Impacts of Mobile Phone Subscription, Internet Users, and Broadband Adoption on National Output in South Korea

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ABSTRACT

Applying the macroeconomic model developed by Romer (2000), this paper finds that more mobile phone subscriptions, Internet users, and broadband adoption raise output (real GDP) in South Korea. In addition, fiscal expansion and a higher expected inflation rate reduce output whereas real appreciation of the Korean won increases output. Therefore, governments should support investments in ICT (information and communication technologies) in order to enhance output.

Keywords: Broadband Adoption, Exchange Rates, Fiscal Policy, ICT, Internet Users, Mobile Phone Subscriptions.

I. INTRODUCTION

South Korea is among the Asian countries with relatively high mobile phone subscriptions, Internet users, and broadband adoption. According to the International Telecommunication Union (ITU), during 2000-2020, South Korea’s mobile phone subscriptions rose from 56.60 to 137.54 per 100 inhabitants; Internet users as a percent of the population increased from 44.7% to 96.51%, and broadband adoption went up from 8.17 to 43.55 per 100 inhabitants. These developments are expected to increase knowledge spillovers leading to increasing returns to scale (Romer, 1986, 1990, 1994), information flows, efficiency, productivity, consumer spending, remote education and learning, teleconferences, and other business and economic activities and are conducive to output increase. Applying a well-known model proposed by Romer (2000), this paper examines separate effects of mobile phone subscriptions, Internet users, and broadband adoption on national output in South Korea. More mobile phone subscriptions, Internet users, and broadband adoption tend to shift both aggregate demand and aggregate supply to the right, leading to an increase in national output. In this study, the macroeconomic model also incorporates fiscal policy and exchange rates in order to determine whether expansionary fiscal policy or real depreciation of the Korean won would be effective in raising national output.

II. LITERATURE SURVEY

The literature will be discussed based on which of the following four categories was used in the formulation of the model and empirical work: (1) the composite ICT indicator, (2) Internet users, (3) Internet users and fixed broadband adoption, and (4) Internet users, mobile phone subscriptions, fixed phone subscriptions or personal computer users. The literature survey will focus on South Korea and other Asian and Pacific countries.

Yousefi (2011), Vu (2013), Ahmed and Ridzuan (2013), Ishida (2015), Samimi et al. (2015), Hwang and Shin (2017), Niebel (2018), Chung (2018), Sinha and Sengupta (2019), Sawng et al. (2021), and Appiah-Otoo and Song (2021) selected the composite ICT indicator in their studies. Major findings are summarized as follows: Except for Ishida (2015) who found a negative effect of ICT on output, other studies showed that ICT had a positive impact on output, productivity, or value-added. Yousefi (2011) assessed the effect of ICT on economic growth in 62 countries during 2000-2006. These countries were divided into high and upper-middle-income countries including South Korea and lower-middle-income countries. He showed that ICT made significant contributions to economic growth in the first group but did not succeed in effecting economic growth in the second group.
Ahmed and Ridzuan (2013) studied the effect of ICT on real GDP for ASEAN5+3, which stands for Indonesia, Malaysia, the Philippines, Singapore, Thailand, China, Japan, and South Korea. They showed that the elasticity of real GDP with respect to ICT was estimated to be 0.0433 for ASEAN5 and 0.0225 for ASEAN5+3, suggesting that the effect of ICT on real GDP in percentage was larger in ASEAN5 than that in ASEAN5+3.

Samimi et al. (2015) compared the impact of ICT on economic growth in developed and developing countries during 2001-2012. They found that ICT had a positive effect on economic growth in both developed and developing countries and that the impact in developing countries was greater than that in developed countries mainly because developing countries were in the initial stage of ICT adoption and experienced more economic growth.

Niebel (2018) revealed that the impacts on output in the developed, developing, and emerging countries were not significantly different. Sawng et al. (2021) found that the positive relationship between ICT and output was confirmed in the long run. Appiah-Otoo and Song (2021) indicated that the positive impact of ICT on output in the low- and middle-income countries was greater than that in the high-income countries.

Wahab et al. (2020), Hsing et al. (2021), and Yin and Choi (2021) selected Internet users as a proxy for ICT. Wahab et al. (2020), Hsing et al. (2021) reported that Internet users had a positive effect on output. Yin and Choi (2021) indicated that lagged Internet users had a positive impact on output for the whole sample whereas lagged Internet users did not affect output for the East Asian countries including South Korea.

Pradhan et al. (2018) investigated the effects of Internet users, broadband adoption, and other relevant variables on economic growth in G-20 countries including South Korea during 2001-2012. They showed that these variables had a long-term stable relationship and that expansion of Internet users and fixed broadband adoption contributed to increasing real GDP per capita. Camba and Camba (2020) revealed that Internet users and fixed broadband adoption impacted output in the long run. Shodiev et al. (2021) showed that a 1% increase in Internet users would raise real GDP per capita by 0.2218% and that a 1% increase in fixed broadband adoption would cause real GDP per capita to rise by 0.1669%.

Kurniawati (2021) reported that fixed and mobile phone subscriptions had positive effects on output in middle-income countries whereas Internet users had a positive effect on output in high-income countries including South Korea.

Vu (2011) examined the effects of Internet users, mobile phone subscriptions, and personal computer users on the growth rate of real GDP for 102 countries including South Korea during 1996-2005. He indicated that a quadratic form for each of these three variables would be more appropriate and that the fixed effect should be included in the estimated equation. He showed that the initial marginal effect of a change in Internet users, mobile phone subscriptions, or personal computer users was positive, but the marginal effect declined as each variable increased in value (For a comprehensive survey of the literature, see Vu et al., 2020).

A review of these previous studies indicates that none of the above studies include three ICT components, namely, mobile phone subscriptions, Internet users, and broadband adoption in the model.

This paper attempts to fill the gap by incorporating all these three ICT components in the model and empirical work in order to determine whether they may exhibit different impacts.

### III. Theoretical Framework

Extending Romer (2000), Hsieh (2000), and Hsing et al. (2021), we can express the IS function, the monetary policy reaction function, and the aggregate supply function as $Y = x(Y, G, T, R, E, P, N, B)$, $R = x(\pi - \alpha, Y - \beta, E)$, and $\pi = w(\pi^e, Y - \beta, E, P, N, B)$, respectively.

where $Y =$ real GDP in South Korea, $G =$ government spending, $T =$ government taxes, $R =$ the real interest rate, $E =$ the real effective exchange rate, $P =$ mobile phone subscriptions, $N =$ Internet users, $B =$ broadband adoption, $\pi =$ the inflation rate, $\alpha =$ the target inflation rate, $\beta =$ potential output, and $\pi^e =$ the expected inflation rate.

We can solve equilibrium endogenous variables including $Y$ by assuming that $\alpha$ and $\beta$ are constant in the short run by using (1).

$$ Y = f(P, N, B, G - T, E, \pi^e) $$

(1)

The sign beneath each of the variables shows the partial derivative of equilibrium $Y$ with respect to one of the exogenous variables. The sign of $G - T$ may be ambiguous because fiscal expansion tends to result in an increase in equilibrium real GDP in the short run but the crowding-out effect in the long run. Real appreciation tends to increase net capital inflows and shift aggregate demand to the right, hurt net exports and shift aggregate demand to the left, and reduce the price of imported goods and services and shift aggregate supply to the right. The net impact is uncertain. A higher $\pi^e$ tends to shift aggregate supply to the left and reduce equilibrium real GDP.

### IV. Data Sources and Empirical Results

The data were collected from the International Telecommunication Union (ITU), Federal Reserve Bank of St. Louis, the International Financial Statistics, and the World Economic Outlook. $Y$ is measured in millions of the won. $P$ is measured by mobile phone subscriptions per 100 inhabitants. Internet users as a percent of the total population are used to measure $N$. $B$ is measured by fixed broadband adoption per 100 inhabitants. Mobile broadband adoption is not used as the earliest data began in 2008. $G - T$ is represented by government borrowing as a percent of GDP. $E$ is represented by the real effective exchange rate with a base year in 2010. An increase means real appreciation of the
Korean won, $\pi^e$ is represented by the lagged inflation rate. The semi-log form on the dependent variable is used as it yields better results. Annual data from 2000 to 2020 are used as the sample. Consistent data for mobile phone subscriptions, Internet users, and broadband adoption before 2000 were not available.

Fig. 1, Fig. 2, and Fig. 3 illustrate the scatter diagrams describing the relationship between mobile phone subscriptions, Internet users, and broadband adoption, and real GDP in South Korea during 2000-2020. It seems that their relationships were positive during the sample period and that their slopes appeared to be different, suggesting that estimating their coefficients separately may be more appropriate.

Empirical results are reported in Table I. The GARCH process is applied in empirical work to fix heteroskedasticity in the sample. The six right-hand side variables with significant coefficients can explain approximately 99.43% of the change in real GDP. Real GDP is positively associated with mobile phone subscriptions, Internet users, broadband adoption, and the real effective exchange rate, and it is negatively correlated with government borrowing and the expected inflation rate.

To compare the response of real GDP to a change in each of mobile phone subscriptions, Internet users, and broadband adoption, the partial elasticities of real GDP with respect to mobile phone subscriptions, Internet users, and broadband adoption at the means were estimated to be 0.5690, 0.1910, and 0.1742, respectively. A 1% increase in mobile phone subscriptions, Internet users, and broadband adoption would raise real GDP by 0.5690%, 0.1910% and 0.1742%, respectively. Therefore, mobile phone subscriptions made more contribution to national output in percent than Internet users and broadband adoption.

The negative coefficient of government borrowing suggests that fiscal expansion may not generate the expected outcome as the government had expected due to the crowding-out effect. The positive coefficient of the real effective exchange rate indicates that the negative effect on fewer exports is overwhelmed by the positive effects of a decrease in domestic inflation and an increase in net capital inflows.

Except for the findings by Ishida (2015) and Siddiqui and Singh (2019), who showed that ICT and output had a negative relationship and Yin and Choi (2021), who showed that ICT and output had a negative relationship, the results of this study are in line with most other studies.

| TABLE I: ESTIMATED REGRESSION OF LOG-REAL GDP FOR SOUTH KOREA |
|------------------------|-------------------|-----------------|
| Variable               | Coefficient       | Probability     |
| Intercept              | 13.18764          | 0.0000          |
| Mobile phone subscriptions | 0.005771        | 0.0000          |
| Internet users         | 0.002384          | 0.0000          |
| Broadband adoption     | 0.005430          | 0.0000          |
| Government borrowing   | -0.009030         | 0.0000          |
| Real effective exchange rate | 3.96E-05        | 0.0060          |
| Expected inflation rate | -0.003874       | 0.0009          |
| R-squared              | 0.994292          | -               |
| Adjusted R-squared     | 0.989622          | -               |
| Sample period          | 2000-2020         | -               |
| Number of observations | 21                | -               |
| Mean absolute percent error | 1.2206%        | -               |

V. SUMMARY AND CONCLUSIONS

This study has investigated the effects of mobile phone subscriptions, Internet users, and broadband adoption on national output for South Korea during 2000-2020. A theoretical model based on Romer (2000) and incorporating fiscal policy and exchange rate movements is specified. The results show that more mobile phone subscriptions, more Internet users, more broadband adoption, less government borrowing, real appreciation of the Korean won, and a lower expected inflation rate would raise national output.

When mobile phone subscriptions, Internet users, and broadband adoption increase, it is expected that the national
output also increases. Based on the results of our study, it is recommended that more investment should be made in these areas by the private sections. From the public sector’s perspective, the implication is the important role that governments can play in raising the national output through stimulating policies such as providing tax incentives, offering low-interest loans, or supplying low-cost lands. Among the three ICT components, broadband adoption reached 43.55 per 100 inhabitants in 2020 and is expected to have more room to expand.

From the results of our study, it is observed that the implementation of fiscal expansion through an increase in government borrowing is not effective or even detrimental to ICT growth. Although the rising of government deficits and debt as a percent of GDP from 2019 to 2020 was the response to the sluggish economy, the result was the negative impact on the GDP and hence throttle the growth in ICT.

The positive effect of real appreciation is quite interesting because this result suggests that when the Korean won was depreciating, the exports increased, and the aggregate spending also increased. However, more thorough studies should be conducted to examine the costs and benefits of the long-term impacts of these related factors.

REFERENCES


