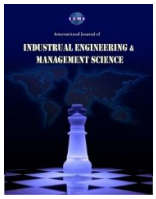
University of Hormozgan

International Journal of Industrial Engineering & Management Science

journal homepage: www.ijiems.com



Investigating the Effect of the Broadband Penetration on the Main Economic Variables in the Form of a Macro-Econometric Model

Amin Beiranvand [a *], Mahbube Delfan[a]

[a] *Faculty of management and economics, Lorestan university*

ARTICLE INFO

Article history:
Received: 2020-12-26
Received in revised form: 2021-01-17
Accepted: 2021-09-14

Keywords:
Broadband Penetration
Macroeconomic Structural Pattern
Main Economic Variables
JEL Classification: D3, O3

ABSTRACT

The present study is aimed at evaluating the effects of broadband penetration on the main macroeconomic variables. To this end, a macroeconomic structural pattern is set which is consistent with Iran's economic condition. The equations of the model are estimated in ARDL framework using the time series data from 1979 to 2013 in constant prices.

Then by using a dynamic simulation model, the pattern's validation test was done. The results reveal that the regulatory pattern can easily trace the movement process of the variables in the studied area. Next, to see the effects of the modification of the broadband penetration rate, considering the proposed quantitative targets in the infrastructure development document of the National Information Network, two scenarios are examined. Based on the results of the first scenario (a gradual increase in household penetration rate) and the second scenario (a sudden increase in household penetration rate), it is suggested that in order for the broadband penetration to have more beneficial impact on the country's economy, the sudden increase in household penetration rate should be applied. This is because a gradual increase in household penetration rate will have negative effects on the macroeconomics variables in the long run, with the sudden increase having positive effects.

1. Introduction

Some studies have estimated the broadband economic impact (Minges 2015), for example Zaballos and López-Rivas (2012) have used a non-linear model for a study on broadband economic impact in Latin American and Caribbean (LAC) countries. Data covers 26 LAC countries for the period 2003–09. The results found that a 10 percent increase in fixed broadband penetration triggered an average increase of 3.19 percent in per capita GDP Thompson and Garbacz (2011) uses panel data for a sample of developed countries covering the years 2005 to 2009. The study includes country and time fixed effects, finding that

every 10-percentage point increase in fixed broadband household penetration increases GDP per household by 0.77 (significant at the 10% level). On the other hand, every 10-percentage point increase in mobile broadband household penetration is found to reduce GDP per household by 0.52 (significant at the 1% level).

Several paperes show the impact of network construction on job creation (Katz 2010.): Crandall et al. (2003), Katz et al. (2008), Atkinson et al. (2009), Liebenau et al. (2009) Katz et al. (2009), and Katz et al. (2010). all of these studies relied on input-output matrices and assumed a given amount of capital investment: US $ 63 billion (needed to reach ubiquitous broadband service) for Crandall et al. (2003), CHF 13 billion for Katz et al. (2008) (to build a national multi-fiber network for Switzerland), US $ 10 billion for Atkinson et al. (2009) (as a US broadband stimulus), US$ 6.3 billion to implement the Broadband Technology Opportunity Program (Katz et al., 2009), US $ 7.5 billion for Liebenau et al. (2009) (needed to complete broadband deployment in the United Kingdom), US $ 45 billion for Katz et al. (2010) (required to implement Germany's National Broadband Strategy).

The current article seeks to adjust the structure of the macro-econometric pattern in a way that not only it presents the short term and long-term effects of the broadband penetration rate, but also provides a base for structural analysis and presentation of short term and midterm predictions of the main economic variables. In this study, we have tried to set a pattern that is

* Corresponding author.
E-mail address: beiranvand.amin@gmail.com

consistent with Iran's economic condition so that it can indicate clearly the effect of the modification of the broadband penetration rate on the major macroeconomic variables.

The theatrical framework of this model is a combination of neoclassical and Keynesian perspectives. While the Keynesian perspective is the dominant perspective for the model in many cases, markets are seen with the neoclassical perspective and supply and demand equations have been specified for each one. These equations, in equilibrium conditions, determine the price and quantity of the market equilibrium. Unlike the Keynesian model, the economic supply side is modeled by using the production function. Structural pattern has two categories of equation that are related to each other, with one of them specifying the long-run equilibrium relationship and the other showing short term dynamics of the model's variables toward a long-run equilibrium. These two categories of relationship make both short term and long-term analyses possible.

The main specified equations of the pattern are: private sector consumption expenditure, private sector investment, non-oil exports, imports, production function, general level of prices, labor demand and labor wage index.

The following section gives a description of the theatrical foundation of any of relationships of the model.

2. The model

2.1. The Structure of Goods and Services Market

In countries such as Iran, due to production bottlenecks, economic supply-side can't adjust itself to the demand conditions simply. Aggregate demand is achieved through the sum of consumption and investment spending and net exports. Any imbalance in aggregate demand and supply will influence the general price level. This effect, later, will make economic supply and demand balanced gradually. In the following part, we will first examine the market demand and then will specify its production and supply.

3.3.3. Demand-side

The major components of GDP (using the cost method) make the demand side which are presented below by alliance relations:

AD = CO + I + G + X – M, I = IP + IG, IP = IICT + IPICT, X = XOG + XNO

So where:

AD: Demand for all goods and services, CO: Private sector consumption, I: Total investment, G: Public sector consumption expenditure, X: export, M: import, IP: private sector investment, IG: Public sector investment, IICT: communication sector investment, IPICT: private sector investment in other sectors, XOG: oil and gas exports, XNO: non-oil exports.

These variables have been included actually (as they are) in the model, except for the variables that end in J (the flow variables), thereby the nominal values of these variables can change with the general price level. Thus, we can make sure that a nominal shock can't affect a real demand or production levels automatically. Now we will describe the behavioral functions of the components of the aggregate demand.

a) Private Sector Consumption

Most empirical patterns that explain private consumption expenditure, have considered consumption expenditure as a function of a disposable income and private sector wealth. We have used real liquidity variable as an alternative to private sector wealth. In addition, in this respect, inflation rate can be considered as the opportunity cost in explaining the consumption behavior of households in their purchases of durable goods. Private consumption expenditure function is defined as follows. The symbol above each variable indicates the expected relationship between that variable and the dependent variable.

$$CO = CO\,(YD+, M2P+, P0-)$$

CO: demand for private consumption expenditure PO: inflation rate YD: disposable income M2P:the real liquidity of private sector

b) Private Sector Investment

Based on the principle of flexible acceleration, production and income are the major determinants of a favorable level of capital accumulation. Another variable is interest rate which, according to some theories of economics, has been considered as an investment opportunity cost. Import is another variable, with the approach that the increase in import will pave the way for the increase in intermediate and capital imported goods for better and more investment.

Moreover, in this study, to investigate the effects of broadband penetration on the economy, private sector investment is divided into ICT investment and investment in other sectors. Knowing that that broadband penetration affects investment in the ICT sector in the first place and then through ICT investment will affect macroeconomic variables, two functions are considered for the private sector investment.

The investment function in other sectors:

IPICT = IPICT (GDP^{+}, IG$^{?}$ M\$$^{+}$, R^{-})

The investment function in ICT:

IICT = IICT (VICT^{+}, BBP$^{?}$ M\$$^{+}$, R^{-})

IPICT: demand for private sector investment, IICT: demand for investment in ICT, GDP: gross domestic production in constant prices, IG: public sector investment spending, M\$: import of goods and services (in million dollars), R: bank interest rate , VICT: communications sector value added, BBP: Broadband penetration.

Non- oil Export:

The export is divided into two parts in this model, i.e. oil export and non-oil export. Oil export, due to quotas set by OPEC and also international oil prices, is considered exogenous in the model. Non-oil export supply function can be written as follows:

XNO\$ = XNO\$ (GDP^{+}, EFR^{+})

XNO\$: supply of non-oil export (in million dollars), GDP: gross domestic production, EFR: real exchange rate.

d) Import

Import demand in the model, as the usual demand function, is considered a function of income. Also, the real exchange rate is another variable that affects import. It is expected to have an inverse relationship with import demand. Of the other determinants of demand for imports are exchange earnings. In this model, total export in dollar is used instead of exchange earning and it affects the amount of import as a financial constrain in the international payment.

Therefore, demand for imports is stipulated as follows:

M\$ = M\$ (GDP^{+}, EFR^{-}, X\$$^{+}$)

M$: demand for imports of goods and services (in million dollars), EFR: real exchange rate, X$: total export (in million dollars), GDP: gross domestic production

3.3.4. Supply-side

Based on the theoretical foundations of production, it can be assumed that the total production can be presented by a function of two factors: labor and capital accumulation.

$Q = Q(L, K)$

Q: domestic gross production, L: labor, K: capital accumulation

But considering that the aim of this study was to investigate the effects of broadband penetration on economic variables, and that broadband penetration of ICT affects investment in the first place and then it will affect macroeconomic variables through ICT investment, capital accumulation has been divided into the ICT sector capital accumulation and other sectors capital accumulation. The division is done so that the broadband penetration effect through capital channel on the GDP can be investigated. As a result, the production function can be demonstrated as follows:

$GDP = GDP(L^{+}, KICT^{++}, KKICT^{+})$

GDP: gross domestic production, L: labor, KICT: ICT sector capital accumulation, KKICT: other sectors capital accumulation.

3.3.5. The Balance of Aggregate Supply, Aggregate Demand and Prices Level

The existence of any imbalance in the goods market results in the increase in the the general price level, thereby moderating the supply amount as well as aggregate demand in a way that balance dominates the market again. Therefore, the price is a factor in moderating aggregate supply and demand. The difference between total supply and total demand, which makes up the change in inventories, affects the direction and degree of general level of prices.

Inventory change relationship can be considered as follows:

$INV = Q^{S} - Q^{D}$

INV:changes in inventory, QS:aggregate supply, QD:aggregate demand

If INV>0, the general price level tends to decrease, but if INV <0, the general price level tends to increase (other conditions being constant). The general price level can also be specified in the model as follows:

$P = P(INV^{-}, PM^{+}, EF^{+}, M2J^{+})$

P: The prices general level, INV:changes in inventory, PM:import price index, EF:the exchange rate in the parallel exchange market, M2J:nominal money supply (cash).

3.3.6. Money Market Structure

The money market is very important, because the implementation of monetary and partly financial policies (governments compensate their deficits by borrowing from the banking system)., mainly through the transformation that occurs in the money market, will affect the target variables. The demand for money in the model is as follows:

$M2P = M2J / P$

M2P: real demand for money, M2J: liquidity, P: the general price level.

Money supply: The nominal money supply is considered as the sum of the monetary base resources in money increase rate which is determined as endogenous in the model.

$M2J = MU * MBJ$

Monetary base consists of the following components:

$MBJ = FACBJN + RAMBJ$

M2J: is liquidity in current price, MU: monetary base multiplier, MBJ: monetary base in current price, FACBJN: net foreign assets of central bank in current price that is considered endogenous in the model, RAMBJ: included three parts, net government debt to central bank, bank debt to central bank and other net assets of the central bank in current price and all three components of the current prices are considered exogenous. The monetary base multiplier (MU) is predetermined and defined as follows:

$$MU = \frac{1+\alpha}{\alpha+\beta+\gamma}$$

α:the ratio of currency and coins to bank deposit, β: the rate of legal reserves, γ: the rate of free banks' reserves.

5) Labor Market

Unlike other markets which are in balance usually, the labor market is often imbalanced. Unemployment in economy is a sign of this imbalance. In fact, variables such as the unemployment rate illustrate this imbalance. Labor demand function is as follows:

$L = L((W/P)^{-}, GDP^{+})$

L: the demand for labor, GDP: gross domestic production, p: gross domestic production implicit index, W: labor nominal wage.

Now consider the labor supply. In this regard, we assume that labor supply in the short and long term is equal to the active population.

$LS = LF$

LF: active population, LS: labor supply. The number of the unemployed and unemployment rate are calculated as follows:

$U = LS - L, \quad UR = U / LS$

L: labor demand, LS: labor supply, U: the number of the unemployed, UR: unemployment rate.

As mentioned earlier, the labor market is the only market that has always been imbalanced in the model, so real wage determination is based on the Philips curve in this model. The Philips curve shows the relationship between real wage growth rate, labor productivity and additional labor demand. The amount of employment in the short term is supposed only to be determined by labor market demand, and excess supply of labor in the market adjusts wage rate in the form of a Philips curve and thus, unemployment rate in the long run has a tendency towards a natural rate of unemployment. Wage function is specified as follows:

$WP = WP(APL^{+}, UR^{-}, P0^{-})$

WP: labor real wage index, PO: inflation rate, APL: labor productivity, UR: unemployment rate.

6) Government Revenue and Expenditure

In this section we have specified the relationships that are needed for the determining government revenue and expenditure in the regulatory macro-econometric model. These relationships consist of direct and indirect taxes, oil sales income, consumer spending and government investment. Also, other government revenue is considered exogenous.

Direct Taxes in Current Prices

Direct taxes as a function of nominal GDP and direct taxes for the prıor period are considered as follows:

TDJ = TDJ (GDPJ, GDPJ (-1), TDJ (-1))

Indirect Taxes in Current Prices

Import tax forms part of indirect taxes. Thus, indirect taxes as a function of dollar imports, nominal GDP, indirect taxes and prior period import are considered as follows:

TIJ = TIJ (GDPJ, M$, M$ (-1), TIJ (-1))

Oil Sale Revenue

In addition to tax revenue, Oil sale revenue can be noted. In the present study, oil sale revenue is a function of oil sector value added, oil and gas export (in dollar) and their lags, and it is considered as follows:

GOREJ = GOREJ (VOGJ, VOGJ (-1), VOGJ (-2), XOG$, XOG$(-1), XOG$(-2), GOREJ (-1))

Government Consumption Expenditure in Current Price

In this model, government consumption expenditure as a function of nominal GDP, total government revenues and government investment expenditure until the prior period is considered as follows:

GJ = GJ (GDPJ, GRJ, GJ (-1))

Government Investment Expenditure in Current Prices

Government investment expenditure as a function of nominal GDP, total government revenues and government investment expenditure until the previous period is considered as follows:

IGJ = IGJ (GDPJ, GRJ, IGJ (-1))

The Literature

3. Research Methodology

The time series data of macroeconomic variables is mostly obtained from the Annual National Accounts' tables 1391-1338 presented by the Central Bank. The names of those variables that have time series data (in Rials) have been illustrated by J and the data in dollars is identified with $. Price indexes used in the model have 1383 as the base year. And statistics relating to employment and population are given per individual.

Statistics relating to OECD countries prices general level index has been achieved from world's bank website.

The data reference on fixed exchange rates (both official and free) is economic indicators of Iran's central bank. Data on interest rates is determined by long-term deposits interest rate which is taken from the data given by the central bank. Also, the other data used in this study is taken from the economic reports of different years and time series of the Central Bank of the Islamic Republic of Iran.

An outline of the Adjusted Model

Private Sector Consumption

$CO^L = CO^L$ (YD+, M2P+, P0-)

$\Delta CO^S = \Delta CO^S$ (ΔYD+, ΔM2P+, ΔP0-, $(CO^S - CO^L)_{-1}$)

Private Sector Investment in Other Sectors

$IPICT^L = IPICT^L$ (GDP^+, $IG^?$, $M\$^+$, R^-)

$\Delta IPICT^S = \Delta IPICT^S$ (ΔGDP^+, $\Delta IG^?$, $\Delta M\$^+$, ΔR^-, $(IPICT^S - IPICT^L)_{-1}$)

Investment in ICT

$IICT^L = IICT^L$ ($VICT^+$, $BBP^?$, $M\$^+$, R^-)

$\Delta IICT^S = \Delta IICT^S$ ($\Delta VICT^+$, $\Delta BBP^?$, $\Delta M\$^+$, ΔR^-, $(IICT^S - IICT^L)_{-1}$)

Non-oil exports

$XNO\$^L = XNO\$^L$ (GDP^+ , EFR^+)

$\Delta XNO\$^S = \Delta XNO\$^S$ (ΔGDP^+ , ΔEFR^+, $(XNO\$^S - XNO\$^L)_{-1}$)

Import

$M\$^L = M\$^L$ (GDP^+, EFR^-, $XOG\$^+$)

$\Delta M\$^S = \Delta M\$^S$ (ΔGDP^+, ΔEFR^-, $\Delta XOG\$^+$, $(M\$^S - M\$^L)_{-1}$)

Production

$GDP^L = GDP^L$ (L^+, $KICT^+$, $KKICT^+$)

$\Delta GDP^S = \Delta GDP^S$ (ΔL^+, $\Delta KICT^+$, $\Delta KKICT^+$, $(GDP^S - GDP^L)_{-1}$)

Prices General level

$P^L = P^L$ (INV^-, PM^+, EF^+, $M2J^+$)

$\Delta P^S = \Delta P^S$ (ΔINV^-, ΔPM^+, ΔEF^+, $\Delta M2J^+$, $(P^S - P^L)_{-1}$)

Labor Demand

$L^L = L^L$ ($(W/P)^-$, GDP^+)

$\Delta L^S = \Delta L^S$ ($\Delta (W/P)^-$, ΔGDP^+, $(L^S - L^L)_{-1}$)

Labor Real Wage Index

$WP^L = WPL(APL^+, UR^-, P0^-)$

$\Delta WP^S = \Delta WP^S(\Delta APL^+, \Delta UR^-, \Delta P0^-, (WP^S - WP^L)_{-1})$

Unions

1. M2P = M2J / PCI
2. YD = GDP - VOG - TD - DEP
3. P0 = (PCI / PCI(-1) - 1) * 100
4. M2J = MU * MBJ
5. IP = IICT + IPICT
6. I = IP + IG
7. GDPJ = (PGDP * GDP) / 100
8. IIICT = I - IICT
9. XJ = (EXI * X$) / 100
10. X$ = XNOS$ + XOG$
11. MJ = (EMI * M$) / 100
12. X = (XJ / PX) * 100
13. TB$ = X$ - M$
14. M = (MJ / PM) * 100
15. KICT = 0.93 * KICT(-1) + IICT
16. TB$NO = XNOS$ - M$
17. K = KICT + KKICT
18. KKICT = .957 * KKICT(-1) - 0.35 * WDK - .15 * ERDK + IIICT
19. INV = GDP - AD
20. AD = CO + I + G + X - M + ERROR
21. GDPF = GDP - TIN
22. GDPNO = GDPF - VOG
23. MBJ = FACBJN + RAMBJ
24. MU = (1 + ALFA) / (ALFA + BETA + GAMA(
25. TI = (TIJ / PG) * 100
26. TD = (TDJ / PCI) * 100
27. TTJ = TDJ + TIJ
28. TINJ = TIJ - RTINJ
29. GRJ = TTJ + GOREJ + GRRJ
30. GRR = (GRRJ / PG) * 100
31. IG = (IGJ / PIG) * 100
32. BDJ = (GJ + IGJ + GIGJRE) - GRJ
33. BP$ = TB$ + RABP$
34. BP$ = TB$ + RABP$
35. FACBJN = FACBJN(-1) + (BP$ * E / 1000) - DFACBJN
36. FACBJN$ = FACBJN$(-1) + BP$
37. U = LF - L
38. EFR = (EF * POECD) / PGDP
39. TIN = (TINJ / PTIN) * 100
40. UR = (U / LF) * 100
41. G = (GJ / PG) * 100

Using Dynamic Simulation for the Model's Validity Test

Focusing on each of model's equations separately and analyzing their results may provide only a small picture of the actions and reactions between economic variables. Thus, for a better and more comprehensive picture of how Iran's economy works and to provide a comprehensive analysis of economic policies, we will provide the dynamic model of Iran's economy which has been prepared as a set of equations and based on estimations done in the previous section.

1. **Dynamic Simulation of Adjusted Macro-Econometric Model**

The purpose of this simulation is to see the model's power in tracing the actual values of the model's endogenous variables. All simulations performed in this study are dynamic.

To this end, the actual values of time series data of the model's endogenous variables have been used in the studied area, but the quantity of endogenous variables have been used only for the year 1979 which is the starting year of the simulation. The model's endogenous variables have been simulated until 2013, i.e. for 35 years.

A first step in measuring how close the simulated values are with the actual values of endogenous variables can be to observe the diagram of the simulated values as well as that of the actual values of the major variables of a macro-econometric model. A look at these diagrams indicates that not only the values simulated by the model pursue the actual valued closely, but also the turning points predict the variables' movement process in a good way. So, it seems that the model has an appropriate structural stability.

In order to provide a quantitative measure of how well the estimation of simulated values is done by the model, the root mean square of relative error index (RMSPE) and Theil Inequality Index (U) are calculated for the discussed variables. And it has been reported in the table below. (RMSPE) Index indicates the average of the difference percentage of variables' simulated values from their actual values or the percentage prediction error average in the studied area. Also, when the prediction is the same as the actual values, then Theil index (U) will be zero. Thus, the smaller and the closer U is to zero, the better the model's performance is in simulating the variables' actual movement process. The results of the quantitative measurement of the model's validity have been provided in Table 1.

Table 1. results of the quantitative measurement of the model's validity

variable	U	RMSPE	variable	U	RMSPE
L	0.017	1.84	Ad	0.130	12.61
Pgdp	0.139	20.88	Gdp	0.063	6.88
M2j	0.215	31.60	Grj	0.059	9.17
Ttj	0.102	21.40	Gj	0.091	14.82
Yd	0.100	11.41	Igj	0.129	17.52
Xnos$	0.199	33.57	I	0.141	16.36
Wmini	0.162	24.38	K	0.048	5.36
X$	0.051	5.15	Ip	0.161	18.79

4. Evaluating the Broadband Penetration Change Effects by Using the Model Simulation

According to what has been said on the above Table: Proposed quantitative targets for the development of the Information National Network on page 47 of the designing project of infrastructure development model of Information National Network and plan development for its application: Infrastructures Development's Document of the Information National Network, quantitative target of the households broadband penetration will be 50 percent by the end of year 96, 70 percent by the end of year 99 and 100 percent by the end of 1404.

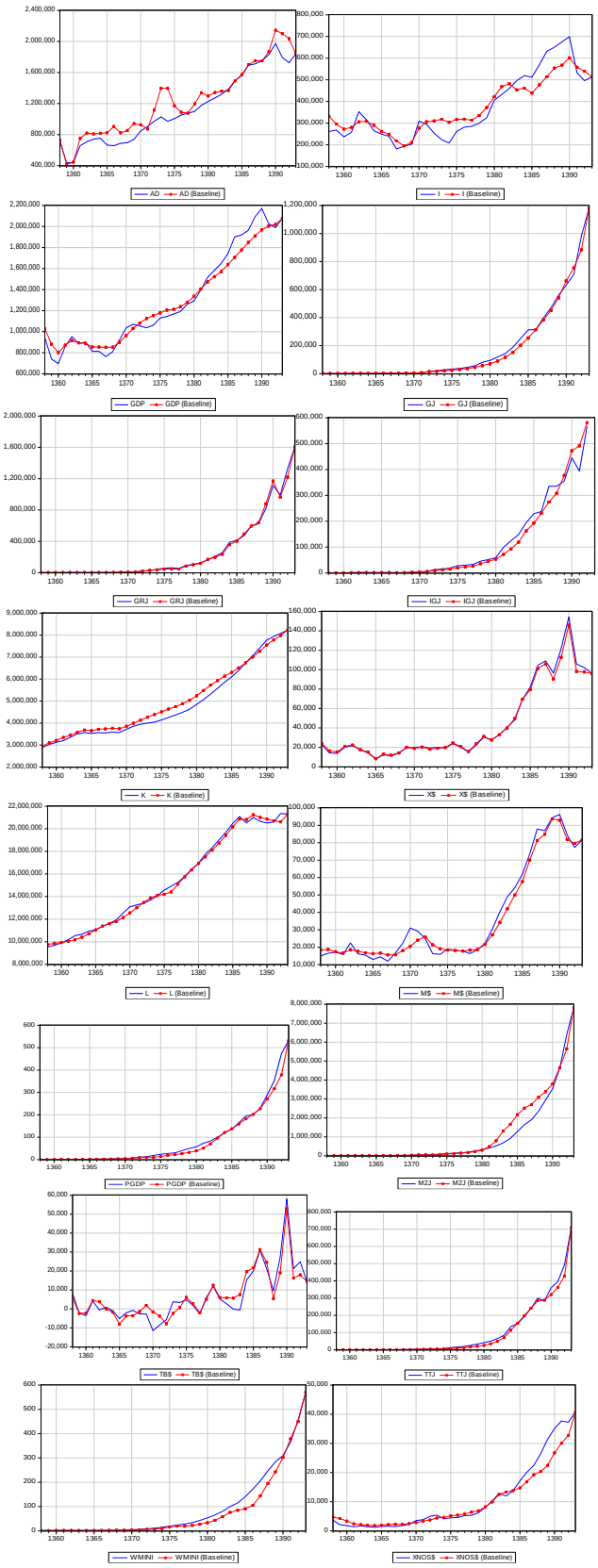


Fig. 1. results of the quantitative measurement of the model's validity

To investigate the effect of changes in household penetration on major macroeconomic variables, we have two scenarios ahead. We will discuss the effects of these two scenarios on major macroeconomic variables below.

4.1. The First Scenario: a Gradual Increase in Household Penetration Rates

Scenario 1 is designed with the assumption that household penetration rate is 37.85 percent at the end of year 93 and following the first goal, household penetration should increase 4.049 percent annually from the first year to the third year. Therefore, it can reach 50 percent at the end of the third year. Also, from the fourth to sixth year, the penetration rate should reach 70 percent at the end of the sixth year with the annual growth of 6.667 percent and penetration rate approaches 100% from the seventh to the tenth years with an annual growth of 6 percent.

The results indicate that production has increased in the early years of the period but in the middle and last years it has decreased 1.6 percent on average. In the same way, employment increases at the beginning of the period, and then begins to downtrend and decreases 0.2 percent on average compared to the baseline at the end of the period.

Given the further reduction of production compared to employment, labor productivity reduces1.4 percent on average during the period. The total investment also reduces 2.1 percent on average and non-oil trade balance will be worse. The reaction of the variables of production, employment, productivity, trade balance, private investment and total investment in relation to a gradual increase in household penetration rates is shown in Table 1. The movement process of the most important variables of the model has been provided according to the baseline simulated quantities and simulated values of these variables compared to baseline after penetration changes in the related diagrams for a period of 11 years. These diagrams have been included in Fig. 2.

4.2. The Second Scenario: A Sudden Increase in Household Penetration Rates

The second scenario has been designed with the assumption that household penetration rate is 37.85 percent by the end of year 93 and based on the primary objective, it should reach 50% by the end of the third year, 70 percent by the end of the sixth year and 100% by the end of the tenth year. So, we will increase the penetration rate 12.147 percent at the first year suddenly and we will fix it by the end of the third year. Then, we will increase it 20% in the fourth year and we will hold it fixed by the end of the sixth year. And finally, we will increase it 30% in the seventh year and will keep it fixed by the end of the tenth year.

The results suggest that production, employment and productivity have increased with an upward movement and almost similarly 13.4, 1 and 12.3% on average, respectively compared to the baseline trend. Investment and trade balance have also been improved. The reaction of the variables of production, employment, productivity, trade balance, private investment and total investment in relation to a gradual increase in household penetration rates is shown in Table 1. The movement process of the most important variables of the model has been provided according to the baseline simulated quantities and simulated values of these variables compared to baseline after penetration changes in the related diagrams for a period of 11 years.

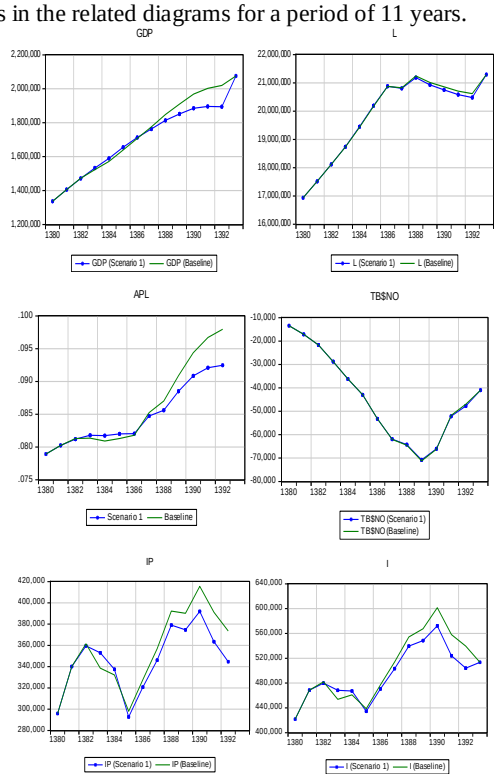


Fig 2. Scenario 1 analytic results

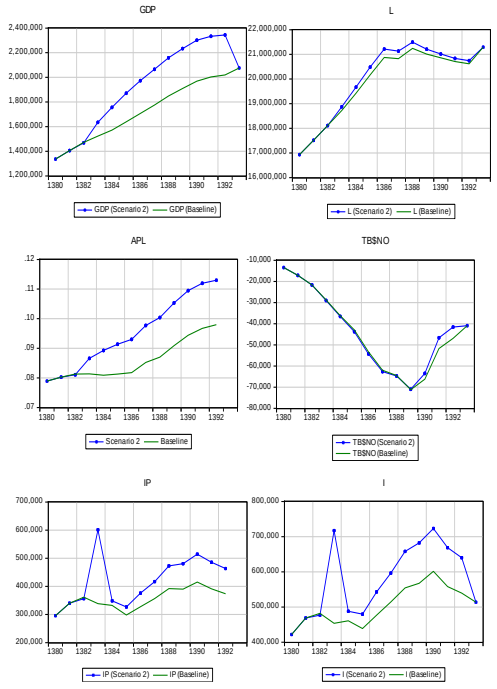


Fig 3. Scenario 2 analytic results

5. Conclusion

The primary aim of this study was to evaluate the effects of broad-band penetration on the main macroeconomic variables. To check this, we have set a structural macro-econometric model. This model has 9 pairs of behavioral equations, 14 communication equations and 42 definition equations. For the estimation of model's coefficients, we have used the ARDL model and time series data from years 1358 to 1393 at constant prices in 1383. Then, the model validity test has been done by using dynamic simulations. To this end, Theil Inequality Index (U) and the root square mean of relative error have been used by the model for the recognition of the movement process of the endogenous variables.

The results suggest that the regulatory model can easily trace the variables' movement process in the studied area. This result implies that the regulatory model is valid. after making sure about model's accuracy, in order to observe the effects of broadband penetration changes, two scenarios were examined with regard to the proposed quantitative targets in the development document of the national information network infrastructure, (the quantitative target of the households' broadband penetration should be 50 percent by the end of year 96, 70 percent by the end of 99 and 100 percent by the end of 1404).

According to Scenario 1 (a gradual increase in household penetration rate) and considering the quantitative objects, from the first year to the third, household penetration rate increases 4.049 percent annually, it increases 6.667 percent from the fourth to the sixth year annually and the penetration rate reaches 100% from the seventh to the tenth year with an annual growth of 6%.

The results suggest that production has increased in the early years of the period but it decreases in the middle and final years in a way that it decreases 1.6 percent on average at the end of the period. Employment also increases at the beginning of the period, and then begins to downtrend and decrease. It decreases 0.2 percent on average compared to the baseline at the end of the period. Considering the further reduction of production compared to employment, labor productivity reduces 1.4 percent on average during the period. The total investment reduces 2.1 percent on average and non-oil trade balance will become worse.

Based on Scenario 2 (a sudden increase in household penetration rates) and considering the quantitative objectives, we have increased the penetration rate 12.147 percent in the first year suddenly and have kept it fixed by the end of the third year. Then, we have increased it 20 percent in the fourth year and held it fixed by the end of the sixth year. Finally, we have increased it 30 percent in the seventh year and have kept it fixed by the end of the tenth year until it reaches 100 percent.

The results indicate that production, employment and productivity in an upward movement and almost similarly have increased 13.4, 1 and 12.3% on average, respectively, compared to the baseline. And investment along with trade balance has improved.

Drawing on the results of these two scenarios (gradual and sudden increase in broadband penetration), it is suggested that for the broadband penetration to have a better impact on the country's economy, we should apply the sudden increase policy of broadband. This is because with the sudden expansion of the broadband, the jobs based on broadband technology develop and they form a larger proportion of value-added of the country's economy over time. And this in turn brings about the increase in production as well as the employment of these sectors. Besides, a sudden increase in broadband penetration causes the jobs that aren't based on broadband technology to change their strategy and moved toward the use of broadband services. Of course, this change in strategy may have negative effects on employment and production in the short-run but it brings about the increase in the production and employment of these jobs in long-run. In sum, the results suggest that a gradual increase in penetration rate will have negative effects on macro-economic variables whereas the sudden increase in penetration rate will have positive effects in the long-run.

References

www.itu.int Central Bank of the Islamic Republic of Iran. Information Technology Organization of Iran, 1393. Iran information community report. Specialized agency site of the United Nations Information and Communication Technology, Retrieved from. Balance sheet and financial reports. Tehran.

Noferesti, M. & Arabmazar, A. (1373). A macro-econometric model for Iran, J*ournal of Research and Economic Policy*, Second Year, No. 1.

Information Technology Organization of Iran, the status of Information and Communication Technology development in the country in terms of statistics and figures at a glance, between 1393 and 1394.

Dargahi, H. (2005). macro-econometric mode:Iranian industry and future economic (industrial development strategy, Volume VI). Tehran: Sharif University of Technology Institute of Scientific Publications.

Noferesti, M. (1378). Unit root and cointegration in econometrics, raca publishment.

Noferesti, M. (1379). "Analysis the effects of monetary and exchange rate policies by cointegration methodology in the framework of a dynamic macro-econometric model," PhD thesis, shahid Beheshti University.

Noferesti, M. (1382). The effect of monetary and exchange rate policies on Iran's economy in the context of a dynamic macro-econometric model, *Journal of Economic Research*, No. 70.

OECD countries site. Retrieved from oecd.org.

www.amar.org.ir. Website of Iran Statistical Centre Retrieved from oecd.org

Mahmoudzadeh, M. (1388), the effects of ICT on the productivity of factors's production in Iran. *Journal of Management*, 2, pp. 107-130.

Central Bank of the Islamic Republic of Iran. (n.d.). Retrieved from www.cbi.ir

Central Bank of the Islamic Republic of Iran. balance sheet and financial reports. Tehran.

World Bank site. Retrieved from world bank.

Committed to connecting the world. (n.d.). Retrieved from www.itu.int

Information Technology Organization of Iran. (2014). the Iranian intelligence community monitoring report.

Katz, D. R. (2010). DATA REQUIREMENTS TO MEASURE THE ECONOMIC. 8th World Telecommunication/ICT.

Minges, M. (2015). Exploring the Relationship between Broadband and Economics Growth. World Development Report 2016: Digital Dividends.

World Bank. (n.d.). Retrieved from www.worldbank.orh

Atkinson, R., Castro, D. & Ezell, S.J. (2009). The digital road to recovery: a stimulus plan to create jobs, boost productivity and revitalize America. The Information Technology and Innovation Foundation, Washington, DC.

Cardona, M., Schwarz, A., Yurtoglu, B. B., & Zulehner, C. (2009). Demand estimation and market definition for broadband Internet services. *Journal of Regulatory Economics*, 35(1), 70-95.

Crandall, R. W., Lehr, W., & Litan, R. E. (2007). The effects of broadband deployment on output and employment: a cross-sectional analysis of US data. Brookings Institution.

Crandall, R., Jackson, C., & Singer, H. (2003). The Effect of Ubiquitous Broadband Adoption on Investment, Jobs, and the U.S. Economy. Washington DC: Criterion Economics.

Gurara, D. Z. (2013). A Macroeconometric Model for Rwanda. African Development Bank Group.

Hu, W. M., & Prieger, J. E. (2005). New Estimates of Broadband Supply and Demand.

Katz, R. (2009). 'Estimating broadband demand and its economic impact in Latin America. Proc. 3rd ACORN-REDECOM, 1-20.

Katz, R. (2012). The impact of broadband on the economy: Research to date and policy issues. Broadband Series.

Katz, R. L., Zenhäusern, P. & Suter, S. (2008). An evaluation of socio-economic impact of a fiber network in Switzerland. Polynomics and Telecom Advisory Services, LLC.

Katz, R., L. & Suter, S. (2009). Estimating the economic impact of the broadband stimulus plan (Columbia Institute for Tele-Information Working Paper). Retrieved from http://www.elinoam.com/raulkatz/Dr_Raul_Katz_-_BB_Stimulus_Working_Paper.pdf

Liebenau, J., Atkinson, R. D., Kärrberg, P., Castro, D. & Ezell, S. J. (2009, April 29). The UK's Digital Road to Recovery. Retrieved from: http://ssrn.com/abstract=1396687

Katz, R. L., Vaterlaus, S., Zenhäusern, P. & Suter, S. (2010). The Impact of Broadband on Jobs and the German Economy. *Intereconomics*, 45 (1), 26-34.

Raul L. Katz. (2010). Data Requirements to Measure The Economic Impact of broadband, 8th World Telecommunication/ICT Indicators Meeting of the International Telecommunication Union held in Geneva, Switzerland on November 24-26.

Tancioni, M., & Simonetti, R. (2002). A macroeconometric model for the analysis of the impact of technological change and trade on employment. *Journal of Interdisciplinary Economics*,13(1-3), 185-221.

Thompson, Herbert, and Christopher Garbacz. (2008). "Broadband Impacts on State GDP: Direct and Indirect Impacts." In 17th Biennial Conference of the International Tele-communications Society, Montreal, June 24-27., 1–17. http://www.imaginar.org/taller/its2008/62.pdf.

Zaballos, Antonio García, and Rubén López-Rivas. (2012). Socioeconomic Impact of Broadband in Latin American and Caribbean Countries. Inter-American Development Bank. http://publications.iadb.org/handle/11319/5754?localeattribute.