DESIGN OF A CGE MODEL TO EVALUATE INVESTMENT IN TRANSPORT INFRASTRUCTURES: AN APPLICATION FOR IRAN

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ABSTRACT

The present paper attempts to design a country scale Computational General Equilibrium (CGE) model to assessment the effects of investment in transport infrastructure. Unlike the previous studies, our model covers impacts of infrastructure expansion on time travel and efficiency of transport capital, simultaneously. After designing, using Iran's Social Accounting Matrix (SAM) data we apply the model for evaluating the impacts of infrastructure expansion in different modes of transport. Simulation results show that investment in railways has the most effects on Iran's economic growth and employment than other modes. On the other hand, our results also show that investment in roads can affect household's welfare more than other infrastructure expansions.

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Keywords: Investment, Transport infrastructure, Congestion, CGE model.

JEL Classification: R42, R53.

Contribution/ Originality

This study contributes in the existing literature by make a country level model that covers impacts of infrastructure expansion on time travel and efficiency of transport capital, simultaneously.

1. INTRODUCTION

Transportation is an economic activity that provides the possibility of movement for man or goods and always has been demanded. Most of economic activities require some (goods or man) movement. Labor and other production inputs must be moved from their sources to production site. On the other hand, products must be delivered to markets and this stage also requires transportation services. Households' consumption and its recreation usually will not be completed without movement. Transportation and its evolution have a basic role in specialization, efficiency promotion and international trade development. Many of advantages may not be utilised without transportation, hence it is clear that transportation significantly promote welfare of mankind societies.

In the economics literature we can find abundant stress to importance of transportation and its infrastructure in economic development process. For example, Rosenstein-Rodan (1943) pointed that investment in transport infrastructures is one of the ways to realization big push theory. He stressed on transport as basic industry and stated that "Let us build railways, roads, canals, hydro-electric power-station, the rest will follow automatically"(Rosenstein-Rodan, 1943).

However, provision of transport services need to main elements of transport. Elements of transport are consisting of transport vehicle, energy, labor and infrastructure. Among of these elements infrastructure is the most expensive and the most durable production input that it used to provision of transport services. In the transport sector infrastructure includes roads, railways, canals, ports, airports, communications (e.g. air traffic control) and terminals (Banister and Berechman, 2001). Insufficient transport infrastructure results in congestion, delay delivery time, fuel waste, pollution and accident (Siddiqui, 2008). These problems reduce economic efficiency and social welfare. The main constraint that limits supply of transport services is infrastructure inadequacy. High cost of infrastructure expansion and the public nature of this element of transport cause that the private sector be reluctant to invest in this part of economy. Hence, in the most cases, government is the responsible to build this element of transport. Nonetheless, it is obvious that governments of all countries face with financial constraints and they have to make some choices between various projects and then allocate their financial resources.

In the literature we can find a range of methods to evaluate impacts of transport infrastructure on economy. These analytical methods usually classified in three categories: micro-scale (microeconomic), macro-scale (macroeconomic) and meso-scale (general equilibrium) methods. As we explain in the following section, each of these methods has some advantages and drawbacks. However, abilities of meso-scale method to trace the broader impacts of infrastructure expansion on one hand, and development of computational tools on the other hand, have caused that a large number of researches in recent decades employ this method. In line with such studies, we design a new framework of Computational General Equilibrium (CGE) model to assessment the broader consequences of transport infrastructure expansion. After designing, we use this model to quantify impacts of such investments in four mode of transport (consist of air, road, railway and water) in Iran. The rest of this paper organized as follows: section 2 reviews literature and section 3 presents

detail of designed CGE model. Section 4 devoted to calibration's issues, section 5 present simulation results and finally section 6 is devoted to conclusions and Policy Implications.

2. EMPIRICAL LITERATURE

As we noted in previous section, evaluation the investment in transport infrastructure performed by three methods: microeconomic, macroeconomic and general equilibrium methods. This section provides a short review of literature of these methods.

2.1. Microeconomic Method

This method focuses on the improvements in the productivity of individual firms due to such investments and Cost-Benefit Analysis (CBA) is the favored tool for this method (Lakshmanan, 2011). This method assumes that infrastructure improvement will shift the supply curve of trips, this leads to changes in price and quantity in trip market and therefore consumer surplus will change. The variation of consumer surplus is the main measurement of microeconomic method to assessing the effects of infrastructure improvement. However, it is argued that this method does not capture some impacts of such investment and have some major weakness (see Jones *et al.* (2014)). Sue Wing *et al.* (2008) argue that this method is more appropriate for assessing individual projects than for assessing a program of infrastructure spending. Due to our research objective, we can conclude that this method is not suitable for our purpose.

2.2. Macroeconomic Method

Another approach to evaluate impacts of infrastructure expansion is macroeconomic method. This method is based on econometric estimations. It is argued that where infrastructure is inadequate, the firms are confronted by high marginal costs at every level of production, therefore when infrastructure improves marginal cost decrease and its curve shift to a lower level. For a given level of production, these changes led to cost saving and for a given level of cost, production will increase. These two consequences at national or regional scale are the bases of regressions that used to evaluate impacts of infrastructure expansion. Some studies like Aschauer (1989) according to production increase, add transport infrastructure proxy as an additional variable to country (or region) total product regression. The coefficient of this new explanatory variable is a measurement of total impacts of investment in transport infrastructure. According to cost reduction and duality theory, some other studies like Nadiri Ishaq and Mamuneas (1996) estimate a cost function and add transport infrastructure proxy as an additional variable. This method is based on the infrastructure proxy's coefficient in cost regression to assessment impacts of transport infrastructure expansion.

Because that the application of macroeconomic method is simple and its data requirement is not problematic, there are a large number of studies that used this method. For example, Mera (1973), Ratner (1983), Wigran (1984), Elhance and Lakshmanan (1988), Aschauer (1989), Munnell (1992), Nadiri Ishaq and Mamuneas (1996), Canning (1999), Bonaglia and Ferrara (2000), Mousavi Jahromi and Ebadati Fard (2006) and Daei Krim Zade *et al.* (2007) are some of studies

that use macroeconomic approach to evaluate impacts of transport infrastructure expansion. However, some critics raise about this method of assessment. The main critic is that macroeconomic method doesn't describe the ways through which transport infrastructure finally led to economic growth, clearly. For this reason, this method sometimes called black-box. Another limitation of macro-level studies is that they treat transportation infrastructure as a homogeneous good that can be measured in dollar terms (Sue Wing *et al.*, 2008). However, general equilibrium model and its applied form (e.g. Computable General Equilibrium (CGE)) can correct some drawbacks of earlier methods.

2.3. General Equilibrium Method

Drawbacks of previous methods and development of computational tools has led to some studies in the last two decades tend to use of general equilibrium method, especially in developed countries. Mayeres and Proost (1997) designed a CGE model based on congestion concept. These researchers model a simple economy with a utility maximizing household and two profit maximizing firms. In their model investment in transport infrastructure (via congestion mitigation) increase both firm productivity and quality of household's services.

Conrad (1997) and Conrad and Heng (2002) design a large scale dynamic recursive CGE to determine optimal investment in the infrastructure. Their model consists of a utility maximizing representative household and a group of firms. In this model one firm produce transport services and capital stock of each firm is divided into two parts: mobile capital and transportation capital (this type of capital represent vehicles). These researchers assume that investment in transport infrastructure directly and indirectly (via congestion reduction) promote efficiency of transportation capital. It seems that this model has two main drawbacks: first, the model doesn't include time saving that arise from infrastructure expansion and the second, data requirements of model are problematic for developing countries.

Parry and Bento (2001; 2002) built a model in which congested modes' travel time determine endogenously and representative household faced with time and financial constraints. In this model infrastructure expansion reduce travel time and therefore, increase labor supply and finally increase production. This study does not include the effects of infrastructure expansion on transport capital efficiency. Siddiqui (2008) using Conrad and Heng model, evaluate the impact of public investment to improve transport services on the Pakistan economy. This study includes both direct costs and indirect costs (externalities) of transportation. In this study benefits of infrastructure expansion are measured by price variation in all sectors of economy. Like Conrad and Heng (2002), this study has ignored the time savings that arise from investing in transport infrastructures.

Sue Wing *et al.* (2008) design a highly detailed CGE model for the evaluation of transport infrastructure investment. In practice, empirical use of this model in developing countries seems hard, because the model requires a large volume of micro data which hardly can be obtained in such countries. This study also does not include the effects of infrastructure expansion on transport capital efficiency.

A review of these studies shows that none of above mentioned studies includes all potential impacts of transport infrastructure expansions simultaneously. To fill this gap, it is possible to combine the two ideas to build a more complete model for evaluating effects of investment in transport infrastructure. First idea is that infrastructure expansion increase efficiency of transport capital even in non congested modes. This idea is taken from Conrad and Heng (2002), they argued that "An extended network of roads between major industrial areas and cities and a better connection between the modes of transportation improves the efficiency of the stock of vehicles in terms of a factor augmenting effect. This aspect holds for any country, irrespectively whether there is congestion in terms of bottlenecks at certain times of the day".

Second idea is that in congested modes infrastructure expansion reduces travel time and therefore improves labor supply of household. This idea is more familiar and has been used in many of previous studies (for example Parry and Bento (2001; 2002) and Sue Wing *et al.* (2008)).

This paper will attempt to encompass both noted ideas within a CGE framework and then apply the final model to assessment the impacts of infrastructure expansion in Iran.

3. MODEL

The general assumptions of our model are the following: the model consists of a representative household, four transport sectors (i.e. road, air, railway and water transport) and three non-transport sectors (i.e. manufacture, agriculture and non transport services). The model also includes two production factors (labor and capital), government and external sector (i.e. export and import). We assume that conditions of perfect competition market are satisfied, all the production functions have constant return to scale and all prices and wages are flexible.

3.1. Household

Initially we divide firm and commodities in two groups, i non-transport producers and their associated goods and services, which we index using the subscript $i = \{agriculture, manufacture\ and\ non - transport\ services\}$, and j transport producer and their associated services which we index using the subscript $j = \{road, railway, water\ and\ air\}$. we also assigned factors by subscript k and hence (F_k) and (W_k) refer to their endowments and prices, respectively.

We assume that representative household has a utility function as follow:

$U =$

$$\prod_i C_i^{\alpha_i} \prod_j Tr_j^{\beta_j} \tag{1}$$

Where (1) show that household obtain utility (U) from non-transport commodities (C_i) and transport services (Tr_j) and (α_i), (β_j) are share parameters.

Representative household faces with two constraints, consist of time and financial as follow:

$$\sum_{i}(1 + \tau_i^C)P_i^C C_i + \sum_{j}(1 + \tau_j^C)P_j^T Tr_j$$

$$= (1 - s^h)(1 - \tau^{inc})\left(\sum_{k} \varphi_k W_k F_k + TP\right) \qquad (2)$$

$$F_L + l + \sum_{j} \emptyset_j Tr_j$$

$$= \bar{T} \qquad (3)$$

In equation (2), (P_i^C) and (P_j^T) are the producer prices of non-transport commodities and transport services respectively, (τ_i^C) and (τ_j^C) are corresponding production tax rates. (s^h) is saving rate of household, (τ^{inc}) is income tax rate, (TP) is total transfer payments that household receives and (φ_k) is the share of household of k-th factor revenues. In equation (3), (F_L) is labor supply of household, (l) is leisure time, $(\emptyset_j)$ is the travel time of j-th mode and $(\bar{T})$ is time endowment of household. We assume that the time travel of non-congested modes are exogenous and not affected by stock of infrastructure, but in congested modes travel time is endogenous and vary with stock of infrastructure as follow:

$$\emptyset_j = \emptyset_j^0\left[1 + 0.15\left(\frac{Tr_j^T}{CAP_j}\right)^4\right], \qquad (4)$$

In this equation[1] $(\emptyset_j^0)$ is the time travel when there are no other vehicle, Tr_j^T is the sum of household and producers demand for j-th mode of transport and CAP_j is a measure of roads capacity. This relationship makes it possible that, infrastructure expansion led to time travel reduction and finally labor supply will be affected.

3.2. Producers

As we noted above, producer is divided in two groups: transport services provider and non-transport commodity producer. Producers' behavior will be described in following.

3.2.1. Transport Producers

The main step in describing transport producers' behavior is developing a production function for each mode of transport. Inputs that are required in transport production process can be classified to three categories: labor, capital and intermediate inputs. We assume that labor and intermediate inputs without any special consideration enter to production function, complementarily. But capital input that is required in transport sector has special characters. This input consists of two elements, vehicles and infrastructure, and their features are quite different[2]. The connection of these two elements together and their relation with output is the main question. Conrad and Heng (2002) introduce a pattern that describes the connection between these two elements of transport capital input. They assume that expansion of infrastructure stock (KI) increase efficient capital transport

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[1] It is known as the Bureau of Public Roads (BPR) function Small and Verhoef (2007).

[2] For more detail see Button (2010).

(KT) even in uncongested modes. In their discussion, capital transport refers to transport vehicles and the relation is as follow:

$$KT_j = KT_j\left(KT_j^0, KI_j\right)$$

$$= KT_j^0 . \exp\left(-\frac{\alpha_j}{KI_j}\right) \tag{5}$$

Where $\alpha_j > 0$, KT_j^0 is the stock of transport capital of j-th mode. This equation shows that the service of transport capital is proportional to the stock and it can be improved by a better provision of infrastructure. Due to the non-optimal provision of infrastructure, firms are compelled to keep a higher stock of transportation capital, KT_0, than required when there would be an efficient provision of infrastructure (Conrad and Heng, 2002)

In congested modes it is expected that infrastructure expansion be more effective due to lower the index of congestion Z. in other words, in congested modes infrastructure expansion affect efficient transport capital in two ways. First, according to equation (5), an extended network and a better connection between the modes of transportation improves the efficiency of the stock of vehicles in terms of a factor augmenting effect, this relation holds, irrespectively whether there is congestion or not. Second, in congested modes infrastructure expansion will lower congestion and this effect reinforces the former effect. To encompass this additional effect of infrastructure expansion in congested modes we use of the following relation:

$$KT_j^e$$

$$= KT_j . Z^{\varepsilon_{KT_j^e,Z}} \tag{6}$$

Where $\varepsilon_{KT_j^e,Z} < 0$ is the elasticity of effective capital with respect to Z. The higher is Z, the less productive is the transportation capital. In equation (6) KT_j^e is effective transport capital in congested modes. Inspired by the study Conrad and Heng (2002) we define an index for congestion as follow:

$$Z = \frac{KT_j^0}{KT_j^*}$$

$$\geq 1 \tag{7}$$

Where KT_j^* is the optimal stock of transport capital that minimizes the transport cost of producer (for current level of output) with optimal provision of infrastructure and KT_j^0 is the current level of capital stock. Because in congested modes transport capital stock that is required to produce current level of output in the presence of optimal level of infrastructure is less than current stock of transport capital, therefore, this index is greater than unity. In other words, congestion decrease efficiency of each unit of transport capital and hence, to produce a given level of output more transport capital is needed than optimal situation. The final point is that Z for uncongested modes is equal to unity and therefore $KT_j^e = KT_j$.

After determination the relation between infrastructure and vehicles (transport capital) as two elements of transport capital input we must specify transport production function. Low substitutability between inputs in transport sector is a plausible justification to employ a Leontief-

type production function. Therefore, we specify production functions of different modes of transport as follow:

$$Q_j^{Tr} = min\left\{\frac{C_j}{\alpha_{c,j}}, \frac{F_j^L}{\alpha_{Lj}}, \frac{KT_j^e}{\alpha_{Kj}}\right\} \tag{8}$$

Where Q_j^{Tr} is output of j-th mode of transport and C_j is output of other sectors that is used in this sector as intermediate input. Symbol F_j^L refers to labor and α's are input requirement coefficients.

3.2.2. Non-Transport Producer

In this study we use a nesting technology and divide production process into two stages. in the first stage, we define two sub-processes and in first sub-process, capital and labor are used for the production of a composite factor (value added). In the second sub-process of first stage, different modes of transport used by each non-transport producers make a composite transport input. We assume that both of aggregator functions in two sub-processes have constant elasticity of substitution (CES) specification. in the second stage, value added and composite transport input combine with intermediate inputs to produce final output of each non-transport producers. Production function at this stage is as follow:

$$Q_i = min\left\{\frac{C_i}{\alpha_{c,i}}, \frac{Y_i}{\alpha_{i,Y}}, \frac{Y_i^{Tr}}{\alpha_{i,Tr}}\right\} \tag{9}$$

Where Q_i is output of i-th non-transport producer and C_i is output of other sectors that is used in this sector as intermediate input. Symbols Y_i and Y_i^{Tr} refer to value added and composite transport input, respectively, and α's are input requirement coefficients.

3.3. Government

The government is one of the major agents that could affect the economy of any country by financial power and Legal authorities. So, to create a realistic general equilibrium model, the government should be included as a main agent. It is more important in this study for two reasons. First, in Iran and the other countries with abundant natural resources, revenues from the natural resources export give the ability to the governments to financially intervene in the economy more than other governments. They make high volume of final demand in the goods and services markets and employ the considerable share of labor force; hence one could not ignore the economic role of the government of these countries in a realistic analysis. The second is just related to special subject of this study. Transport infrastructures are often introduced as public goods, so due to the lack of excludability character, they are essentially created by the governments. Thus the government, as main investor of transport infrastructures, should be in the model. Review of studies in the field of general equilibrium modeling suggests that there is no consensus on the describing of the government behavior. Hosoe *et al.* (2010) noted that there is no single perfect way

of modeling the government activities from the viewpoint of microfoundations as we have modeled the behavior of the household and the firms based on their microfoundations. They believed that the availability of data or sometimes the preferences of the modeler are the main factors in the modeling of government behavior.

In this study, the government earns its revenue by tax on the household income, import tariffs, taxes on production and sale of services of capital that it owns. Also the government of Iran due to the ownership of oil and gas revenues, could spend without relying on tax revenues, this is included in the model by possibility of negative savings for the government. In the expenditure side, the government is one of the final buyers of goods and services and also pays some transfer payment to households.

3.4. Investment and Saving

During the period from 1959 to 2010, on the average, more than 31% of GDP of Iran is spent on the investment. In general equilibrium analysis typically is assumed that a virtual agent make all investment decisions. Funds are provided for investment by household, government and foreign savings. We also follow this pattern and assume a virtual agent collecting savings in the economy and spending them on purchases of investment goods. We assume that investment purchases of each sector are a constant proportion of the total investment.

3.5. International Trade

Like many of analyzes about the Iran economy, we also assume that Iran is a small country in international markets. To reach import demand functions, using common assumption of Armington (1969), we assume that domestic goods and imported goods are imperfectly substitutable with each other. Also to check the supply side of international trade, we use a function with a constant elasticity of transformation between exports and domestic market supply and thus, we get the export supply functions for each sector.

3.6. Market-Clearing Conditions

An equality condition of supply and demand is embedded in the model for each market of goods and services. For transport capital market of each mode of transport, a clearing condition is specified. Therefore, it is assumed that transport capital is mode-specific and could not transfer to the other transport and non-transport sectors. But in the case of non-transport sectors it is assumed that capital is mobile between them. In the other words, it is assumed that capital in the non-transport sectors is homogeneous. The final condition is the market clearing condition for the labor market that because of unemployment rate of 11 percent in the 2006 in Iran, it is assumed that the total employment in the model could be 11% more than what employed in the base year (2006) without any change in wages.

4. CALIBRATION OF MODEL

The model is built around Iran's social accounting matrix (SAM) for the year 2006. This SAM is latest version of Iran's SAM that officially published at 2013 by Islamic Parliament Research Center[3]. In Iran, like other developing countries Input-Output (IO) tables and SAM constructed once every several years and as Hosoe *et al.* (2010) argued we often have to use IO tables and SAMs that are several years old.

by Our model is designed in a way that most of the parameters in it simply calibrate by using the information of the SAM. But some parameters of the model do not calibrate by the standard general equilibrium model and the information of the SAM. In this section, we focus on these parameters.

Leisure time (l) is considered as a fixed amount before and after the change in the stock of infrastructure. Parameters of ($\emptyset_j$) for all modes of transport are equal to unity in the base run equilibrium. We assume that road transport is the only congested mode of transport and for this mode the ratio of ($\frac{\emptyset_j^0}{\emptyset_j}$) in the base run equilibrium is considered equal to 0.95[4]. Given to this ratio and the information of SAM, amount of (CAP_j) is obtained for road transport. On the parameters of equation (5) should also be noted that (KI_j) is considered as an indicator of the stock of transport infrastructure. Note that the units of these indicators are not necessarily the same for different modes of transport but infrastructure shocks and infrastructure stock proxies must have necessarily the same unit. For example, (KI_j) for the rail transport is considered as the total length of the railways in Iran and increase in the stock of rail infrastructure, in the main scenario of study, is imposed on the model as an increase in the railway length. We also like Conrad and Heng (2002) and Siddiqui (2008) assume the ratio of efficient transport capital to transport capital in the base year ($\frac{KT_j}{KT_j^0}$) for all modes of transport is equal to 0.9 and in this way we obtain (α_j) for each mode of transport. Then, by (α_j) for each kind, we calculate changes in the ratio of ($\frac{KT_j}{KT_j^0}$) by change in the volume of infrastructure. About equation (6), congestion index (Z) for the road transport (as the only congested mode in the model) as follow as Conrad and Heng (2002) and Siddiqui (2008) assume to be 1.2 and ($\varepsilon_{KT_j^e,Z}$) is considered equal to -0.06 and also the elasticity of congestion to the volume of infrastructure assume to be -4.

5. SIMULATION RESULTS

The government of Iran recently announced that want to spend 1.5 billion dollars from the National Development Fund to expand transport infrastructures. So the scenario of this study for simulation of a change in the stock of transport infrastructure in each mode of transport is about 1.5

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[3] This SAM is available online: http://rc.majlis.ir/fa/report/show/827435

[4] However, in the sensitivity analysis we change this amount and test the results for 0.90 and 0.99 amounts.

billion dollars. This amount of the investment by using the information about the cost of latest infrastructure development projects implemented in Iran in each mode of transport transform to the shocks of infrastructure index into the existing stock of infrastructure. For example, exiting information indicates that in the 2006 in Iran, there was 11137 kilometers of railway and in the other hand, data of last projects of railway development in this country showed that in 2013 the cost of each kilometers of railway on average is about 1.550 million dollars. So with 1.5 billion dollars and due to more accurate data, an infrastructure shock about 964 kilometers railway imposed on the model. We follow the same way to define other modes infrastructure's shocks. It should be noted that these shocks are imposed on the model as the increase in the transport capital productivity of each mode.

Another point that should be mentioned is that investment in road transport infrastructure as the only congested mode in the Iran has three effects on the model and these effects should be simultaneously considered in the simulation. Increase in the stock of infrastructure in this mode, first cause the increase in the productivity of capital transport of itself that is the same to the other transport modes in the model. Second, some saving in travel time is created that cause reduction in the generalized cost of transport for household and ultimately, saving time lead to increase labor supply in the labor market. Hence, to impose road-specific shock, we tried to consider these three effects simultaneously. In the remaining part of text, we have tried to present some of major results of imposed shocks of 1.5 billion dollars on the stock of infrastructure of different modes of transport in tables (1) to (4).

Table (1) reports the results of the model after the imposition of shock on the water mode transport infrastructure. The results indicate that changes in water mode transport infrastructure could not have significant impacts on the major macroeconomic variables (such as public welfare and economic growth). The most important effects created as the results of the increasing in the stock of water transport infrastructure are reduction in the demand of road transport and also reduction the consumer prices level of all goods and services in the model (especially the price of water transport services).

Table-1. Percent of changes in the macroeconomic variables after the shock in infrastructure of water transport

	Total economy	Rail transport	Road transport	Water transport	Air transport	Service sector	Industry sector	Agriculture sector
Employment	0.0007	-0.003	0.018	0.148	-0.0005	0.002	0.0002	-0.0006
Output	0.0005	-0.004	-2.864	0.043	-0.083	-0.229	-0.035	-0.133
Consumer Price Index	-0.073	-0.046	-0.074	-0.118	-0.087	-0.072	-0.080	-0.038
Household utility	0.0001	--	--	--	--	--	--	--

Table (2) shows the results of the imposition of a shock to the air transport infrastructure. as we could observe, the economic growth, employment and household welfare increase far greater than what change that occurred by water transport infrastructure expansion. Again, it is observed that similar to water transport, air transport could significantly reduce the burden of road transport demand.

Table-2. Percent of changes in the macroeconomic variables after the shock in infrastructure of air transport

	Total economy	Rail transport	Road transport	Water transport	Air transport	Service sector	Industry sector	Agriculture sector
Employment	0.003	-0.016	0.083	-0.0002	0.852	0.005	-0.0004	-0.001
Output	0.003	-0.016	-2.801	-0.104	0.768	-0.226	-0.036	-0.134
Consumer Price Index	-0.076	-0.046	-0.074	-0.058	-0.846	-0.074	-0.080	-0.038
Household utility	0.006	--	--	--	--	--	--	--

The results presented in table (3) show that investment in rail transport infrastructure could have the greatest impact on employment and economic growth and create greater drop in the consumer price index. The development of this mode of transport could also be the best alternative to road transport in the Iran.

Table-3. Percent of changes in the macroeconomic variables after the shock in infrastructure of rail transport

	Total economy	Rail transport	Road transport	Water transport	Air transport	Service sector	Industry sector	Agriculture sector
Employment	0.025	0.177	-0.057	-0.076	-0.034	0.013	0.015	0.008
Output	0.012	0.177	-2.937	-0.180	-0.117	-0.226	-0.029	-0.127
Consumer Price Index	-0.083	-0.289	-0.071	-0.067	-0.083	-0.070	-0.081	-0.040
Household utility	0.003	--	--	--	--	--	--	--

Results presented in table (4) indicate that investment in road infrastructure among other mode of transport has the greatest effect on household welfare and after the rail transport as a second best has the greatest impact on economic growth and employment.

Table-4. Percent of changes in the macroeconomic variables after the shock in infrastructure of road transport

	Total economy	Rail transport	Road transport	Water transport	Air transport	Service sector	Industry sector	Agriculture sector
Employment	0.020	0.0002	5.445	-0.034	-0.008	0.013	0.021	0.012
Output	0.011	-0.0001	2.407	-0.138	-0.090	-0.227	-0.026	-0.124
Consumer Price Index	-0.068	-0.043	-0.462	-0.051	-0.081	-0.068	-0.075	-0.036
Household utility	0.051	--	--	--	--	--	--	--

6. CONCLUDING REMARKS

In this study, we tried to design a computable general equilibrium model that is applicable in a country's scale and be able to determine priority of investment in the transport infrastructure among different modes. In the model that designed in this study, transport infrastructure affects the economy of a country through two canals. First, in the congested modes of transport, increase in the stock of infrastructure will reduce travel time and thus increase the disposable time stock of the society. Second, in all modes of transport, congested or uncongested, development of infrastructure cause increase in efficiency of capital transport but this effect in the congested modes is greater. After designing of the model, we tried to examine the scenario of 1.5 billion dollars increase in the stock of infrastructure of different modes of transport by the designed model and according to the results, priorities of investment in the transport infrastructure of Iran are determined. Results of simulations show that increase in the rail transport infrastructure in Iran could have the greatest

impact on the economic growth, job creating and reduction of general level of prices and then respectively road, air and water transport stand in second, third and fourth priorities. Also development of road transport infrastructure has greatest impact on the household welfare and after it, air, rail and water transport stand respectively. Our results are consistent with Iran's infrastructure patterns. Data of capacity and performance of different modes' infrastructures shows that Iran has excess supply in air and water transport. In the recent years a number of airports in Iran were without any business for much part of the year and many of seaports have used only part of its capacity. Our results confirm this situation and show that investment in roads and rails could affect economic growth much more than investment in other modes.

The results of this study have important policy implications for policy makers of Iran. According to the results of this paper we found that investment in the terrestrial mode of transport (such as rail and road) is associated with more economic growth and investment in water and air transport have not any significant impact on economic growth and employment. If the goal of policies is increase in the welfare, development of road transport infrastructure is the first priority of investment.

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