DETERMINING PRIORITIZED INDUSTRIES IN ĐÀ NẴNG VIA THE DYNAMIC COMPUTABLE GENERAL EQUILIBRIUM MODEL

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The Dynamic Computable General Equilibrium Model (hereinafter referred to as "Dynamic CGE Model") has been applied in many of countries in the world. It enables to study chronological impacts of investment policies on the local economic development based on various scenarios. This study is to investigate the application of the Dynamic CGE Model into finding certain industries which will bring in the optimum growth for Đà Nẵng City in the period 2011-2020. The interviews have proven that processing and trading are two industries with the pervasive impact on the municipal economy. Thus, if investments are poured into them, they will definitely generate favorable stimuli to the growth of production value and gross output of Đà Nẵng City. The industries of construction and hospitality, due to not having a close linkage with other industries of the city, have not generated a high pervasiveness.

Keywords: Dynamic CGE Model, prioritized industries

1. Introduction

To define a priority industry for investments takes an important role in establishing short- and long-term economic strategies. Over the past few years, many regions in Vietnam in particular and Đà Nẵng City in general have paid a great deal of attention to identification of priority industries so as to put forwards appropriate back-up policies. Đà Nẵng City is considered as the technical cultural economic hub of the Central Vietnam and Western Highlands. Of its 2009 gross output, the agriculture accounted for 3.56%, the industry made up 43.26% and the service sector 53.18%. In the time to come, the city will keep transforming its economy with a greater stress on the service sector. Nonetheless, measures employed to define priority industries are quite qualitative; and thus research results, in many cases, are not convincing enough.

The Dynamic CGE Model allows studying chronological impacts of exogenous elements (such as ups and downs of capital flows) on the economic growth of a country, territory or a certain region based on the close bond among industries and economic entities. Theoretically speaking, all industries of a territory have a close relationship with one another. The product of an industry may be used as a factor input for others and vice versa. Therefore, the rapid growth of an industry will entail an increase in the demand for products of other industries, thereby stimulating the growth of the economy as a whole. This growth of an industry, in its turn, will require more labor and capital thereby affecting other industries when sources of labor and capital are limited. Besides, consumer behaviors and saving strategies at service of future investments also sharply affect the economic growth in such both long and short run.

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In the dynamic CGE model, all of chain effect shall be simulated and calculated so as to foresee possible consequences via various scenarios.

By means of the Dynamic CGE Model, this study is to answer to the question of which industry, under the currency economic structure, will bring in the optimum growth for Đà Nẵng City in the period 2011-2020?" Findings of the research may contribute to policies on investment in Đà Nẵng City in the time to come; and may be referred to by those who are interested in the application of the CGE model into analyzing impacts of Vietnam's economic policies.

2. Basic structure of the dynamic CGE model

This part is to briefly summarize theoretical fundamentals of the Dynamic CGE Model. This method simulates the economy of a country or a region by means of econometric equations and the support of computers. The theoretical fundamentals of the model are based on studies by Dervis, de Melo, and Robinson (1982), by Vargas, Schreiner et al. (1999), by Hosoe (2001), by Chen (2004), and by Toàn (2006).

The Dynamic CGE Model is split into three equilibria as follows:

a. The dynamic equilibria:

- Spending/savings of households

It is presupposed that households always maximize both the long- and short-run utility. They always weigh up the allocation of income for consumptions against savings for future use with a view to maximizing the short-run utility at a certain period and the total present value of the gross utility in the future. To achieve that, the optimization problem for each household can be written as follows:

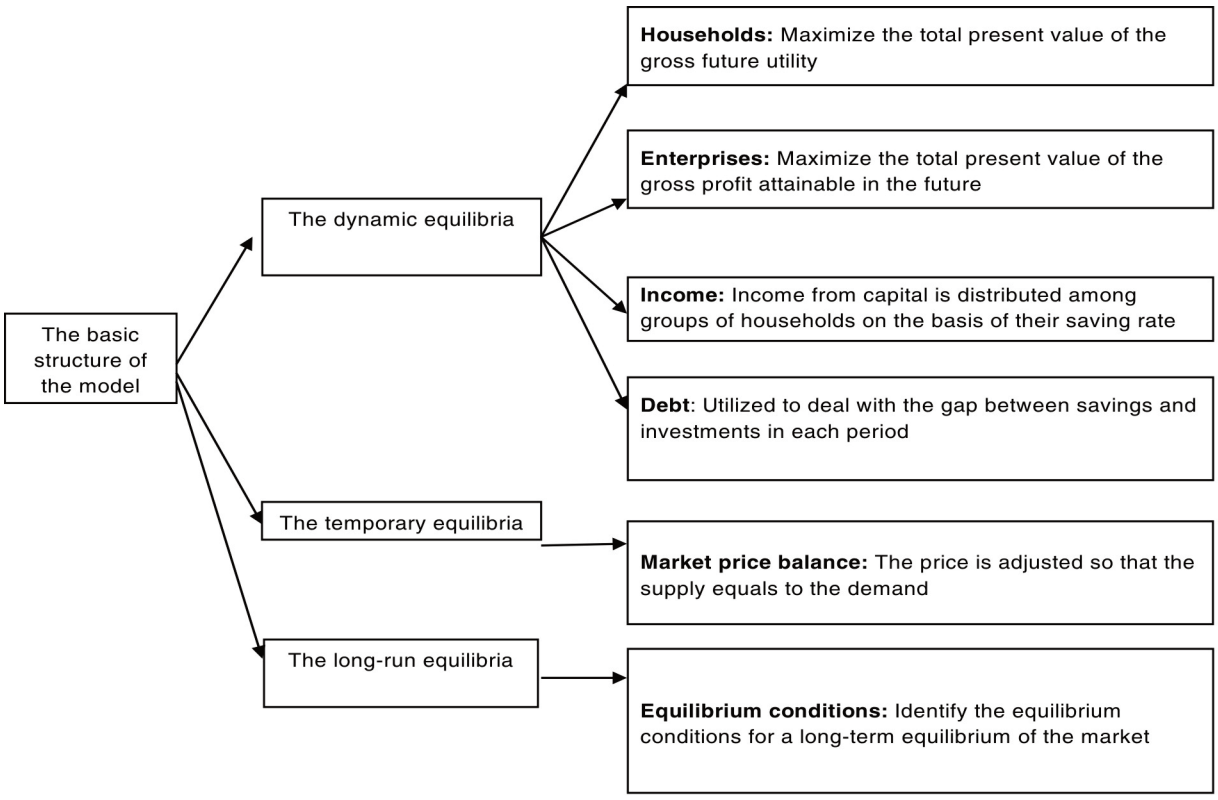

Figure 1: The basic structure of the Dynamic CGE Model

$$\sum_{t=1}^{\infty} N_{rt}\left(\frac{1}{1+\rho}\right)^{t} u(U_{rt})$$

It asks for:

$$\sum_{t=1}^{\infty} \mu(t) N_{rt} CPI_{rt} U_{rt} \le \sum_{t=1}^{\infty} \mu(t)(Y_{rt} - SAV_{rt} - i^{*} \cdot H\_DEBT_{rt})$$

Where, ρ is the positive parameter representing the discount rate of the inter-temporal utility, μ represents the utility at a time point, U_{rt} is the average consumption per capita of each household at the time t; CPI_t stands for the consumer price index; $CPI_{rt}U_{rt}$ is the gross spending of an individual in each group of households, Y_{rt} and SAV_{rt} are the gross income and savings per year of each group of households, $i^{*}\cdot H\_DEBT_{rt}$ represents the annual interest payment for external loans (from a foreign country or somewhere out of the surveyed region) made by each group of households, $\mu(t)$ is the discount coefficient of value flow from the time t in the future onto now, r_t is the interest rate at the time t.

By solving [1], we will work out conditions for households to divide their incomes into current spending and savings for future as follows:

$$\frac{Y_{r,t+1} - SAV_{r,t+1} - i^{*} \cdot H\_DEBT_{r,t+1}}{Y_{rt} - SAV_{rt} - i^{*} \cdot H\_DEBT_{rt}} = \left(\frac{1+r_{t+1}}{1+\rho}\right)(1+n)$$

- Enterprises and investment

Households hold the entire capital of the economy. However, in order to facilitate the research, it is presupposed that household investments are detached from their spending and savings and executed through an independent investor. The independent investor, on the ground of current economic conditions, defines an optimum amount of investment at each certain point of time so as to maximize the total present value of profits earned from investments; and then distributes such the earnings to the households. In each period, the cumulative capital of each industry is defined via differences between the amount of investment within the period and the depreciation level of this period. The investment problem can be written as follows:

$$V_{j0} = \sum_{t=0}^{\infty} \mu(t)(wk_{jt} K_{jt} - J_{jt})$$

It asks for:

$K_{j,t+1} - K_{jt} = I_{jt} - \delta_j K_{jt}$

Where, $\mu(t)$ is the discount coefficient of the cash flow, K_{jt} is the cumulative capital of the industry j at the time t, wk_j represents the cost of using capital, δ_j stands for the depreciation rate, I_{jt} is the increase in assets within the period, J_{jt} is the entire cost of investments within the period, q_{jt} is the shadow price of the present value, PI_t is the price of a basket of investments. By solving [2], it is possible to define the optimal amount of assets needed investing more in each period with a view to maximizing the manufacturers' profit in the long run. The formula of identifying the optimal amount of investment for each industry by time is as follows:

$$I_{jt} = \frac{K_{jt}}{2}\left(\frac{q_{jt}}{PI_t} - 1\right)$$

- External debts

In the model, the external debts are employed to make up for shortage in the investing capital and determined by the differences between the demand for the optimal investment in each period and the total savings of households and the State in the same period. The accumulative debt at a certain period of the economy is calculated as follows:

$$DEBT_t = DEBT_{t-1} + \left[\Sigma_j J_{jt} - \Sigma_r SAV_{rt} - s^{g} T_t (1 - tr^{p})\right]$$

With $\Sigma_j J_{jt} - \Sigma_r SAV_{rt} - s^{g} T_t (1 - tr^{p}) > 0$, it is necessary to borrow external capital for investment. Vice versa, with $\Sigma_j J_{jt} - \Sigma_r SAV_{rt} - s^{g} T_t (1 - tr^{p}) < 0$, the surplus savings will be utilized to cover partly external debts or investments. Assume that the debts of the economy are allocated to households in accordance with their saving rate, we have the following equation:

$$H\_DEBT_{rt} = H\_DEBT_{r,t-1} + \frac{SAV_{rt}}{\Sigma_r SAV_{rt}}\left[\Sigma_j J_{jt} - \Sigma_r SAV_{rt} - s^{g} T_t (1 - tr^{p})\right]$$

- The cumulative capital possessed by households

The economy comprises many groups of households; thus it is necessary to define the cumulative capital of both the entire economy in certain periods and households (H_Kstock_{ri}) as well. This is also a basic feature of the Dynamic CGE Model, that is, it includes many groups of households and is an important ground for allocation of capital-based incomes to households. In principle, the total cumulative capital of all households must equal to the cumulative capital of the economy of a country as a whole.

$$\Sigma_j K_{jt} = \Sigma_r H\_Kstock_{rt}$$

In this model, the investing capital of the whole economy is assumedly allocated to each group of households on the basis of their saving rate in the same period. The annual extra investing capital injected to each industry (I_{jt}) is allocated to each group of households on the basis of their saving rate in the period. Thus, the cumulative capital possessed by each group of household is determined as follows:

$$H\_Kstock_{r,t+1} = H\_Kstock_{r,t}(1-\delta) + \frac{SAV_{rt}}{\Sigma_r SAV_{rt}}\Sigma_j I_{jt}$$

b. The temporary equilibria:

The temporary equilibria express the operations and the relationships of five basic entities of an economy, viz. enterprises, the government, households, investing activities and the rest of the world. Such the relationship is shown in the Figure 2 below.

The model presupposes that the earnings from work are allocated to each group of households at a fixed rate. Meanwhile, capital-based incomes are distributed to groups of household on the ground of their capital amount.

c. The long-term equilibria:

At each point, the equilibrium in supply and demand must be maintained in all markets of commodities, labor and forex. In a long run, the economy of a country must reach its stability and balance by satisfying the following equilibrium conditions

- For investment: The annual investment capital flow must be sufficient to make up for fixed assets depreciation and population rise

$$I_{jT} = (\delta_j + n)K_{jT}$$

- For the equity capital of each group of households: In long run, the share of equity capital held by each group of household must be proportional to its share of savings.

$$d_{rT}^{K} = \frac{SAV_{rT}}{\Sigma_r SAV_{rT}}$$

- Regarding debt equilibrium: At the long-term equilibrium, the total debt of an economy and that

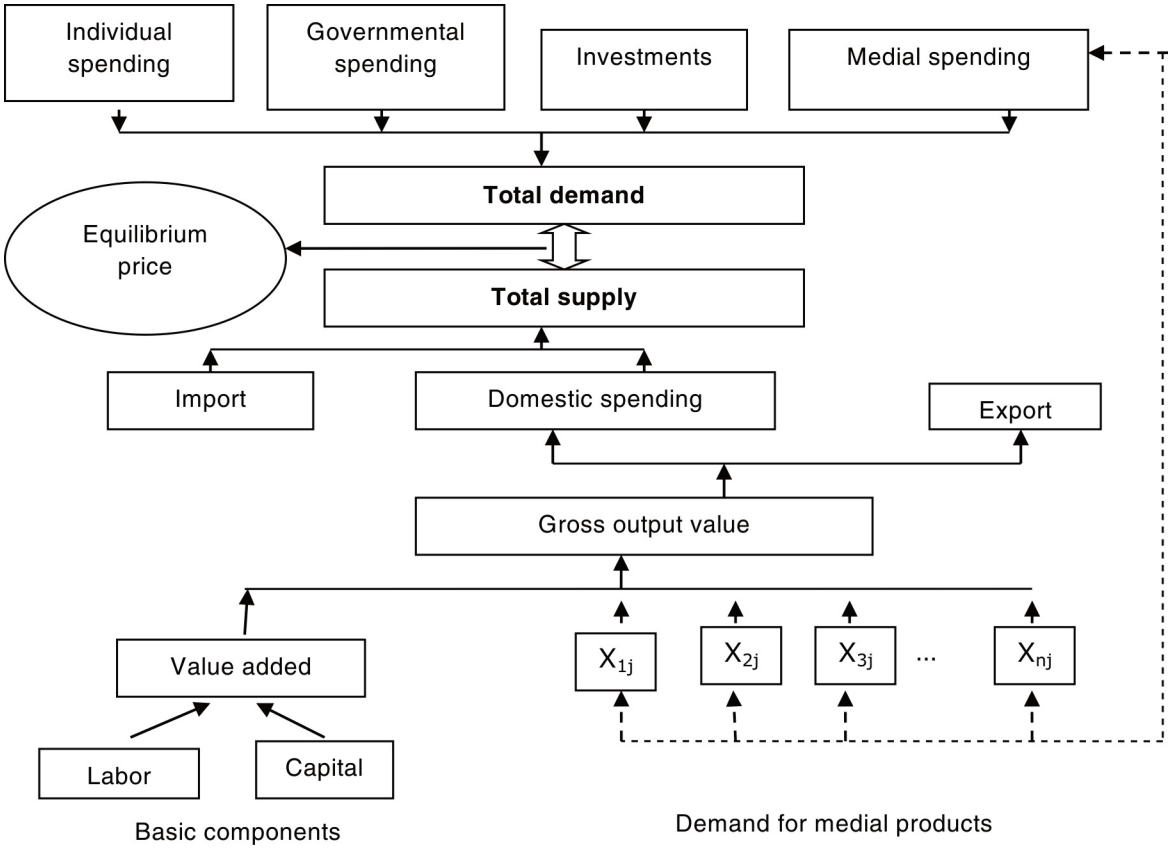

Figure 2: The comprehensive relationship among entities of an economy

of each group of household must go up steadily, meeting the following condition:

$$DEBT_T = \left(\frac{1+n}{n}\right)\{\left[\Sigma_j J_{jT} - \Sigma_r SAV_{rT} - s^g T_T(1-tr^p)\right]\}$$

- Concerning the interest rate equilibrium: In order to insure the long-run equilibrium, it is a must to observe the condition

$r_T = \rho$

3. Research results and discussions

The numerical database utilized in the paradigm is the Social Accounting Matrix (SAM). SAM is a general balance sheet expressing the production, distribution, trade, and consumption of all industries, economic entities and the government as well within a year. In the study, a SAM for 16 sectors of Đà Nẵng municipal economy has been established on the basis of the 2007 IO table, the 2009 Statistical Yearbook of Đà Nẵng City, and other sources as well.

Based on SAM, it is possible to roughly analyze some basic information concerning the structure of industry in Đà Nẵng City in 2009. Apparently, manufacturing industry covers the greatest part in the entire economy. In 2009 alone, this sector did occupy 37.59% of the production value and 23.89% of gross output; its output for export and domestic market also took up a substantial percentage in the total export value. Next, the construction was ranked just right after the manufacturing industry and accounted for 15.86% of the total production value and 12.36% of gross output. Transportation, warehousing, communication and trading also played an important role in the economy. However, contributions of agriculture, sea-farming, and other services just occupied a humble part in the economy.

The relationship between industries of Đà Nẵng City, i.e. the output of a sector is employed as the input of the others and vice versa, is expressed in the Table 2. Let us take the year 2009 for example. The sector 1 (agriculture) sold VND330.41bn worth of its output to sectors in the locality, in which around VND69.29bn worth of its output was traded back to this sector, around VND0.13bn worth of output for the forestry, and etc. Columns of the Table 2 show the output value

Table 1: Shares of sector in Đà Nẵng economy in 2009 (VND million)

Sector	Gross output		Production value		Medial utilization	
	Value	%	Value	%	Value	%
Agriculture	342,051	1.39	607,009	1.16	264,958	0.96
Forestry	45,172	0.18	52,060	0.10	6,888	0.03
Sea-farming	576,402	2.34	928,674	1.78	352,272	1.28
Mining industry	107,418	0.44	171,030	0.33	63,612	0.23
Manufacturing industry	5,892,064	23.89	19,602,280	37.59	13,710,216	49.89
Public utility services	1,947,967	7.90	3,160,905	6.06	1,212,938	4.41
Construction	3,048,618	12.36	8,115,058	15.56	5,066,440	18.44
Trading	3,035,719	12.31	4,799,222	9.20	1,763,503	6.42
Hospitality industry	1,108,113	4.49	1,833,586	3.52	725,473	2.64
Transportation, warehousing, communication	3,406,890	13.81	5,729,722	10.99	2,322,832	8.45
Banking and finance	1,369,046	5.55	1,850,319	3.55	481,273	1.75
Science and technology	127,452	0.52	214,483	0.41	87,031	0.32
Assets trading and advisory service	729,170	2.96	1,067,137	2.05	337,967	1.23
State administration and national defense	329,878	1.34	608,256	1.17	278,378	1.01
Education and training	807,732	3.28	1,062,297	2.04	254,565	0.93
Other services	1,789,730	7.26	2,340,133	4.49	550,403	2.00
Total	**24,663,422**	**100**	**52,142,171**	**100**	**27,478,749**	**100**

Source: 2009 SAM of Đà Nẵng City

of each sector, which was acquired for production in 2009. For example, the sector 1 (agriculture) acquired around VND264.96bn in total from other sectors, in which there were VND69.29bn worth of output from the agriculture itself, VND1.67bn worth of output from the sector 2 (forestry), and so on.

By studying sectors with great potential such as manufacturing industry, construction, warehousing and transportation, communication, and trading, it is possible to draw some primary conclusions as follows.

The output of manufacturing industry is the essential input of other economic sectors in Đà Nẵng City. This can be proven that it, in 2009, provided with an output of VND15,168.74bn. In which, the demand of the manufacturing sector for its own products was really tremendous, equivalent to VND7,812.79bn. Other sectors like construction, transportation and trading also have an enormous need for outputs of the manufacturing industry. Besides, the manufacturing industry, in 2009, bought from other sectors VND13,710.22bn worth of raw materials and services. It is predictable

Table 2: The relationship among economic sectors of Đà Nẵng City in 2009* (VND billion)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Tổng
1	69.29	0.13	2.78	0.00	240.06	0.17	0.01	0.03	12.26	3.96	0.07	0.02	0.00	0.00	0.00	1.61	**330.41**
2	1.67	0.74	3.61	0.21	28.42	0.32	4.68	4.90	0.07	0.21	0.00	0.05	0.48	0.02	0.01	3.64	**49.04**
3	0.75	0.00	41.27	0.00	453.74	3.88	0.02	0.00	22.45	0.89	0.00	0.00	0.00	0.00	0.00	0.18	**523.19**
4	0.36	0.01	0.15	3.19	46.65	3.53	51.11	2.09	0.04	0.32	0.10	0.15	0.21	0.02	0.07	0.00	**107.98**
5	121.37	2.94	197.32	15.22	7,812.79	668.61	3,149.32	800.30	385.56	1,245.91	105.26	29.25	145.43	103.52	105.66	280.28	**15.168.74**
6	7.23	0.22	15.92	6.97	328.59	172.09	48.95	24.33	28.21	28.13	43.65	5.27	5.41	3.38	8.72	33.50	**760.57**
7	26.95	0.98	29.06	5.07	2,604.26	222.87	1,049.77	204.62	70.08	284.10	35.09	9.75	48.48	34.51	35.22	93.43	**4,754.23**
8	29.63	0.80	36.35	2.91	1,820.99	97.63	604.62	144.92	60.20	161.85	33.72	6.57	27.85	22.35	22.86	57.53	**3,130.78**
9	0.31	0.07	1.77	0.17	24.17	1.17	22.21	27.02	11.91	30.39	6.82	2.88	12.05	19.88	10.23	11.60	**182.64**
10	5.92	0.79	10.49	10.41	209.43	32.54	84.80	29.50	59.99	74.99	55.59	5.74	19.48	19.09	16.16	22.77	**657.70**
11	0.22	0.03	9.52	0.10	45.12	3.03	7.47	93.33	38.75	188.70	151.38	0.22	12.54	24.51	0.73	2.09	**577.74**
12	0.08	0.00	0.00	1.58	10.29	0.20	2.51	1.52	0.13	1.05	0.16	19.15	11.41	4.75	16.11	2.62	**71.58**
13	0.09	0.10	3.53	17.56	71.02	2.41	35.27	426.29	34.47	282.25	43.83	7.66	46.27	13.65	4.34	6.04	**994.77**
14	0.00	0.00	0.00	0.00	0.00	0.16	0.00	0.00	0.00	0.39	0.00	0.00	0.00	0.00	0.00	0.00	**0.55**
15	0.93	0.03	0.26	0.16	6.72	2.21	3.08	2.99	0.03	11.00	4.69	0.27	2.27	18.61	28.09	5.33	**86.67**
16	0.17	0.06	0.25	0.08	7.96	2.10	2.62	1.66	1.33	8.67	0.92	0.05	6.09	14.09	6.35	29.78	**82.17**
	264.96	**6.89**	**352.27**	**63.61**	**13,710.22**	**1,212.94**	**5,066.44**	**1,763.50**	**725.47**	**2,322.83**	**481.27**	**87.03**	**337.97**	**278.38**	**254.57**	**550.40**	**27,478.75**

*Please refer to the Table 1 for the complete list of 16 sectors

Source: Author's calculations

that the growth of the manufacturing industry would entail the growth of other sectors. In theory, such the chain reaction will last unlimitedly, casting positive impacts on the economy if we are aware of the most primary sector to be developed properly.

Based on the CGE model, the study will illustrate 16 scenarios of investment. The numerical data for simulation is the 2009 SAM Table of Đà Nẵng City. These scenarios aim at examining effects of investment on the total production value and gross output of Đà Nẵng City over the period 2009-2020 if annual investment in a specific sector (not in the remainder) increases regularly by VND1000bn; and other components are kept unchanged. The simulation results will help answer to the question of which sector should be privileged in investment so as to maximize the economic growth.

According to presuppositions, it is apparent that the Scenario 5 (prioritizing the manufacturing industry) generates the highest growth. The total production value would, in 2020, increase by 15.11% (equaling VND7,878.682bn) compared to the year 2009. The next favorable one is the Scenario 7 – prioritizing the construction; which would bring in a rise of 13.01% in 2020 (equaling VND6,783.696bn) compared to the year 2009. The third one that we must count is trading, with the increase in the total production value reaching some VND6,429.130bn, accounting for 12.33%. The hospitality industry, although exposing its great potentials, would not be able to push up the economy (please refer to the Scenario 9). The analyses based on inter-sector balance sheet also show that the relationship between hospitality industry and other fields within Đà Nẵng City is kind of fragile. Thus, according to the present structure, the hospitality industry has not been able to give a hand to the growth of other sectors. The simulation results also figure out that to attract investments in agriculture (scenario 1), forestry (scenario 2), sea-farming (scenario 3), and assets trading and advisory services will produce the lowest increases in production value.

Table 3: Compare the production value and gross output of Đà Nẵng City in 2020 with those in 2009 based on 16 different scenarios (VND billion)

Scenarios	Preferentially-invested sector	Gross output		Production value	
		Value	%	Value	%
1	Agriculture	382.283	1.55	641.349	1.23
2	Forestry	500.667	2.03	1,308.768	2.51
3	Sea-farming	1,425.546	5.78	2,205.614	4.23
4	Mining industry	1,228.238	4.98	3,238.029	6.21
5	Manufacturing industry	3,445.480	13.97	7,878.682	15.11
6	Public utility services	2,034.732	8.25	5,381.072	10.32
7	Construction	1,891.684	7.67	6,783.696	13.01
8	Trading	3,603.326	14.61	6,429.130	12.33
9	Hospitality industry	2,054.463	8.33	5,756.496	11.04
10	Transportation, warehousing, communication	2,271.501	9.21	4,233.944	8.12
11	Banking and finance	1,696.843	6.88	4,129.660	7.92
12	Science and technology	1,013.667	4.11	2,716.607	5.21
13	Assets trading and advisory services	762.100	3.09	1,517.337	2.91
14	State administration and national defense	439.009	1.78	1,058.486	2.03
15	Education and training	1,287.431	5.22	2,179.543	4.18
16	Other services	707.840	2.87	1,673.764	3.21

Source: Results simulated from the model

In term of gross output, if the trading sector may attract investments, the Đà Nẵng gross output would have a chance to grow quickly, around VND3,603.326bn in 2020 (equaling 14.61%) as compared to the year 2009. The next is the manufacturing industry, with the growth of 13.97% in 2020 (equaling VND3,445.480bn) as compared to the year 2009. The construction industry, although having a tremendous contribution to the total production value of Đà Nẵng City, would just account for 7.67% in the municipal gross output. This is to say, despite the fact that the construction industry may create a lot of new jobs, it cannot bring in much more added values as compared to other economic fields.

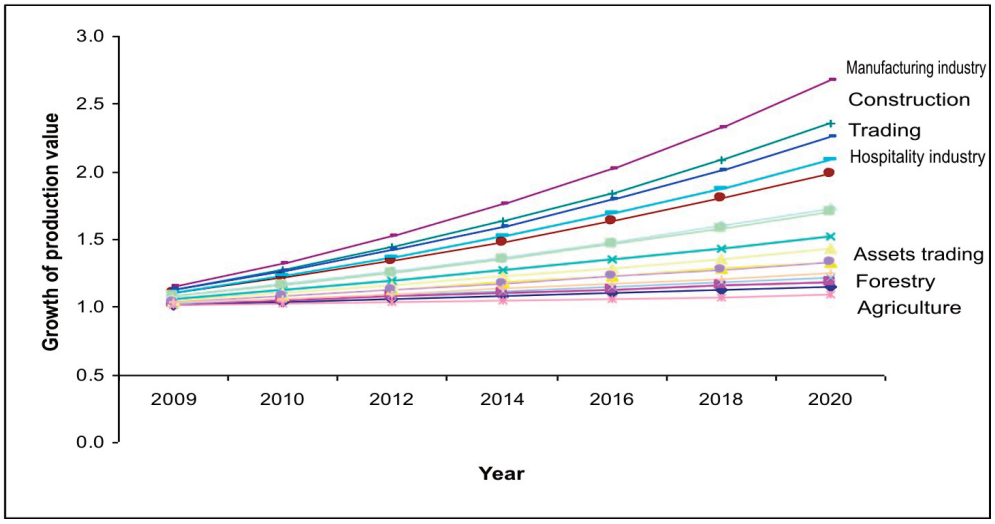

Figure 1: The growth of production value under the effect of different scenarios

Source: Simulation results drawn from the model

4. Conclusion

The dynamic CGE model may be employed to identify sectors/fields that must be privileged in investment so as to optimize the economic growth. The simulation results have pointed out that the manufacturing industry and the trading sector are the most important in Đà Nẵng municipal economy. If we attract investments in these two fields, there would be a favorable impact on the municipal development in terms of production value and gross output. For other sectors such as construction and hospitality industry, due to the fact that they cannot set up a tight bond with others, their impacts is unsubstantial. Besides, this study, due to limits in the numerical database, just analyzes 16 sectors comprehensively. Thus, if there were a detailed numerical database of each sector, the model could analyze each separately so as to determine the one with the greatest pervasivenessn

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