetration by 10%. Findings on employment were somewhat inconclusive, as expected, exhibiting great variations. Finally, cost reduction through e-government services was found quite considerable and beneficial.

Future steps of this work would be the development of a tool that calculates the cost reduction achieved through the sharing of existing and common developed infrastructures.

TABLE III. COST SAVINGS DUE TO E-GOVERNMENT SERVICES

| Country | Num. of trans. (thous.) | Num. of online trans. (thous.) | Time of trans. (yrs.) | Total savings (mill. euros) | Potential savings (mill. euros) |
|---------|-------------------------|--------------------------------|-----------------------|-----------------------------|---------------------------------|
| BGR | 5263 | 1402 | 742.48 | 5.5983 | 10.507 |
| FYROM | 1450 | 159 | 84.4945 | 2.5858 | 11.754 |
| GRC | 7965 | 820 | 434.452 | 8.878 | 43 |
| MNE | 444 | 52 | 27.5424 | 0.02076 | 0.08874 |
| SVN | 1435 | 775 | 410.585 | 9.0518 | (Already achieved) |

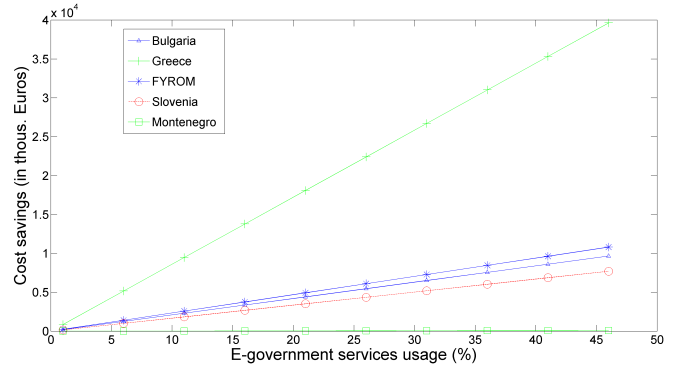


Fig. 3. Total savings per year vs the e-government services usage.

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