# THE IMPACT OF BROADBAND ON PROVINCIAL

# ECONOMIC GROWTH IN TURKEY

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## ABSTRACT

The aim of this paper is to investigate the economic contribution of broadband on provincial economic growth and to test for the direction of causality. The paper employs a fixed effect panel model using the data for 26 provinces of Turkey over 2004-2008. The results of the analysis show that there is a close connection between broadband penetration rate and regional development of Turkey and this relationship is more pronounced for those provinces belonging to the high-income group than for the lower-income group. The results also show that the causal relationship between the real GDP and broadband penetration rate is unidirectional that the causality is running from the real GDP to broadband services. This implies that an increase in real provincial income raises the demand for broadband and leads to a more rapid broadband penetration but no reverse causality is found.

**Keywords:** Broadband, Provincial Growth, Telecommunication, Causality

**JEL:** O10, O40, R11, L96

### Genişbandın Türkiye'deki bölgesel Ekonomik Büyüme Üzerine Etkisi

## ÖZET

Bu çalışmanın genişbandın bölgesel ekonomik büyümeye katkılarını incelemek ve genişbant-ekonomik büyüme arasındaki nedenselliğin yönünü test etmektir. Bu makalede Türkiye'deki 26 bölgeye ilişki 2004-2008 verilerinin analizince sabit etki panel modeli kullanılmıştır. Analiz sonuçları, genişbant penetrasyon oranı ile Türkiye'deki bölgesel kalkınma arasında yakın bir ilişkinin olduğunu ve bu ilişkinin düşük gelir grubundaki bölgelerden daha ziyade yüksek gelir grubuna ait bölgelerde daha belirgin olduğunu göstermiştir. Analiz sonuçları ayrıca reel gayrisafi yurtiçi hasıla (GSYİH) ile genişbant penetrasyon orasındaki nedensellik ilişkisinin tek yönlü olduğunu ve reel GSYİH'dan genişbant hizmetlerine doğru olduğunu göstermiştir. Bu bulgu, bölgesel reel gelir artışlarının genişbant talebini de arttıracağını ve daha hızlı genişbant penetrasyonuna yol açağı ve fakat bunun tersinin doğru olmadığı anlamına gelmektedir.

**Anahtar Kelimeler: Genişbant, Bölgesel Büyüme, Telekomünikasyon, Nedensellik**

## 1. INTRODUCTION

Broadband has attracted a special attention in the economic literature since its deployment in the late 1990s and early 2000s. It has also been considered as one of the driving forces of the rapid growth of the world economy since then (Katz, 2012). The main reason behind these arguments is that the contribution of broadband on economic growth is quite different from the contributions of public infrastructure (such as roads and bridges) and the traditional telecommunication infrastructure (Czernich, Falck, Krestschmer & Woessmann, 2009). While these types of infrastructures contribute to the level of income through reducing transaction costs for businesses, broadband on the other hand may foster long-run growth rate through accelerating the dissemination of ideas and information and by facilitating the development of new products, adoption of new innovation processes, and new organization and management styles (Romer, 1990).

This paper aims to estimate the relationship between regional economic growth and broadband penetration rates in Turkey. To this end, we employed a fixed effect panel data model which allows us to account for regional differences and measure the causal relationship between regional growth and broadband services. In the analysis, we used the data disaggregated by regions over the period of 2004-2008.

Although the subject is very important for the economic performance of countries and attracts a lot of attention, there have been only a limited number of studies which measured the economic contribution of broadband to regional growth and tested for the direction of causality between the said variables. The main reason is the lack of country level time series data on broadband penetration rates. The results from the limited number of studies on the subject indicate that the economic contribution of broadband to growth appears to vary widely due to the level of economic development. The contribution of broadband is closely related to the level

of adoption of technology in those countries. The studies carried out for the developed countries supports the hypothesis that broadband contributes greatly to the economic growth. However, scholars have largely ignored how broadband networks influence economic growth in developing countries. This study intends to fill this gap by providing evidence on the economic contribution of broadband to the regional growth rate in a developing country. This will also allow us to investigate the causal link between broadband and economic growth and to provide new evidence if there exists a threshold level for the impact of broadband.

The rest of this paper has the following structure: Section 2 reviews the theoretical and empirical literature on the broadband-economic growth relationship. Section 3 introduces the empirical methodology and the data. Section 4 presents the empirical results. The final section concludes the study.

## 2. LITERATURE REVIEW

### 2.1 Theoretical background

There is no doubt that technological advancements, in particular broadband technology, are closely linked with economic performance. To assess the direction and the extent of the relationship between broadband and economic growth, we need to understand the nature of this relationship, that is, the main theoretical linkages between these variables (see Thompson & Grabacz, 2011 and Vu, 2011 for detailed theoretical discussions),. The endogenous growth literature provides the relevant theoretical link between broadband and economic growth. Following the endogenous growth literature, we can identify mainly four channels through which broadband can affect growth; namely, via the resource allocation effect, competition enhancement effect, scale effect, and spillover effects. If broadband is to affect economic growth, it must have an intermediate effect on one or all of these channels.

First, broadband technology facilitates the removal of rigidities in markets by accelerating the spread of information and decentralized information processing, which ultimately leads to the reallocation of resources according to comparative advantages. Hence, this brings about static efficiency gains and then an increase in the level of income (*resource allocation effect*). Reallocation of resources stemming from the deployment of broadband generates long-run economic growth rate so long as it reallocates resources from low-technology to high-technology sectors (Young, 1991; Grossman & Helpman, 1992; Romer, 1990). Otherwise, it might have a level effect or might even have a negative effect on economic growth.

Secondly, with the deployment of broadband, competition in the domestic markets increases and this leads to productivity growth (*competition enhancement effect*). Increased competition following the deployment of broadband leads to benefits from X-efficiency gains that are related to the improvements in the quality of management, labor and capital. Since all these improvements may only be achieved through investing in research and development (R&D), education, and innovation, these gains are considered as dynamic gains that result in an increase in productivity growth. Competition also has a growth effect because it reduces redundant research and stimulates researchers to pursue original designs (Romer, 1990; Grossman & Helpman, 1992; Rivera-Batiz & Romer, 1991). Although Rodrik (1991) argues that competition reduces the incentive for firms to invest in research and development (R&D) and hence reduces growth, Aghion, Dewatripont & Rey (1997), Aghion, Harris & Vickers (1997), and Aghion & Howitt (1996) show that the negative effect of competition on the willingness to engage in R&D does not necessarily reduce growth. Furthermore they demonstrate that there is a positive relationship between product market competition and growth in their theoretical models.

The third channel between broadband and growth goes through *scale economies*. The argument is that broadband allows domestic firms to connect with the world markets and this enlarges the market for domestic firms, which in turn enhances their exporting capacity and product diversity that may also reduce their production costs. Market enlargement increases the rate of growth also because the deployment of broadband raises R&D activities (Taylor, 1994; Grossman & Helpman, 1992; Rivera-Batiz & Romer 1991; Thompson & Grabacz, 2011). Tybout (1992, 2000) and Rodrik (1992), however, find the economies of scale argument analytically fragile. Since the productivity gains from economies of scale will be exhausted once firms reach the optimum scale, technical efficiency gains stemming from economies of scale cannot be linked to long-term growth.

The most important benefit of broadband on growth might be observed on the role of broadband in technology spillover. The importance of technology spillover for growth has been examined by Thompson & Grabacz (2011), Feenstra (1990), Grossman & Helpman, (1992), Devereux & Lapham (1994) and Young (1991). Although each of these authors has employed different models and reached different conclusions, they all agree on the fact that technology spillover has important implications for economic growth. Broadband technology accelerates the speed of dissemination of knowledge and makes the information more reachable in a cost-efficient manner, and this may in return facilitate the adoption of new technologies developed by other parties and hence promotes economic growth (Benhabib & Spiegel, 2005).

## 2.2. Empirical Evidence

Over time, a good amount of empirical literature has accumulated on the telecommunication sector, suggesting in general a positive relationship between the spread of telecommunication and economic growth. A large body of this evidence comes from cross-section and panel studies across countries. Single country studies on broadband however are

limited in number due mainly to the data restrictions since broadband was deployed in the late 1990s and early 2000s.

The empirical literature on the relationship between broadband and growth has first focused on estimating the relationship between growth and broadband using cross-sectional or panel of various country data. The second focal point of the literature is to investigate the direction of causality between income and telecommunication development. On the first point, the empirical evidence stems from cross-section and panel data studies widely supports the hypothesis that broadband penetration rate has a positive and statistically significant effect. For example, Koutroumpis (2009), in his study for 15 EU countries, provides evidence that broadband deployment has increased growth significantly in the European Union over 2003-2006. Quiang & Rossotto (2009), in their cross-sectional study covering 120 countries, and Czernich, Falck, Krestschmer & Woessmann (2009), for 25 OECD countries over 1996-2007, also confirm the existence of the positive relationship between broadband and per capita income. In addition to cross-sectional analyses, studies conducted for a single country using panel data on that country's states or regions also yield similar results. Studies carried out by Crandall, Lehr & Litan (2007) and Lehr, Osorio, Gillett & Sirbu (2005) utilizing U.S. states-level panel data and Cieslik & Kaniewsk (2004) utilizing the regional level data for Poland have showed that there is a positive and significant relationship between telecommunications development and income.

Although the aforementioned works have demonstrated that broadband penetration has a positive impact on economic growth, the findings nevertheless suggest that its impact has varied between countries with different levels of income. Röller & Waverman (2001) finds that the impact of telecommunication development was greater in 21 OECD countries than it was in 14 developing non-OECD countries. The study by Koutroumpis (2009) confirms that the

growth effect of broadband is higher for those countries that have higher broadband penetration rates, implying the importance of the threshold effect in broadband impact. That is, broadband deployment begins to have effect on economic growth only after some critical level of broadband penetration and income. However, Quiang & Rossotto (2009) find that growth effects are larger in developing countries than in developed countries.

Empirical literature provides mixed results on the direction of causality between broadband and economic growth. While some studies indicate a bidirectional relationship between economic growth and broadband penetration rate, others indicate a unidirectional relationship which goes through the broadband penetration to economic growth. Moreover, there is also evidence that the direction of causality is closely related to the level of broadband penetration rate and the level of income. Cronin, Parker, Colleran, & Gold (1991, 1993) and Cronin, Colleran, Herbert, & Lewitzky (1993) for the United States, Madden & Savage (1998) for the Central and Eastern European countries, Chakraborty & Nandi's (2003) work for 12 developing countries in Asia, Yoo & Kwak (2004) for South Korea and Wolde-Rufael (2007) for the United States over the period 1947–1996 provide evidence that there is a bi-directional relationship between economic growth and telecommunications development.

The study conducted for Poland at the regional level by Cieslik & Kaniewsk (2004), however, shows that the causality runs from telecommunication development to economic growth rather than the other way around. In a more recent study, Shiu & Lam (2008) also demonstrate that the causality between telecommunication development and income level is unidirectional, running from telecommunications development to income in China, but this result is only held significant for those provinces belonging to the high-income group. In the low-income provinces, they find that the causality run from income level to telecommunication development implying that telecommunication could have an impact on growth after some threshold level had been reached. Lam & Shiu (2010) present similar results for developing

countries in their analysis of 105 countries over the period 1980-2006. They find that while the causality relationship between real gross domestic product and telecommunications development is bidirectional for European and high income countries, it is unidirectional for less-developed countries running from real income to telecommunication services except in mobile services.

## 3. THE METHODOLOGY AND DATA

As the review of the theoretical and empirical literature indicated, there are a number of strong theoretical ties between the real income and the broadband penetration rate as well as the empirical evidences that support these expectations. However, the findings of empirical literature have raised a number of important points that needs for further analysis. These points involve the direction of the causality between economic growth and broadband services, and whether there exists a threshold level after which broadband has a positive effect on growth.

To provide additional evidence on the analysis of the economic contribution of broadband to the economic growth, we employ a fixed effect panel data model in the following form[1]:

$$LPCRGDP_{it} = \beta_0 + \beta_1 LRBBPR_{i,t-1} + +\mu_i + \gamma_t + e_{it} \qquad (1)$$

$$LRGDP_{it} = \alpha_0 + \alpha_1 LRBBPR_{i,t-1}\varphi_i + \omega_t + \varepsilon_{it} \qquad (2)$$

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[1] Because the dependent variable is sometimes defined as reel income and sometimes as per capita real income in the empirical literature, we choose to employ both definitions in our empirical analysis.

where LPCRGDP, LRGDP and LRBBPR represent the logarithm of the real gross domestic per capita income, real gross domestic income and broadband penetration rates respectively. While $i$ indicates the number of provinces, $t$ shows the time periods. $\mu_i$ $and$ $\varphi_i$ are the province specific dummies, and $\gamma_t$ and $\omega_t$ are the time dummies, and $e_{it}$ and $\varepsilon_{it}$ are the usual error terms.

To investigate the relationship between economic growth and broadband penetration, we first estimate the models given in equations 1 and 2 using an annual data for 26 provinces of Turkey during the years 2004-2008. To see whether the contribution of broadband to the level of income is related to the current income level (threshold effect), we divide the dataset into two groups, one of which represents upper income provinces and the other one lower income provinces. Then the panel data models given in equations 1 and 2 are run for each of these two groups. Furthermore, the causality relationship between economic growth and broadband penetration is tested for all the models over the period 2004-2008. Before presenting the findings of the study, the definition of the variables and the data sources needs to be explained.

The choice of the data span and the number of provinces are determined by the availability of data. The data are mainly drawn from the Turkish Statistical Institute (TURKSTATA) and the Information and Communications Technologies Authority. The variable LRGDP, real provincial income, is calculated by dividing nominal provincial income over provincial consumer price indices. The variable LPCRGDP, real provincial per capita income, is obtained through dividing the real provincial income by the mid-year provincial population. The data related to these variables are drawn from TURKSTAT. Broadband penetration rates by provinces are collected from the Information and Communications Technologies Authority and calculated by dividing the number of broadband users in those provinces over the mid-year population.

## 4. EMPIRICAL RESULTS

The empirical findings obtained from estimating the fixed effect panel data models of Equation 1 and Equation 2 are presented in Table 1. The second part of Table 1 shows the F and chi-square test results related to the cross-section and period fixed effect. The findings indicate that the appropriate fixed effect model for the dataset is the cross-section fixed effect model in all cases. The estimation results corresponding to fixed effect model are shown in the first part of Table 1.

An investigation of Table 1 sheds some lights on the relationship between economic growth and broadband penetration. First, the diagnostic statistics of the models indicate that a significant amount of variation in real provincial income is explained by broadband penetration rate and provincial differences (adjusted R-squares across models are between 0.988 and 0.999). Second, the results obtained for the whole sample show that the broadband penetration rate (LBBPR) has a positive and highly statistically significant effect on real provincial income and real per capita provincial income. While one percent change in broadband penetration rate increases real income (LRGDP) by 0.045 percent, it increases per capita income by 0.0324. In other words, broadband penetration leads to 4.5 percent provincial income growth and 3.24 per cent per capita income growth. The corresponding values for the upper (LRGDP1) and lower income provinces (LRGDP2) are 0.0549 and 0.03875, respectively. This indicates that the contribution of broadband services is closely related to the level of provincial income and its contribution is significantly higher in the upper income provinces than in the lower income provinces. Estimation results obtained from the model 1 (columns 2, 5 and 6), although they have relatively lower coefficients, also support these findings related to group differences.

These findings together imply that the impact of broadband services on economic growth is closely related to the level of income in a specific province. Similarly, the

significantly positive effect of broadband on economic growth will only be observed after passing some threshold income level.

**Table 1**

The impact of broadband penetration on provincial economic growth in Turkey, 2004-2008

|  | LRGDP | LPCRGDP | LRGDP1 | LRGDP2 | LPCGDP1 | LPCGDP2 |
|---|---|---|---|---|---|---|
|  | (1) | (2) | (3) | (4) | (5) | (6) |
| LBBPR(-1) | 0.0450* | 0.0324* | 0.0549* | 0.03875* | 0.0385* | 0.0292* |
| Constant | 16.487* | 8.745* | 17.112* | 15.966* | 9.067* | 8.449* |
| Adj. R-squared | 0.998 | 0.995 | 0.999 | 0.997 | 0.991 | 0.988 |
| S.E. of regression | 0.027 | 0.028 | 0.018 | 0.022 | 0.022 | 0.026 |
| F-statistic | 3533* | 799* | 5048* | 1838* | 447.3* | 384.2* |
| Durbin-Watson | 1.633 | 1.542 | 1.854 | 1.722 | 1.454 | 1.428 |
| N. Observation | 130 | 130 | 60 | 60 | 60 | 60 |
| *Cross-section and Period Fixed Effects Tests* | | | | | | |
| Cross-section F | 1415* | 90.65* | 2884* | 1613* | 149.75* | 51.405* |
| Cross-section $\chi^2$ | 641* | 359.2* | 331.2* | 303* | 190.09* | 140.49* |
| Period F | 0.182 | 0.3477 | 1.951 | 0.11423 | 0.3202 | 0.2092 |
| Period $\chi^2$ | 0.766 | 1.4556 | 8.0645** | 0.5113 | 1.4199 | 0.9326 |
| *Granger Causality Tests* | | | | | | |
| LBPR $\rightarrow$ LPRGD | 0.3527 | 0.0291 | 0.6525 | 0.8237 | 0.1825 | 1.6141 |
| LRGDP $\rightarrow$ LBPR | 6.995* | 3.3734** | 4.4412** | 3.5492*** | 3.1784** | 22.3011* |

*Note:* (*), (**) and (***) indicate that coefficients are significant at 1%, 5% and 10% levels respectively.

Although previous discussions indicated that the deployment of broadband contributes significantly to the growth of real income in Turkish provinces, this does not necessarily say anything about the direction of causality. The third part of Table 1 provides the F-test results related to Granger causality tests. Since the null hypothesis of the Granger test is determined as "does not Granger cause", the rejection of the null shows the direction causality. An examination of the results indicates that the direction of causality is running from the level of real income to broadband penetration rather than from broadband to income. This result, in particular, is important for economic policy purposes and in parallel with the BCG report prepared by Dean et. al., (2012), who indicated that broadband is widely used for social purposes rather than economic purposes in Turkey.

## 5. CONCLUSION AND IMPLICATIONS

This paper applies a fixed effect panel data model to examine the impact of broadband penetration on provincial economic growth, to investigate the importance of the threshold effect to the extent that broadband affects provincial economic growth and to test the direction of causality and between these variables.

The overall result of this paper indicates that there is a close relationship between the broadband penetration rate and the real provincial income and the extent of this relationship is stronger for those provinces belonging to the high-income group than for the lower-income group provinces. In addition, the causal relationship between real GDP and broadband penetration rate is unidirectional that goes through real GDP to broadband services.

Taken together, these imply that an increase in real provincial income raises the demand for broadband services; hence broadband services do not seem to have contributed to provincial growth in the period 2004-2008. In the context of economic policy, this finding implies that the dynamic growth enhancing impact of broadband does not come automatically but needs to be

stimulated by decisive policies. In effect, it seems that Turkish provinces in particular and Turkey in general could not be able to exploit the dynamic growth enhancing effects of broadband deployment yet. For that reason, extra measures should be taken to exploit growth effect of broadband such as using broadband more intensively in education, businesses, and trade.

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