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MANUFACTURING AS A LEADING SECTOR IN CITY PLANNING

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1 — Introduction :

Since everything in economics depends on everything else, the question that one will be faced with when planning a new city is where to start ? Which variables (investment, employment, income, etc.) shall we start to determine first ? Also, which sector shall we start with, taking into consideration the feedbacks between the sectors and between the economic variables within each sector ? For example, the number of workers in the service sector depends on the amount of investments allocated to the sector. However, investment in the service sector is determined by the expected total demand for services, which depends on the number of workers (and their families) in all the sectors in the city including the service sector.

The interrelationships among the sectors and among the economic variables within each sector as well is not all what should be taken care of when planning a city. Another important factor that affects the planning process of the new city is the choice of the leading sector, i.e. the sector which initiates and leads the growth of the city in the future. It is believed that the manufacturing sector is the most appropriate one to choose as the leading sector if the objective is to plan an industrial city.

Finally, it should be mentioned that planning a new city is a macro as well as a micro process. In the first stage of planning some economic variables are supposedly determined on the macro level, then a more detailed analysis on the micro level is pursued in the following stage. For example, a macro approach is used to determine investment on the sectoral level in the city, then a micro analysis will be carried out to allocate investment in the

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manufacturing sector among large, medium and small size industries, and within each category among different projects).

This paper is concerned only with the macro part of city planning. It aims at presenting a simultaneous equations model which can be used to estimate some important aggregate economic variables that are needed in planning a new city. Manufacturing is used as the leading sector in the model. The paper is divided into four sections :

The first section is the introduction.

The second section presents the underlying assumptions of the model.

The third section includes a graphic presentation of the model, while

The fourth section includes its mathematical presentation.

2 — The Underlying Assumption of The Model :

The underlying assumptions of the model are :

First, the economic activities in the new city are divided into three sectors : manufacturing, services and construction sectors.[1]

Second, the construction period of any building is one year.[2]

Third, the model uses fixed coefficients. There may be a need to change these while projecting the distant future, either because of the change in technology or as a result of the change in the city size.

3 — The Graphic Presentation of The Model :

Figure (1) shows the graphic presentation of the model.

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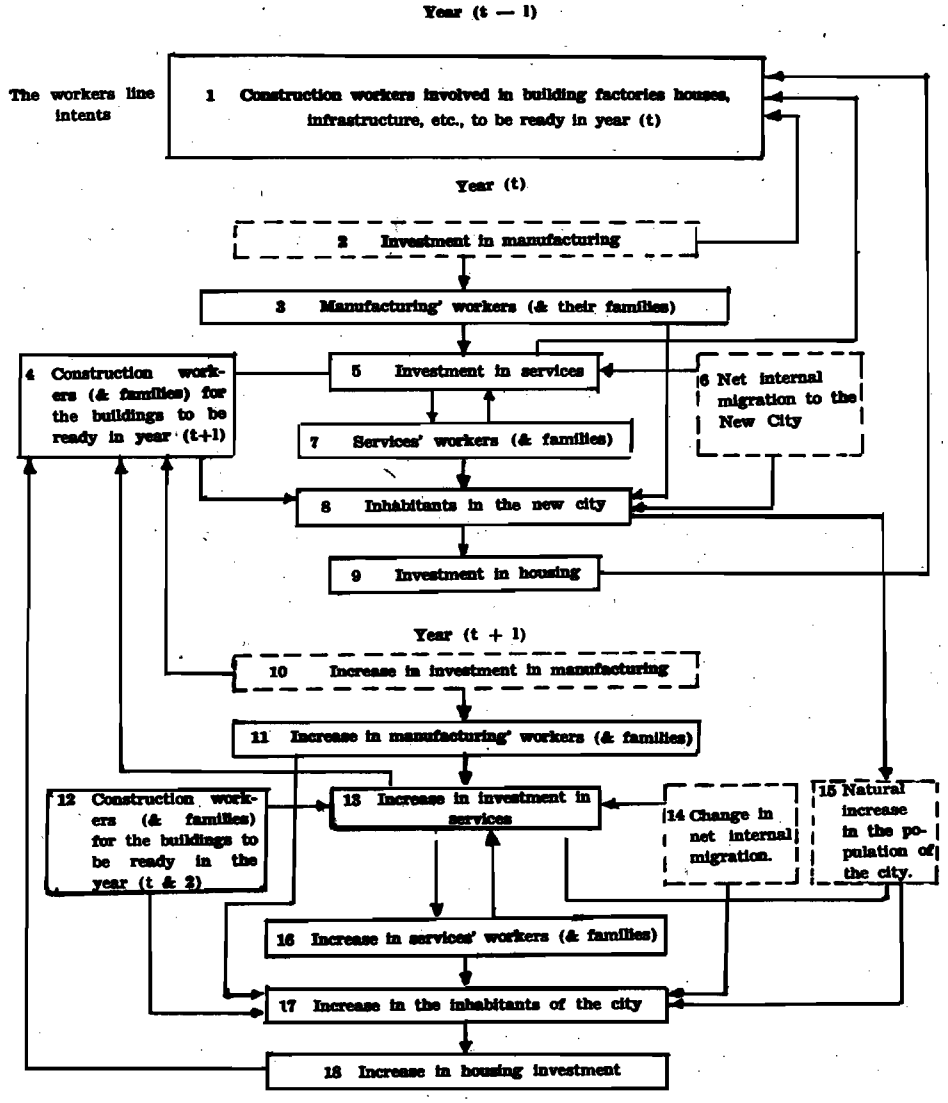
(1) The agricultural sector is deliberately left out, since in the case of New Ameriya City, for which this model was originally built, there is sufficient agricultural products in the vicinity.

(2) This assumption can be relaxed as shown later, see p. 11.

Figure (1)


Year (t — 1)
The workers line intents
1 Construction workers involved in building factories houses, infrastructure, etc., to be ready in year (t)
Year (t)
2 Investment in manufacturing
3 Manufacturing' workers (& their families)
4 Construction workers (& families) for the buildings to be ready in year (t+1)
5 Investment in services
6 Net internal migration to the New City
7 Services' workers (& families)
8 Inhabitants in the new city
9 Investment in housing
Year (t + 1)
10 Increase in investment in manufacturing
11 Increase in manufacturing' workers (& families)
12 Construction workers (& families) for the buildings to be ready in the year (t & 2)
13 Increase in investment in services
14 Change in net internal migration.
15 Natural increase in the population of the city.
16 Increase in services' workers (& families)
17 Increase in the inhabitants of the city
18 Increase in housing investment

The predetermined variables in figure (1) are shown by the dotted-line boxes. These are : investment in manufacturing, net internal migration to the new city, increase in investment in manufacturing in (t+1), change in net internal migration to the city in (t+1), and natural increase in population. The figure shows that, given these four predetermined variables, the aggregate variables of sectoral investment and employment, and the total inhabitants of the city can be estimated.

The graphic presentation of the model as shown in figure (1) can be traced as follows : First, the amount of investment allocated to manufacturing in the city in year (t) (box 2) will be determined. Knowing that, the number of workers (and their families)[1] working in the manufacturing sector (box 3) can be estimated accordingly. The planned amount of investment allocated to the services sector,[2] (box 5) will be determined by knowing the numbers of workers (& their families) working in the manufacturing sector (box 3), the number of construction workers (& their families) involved in building factories, homes, infrastructure, etc., that should be ready in year (t+1), (box 4), net internal migration to the new city (box 6), and also the number of workers (& their families) working in the services sector (box 7). But, it should be noticed that the estimation of the number of workers (& their families) in the services' sector (box 7) and the amount of investment in the services' sector (box 5) are so interdependent that the farmer variable (box 7) is determined by the latter (box 5), & vice versa. The inhabitants of the new city in year (t) (box 8) will be estimated by adding the number of workers (& families) in the manufacturing sector (box 3), the number of construction workers (& families) needed to construct the buildings of year (t+1), (box 4), net internal migration to the city (box 6), and the number of workers (& families) working in the services'sector (box 7). The amount of investment in housing in year (t), (box 9), will be determined according to the estimated inhabitants of the new city (box 8). The number of construction workers in year (t—1) who are needed to build

(1) The average size of the family is assumed to be 5.

(2) The services' sector includes : roads, transportation system, Schools, hospitals, banks, shops, etc.

the factories, houses, etc., that should be ready in the city in year (t), (box 1), are estimated depending on our estimates of the investments in manufacturing (box 2), in services (box 5), and in housing (box 9).

The same procedure will be repeated to estimate the aggregate economic variables — investment, employment and population — of the city in the year (t+1) & the following years, given the annual rate of growth of the manufacturing sector, the annual natural increase in population, and the annual change in net internal migration to the new city. This can be shown clearly from figure (1) as follows :

Given the annual rate of growth of the manufacturing sector, the increase in investment in manufacturing (box 10) can be determined. The increase in the number of manufacturing workers (& their families), (box 11), will be estimated accordingly. The planned increase in the investment in services, (box 13), is estimated depending on the increase in manufacturing workers (& families), (box 11), the construction workers (& families) needed for the building in year (t+2), (box 12), the change in net internal migration (box 14), the natural increase in the inhabitants of the city (box 15), & the estimated increase in the services' workers (& families), (box 16). However the increase in services'workers (& families), (box 16), is estimated interdependently with the increase in investment in the services sector (box 13). The natural increase in the population of the city in year (t+1), (box 15), is estimated by having the inhabitants of the city in year (t), (box 8), & the given annual natural rate of increase of the population. The increase in inhabitants of the city in year (t+1), (box 17), is the sum of the boxes (11), (12), (14), (15), & (16). The planned increase in the investment in housing in year (t+1), (box 18), is determined according to the estimated increase in inhabitants of the city (box 17). Finally, the planned increase in investment in year (t+1) in manufacturing (box 10), services (box 13), and housing (box 18) determine the number of construction workers (& families) in year (t), (box 4), since the construction period of any building is assumed to be one year as mentioned above.

4 — The Mathematical Presentation of the Model :

$$WC\ (t-1) = a\ \overline{M}\ (t) + b\ S(t) + c\ H(t) \quad (1)$$

$$S\ (t) = d\ I\ (t) \quad (2)$$

$$H\ (t) = e\ I\ (t) \quad (3)$$

$$I\ (t) = FWM(t) + FWS(t) + FWC(t) + \overline{NIM(t)} \quad (4)$$

$$FWM\ (t) = 5\ WM\ (t) \quad (5)$$

$$WM\ (t) = h\ \overline{M}\ (t) \quad (6)$$

$$FWS\ (t) = 5\ WS\ (t) \quad (7)$$

$$WS\ (t) = g\ S\ (t) \quad (8)$$

$$FWC\ (t) = 5\ WC\ (t) \quad (9)$$

$$\Delta WC\ (t) = a\ \Delta M(t+1) + b\ \Delta S(t+1) + c\ \Delta H(t+1) \quad (10)$$

$$\Delta M\ (t+1) = \overline{RM} \times \overline{M}\ (t) \quad (11)$$

$$\Delta S\ (t+1) = d\ \Delta I\ (t+1) \quad (12)$$

$$\Delta H\ (t+1) = e\ \Delta I\ (t+1) \quad (13)$$

$$\Delta I\ (t+1) = R\ I \times I\ (t) \quad (14)$$

$$\Delta WM\ (t+1) = h\ \Delta M\ (t+1) \quad (15)$$

$$\Delta FWM\ (t+1) = 5\ \Delta WM\ (t+1) \quad (16)$$

$$\Delta WS\ (t+1) = g\ \Delta S\ (t+1) \quad (17)$$

$$\Delta FWS\ (t+1) = 5\ \Delta WS\ (t+1) \quad (18)$$

$$\Delta I\ (t+1) = \Delta FWM\ (t+1) + \Delta FWS\ (t+1) + \Delta FWC\ (t+1) + \overline{NIM}\ (t+1) + \overline{NR}\ I\ (t) \quad (19)$$

$$\Delta WC\ (t+) = \Delta FWC\ (t+1) / 5 \quad (20)$$

where WC = number of workers in construction

M = investment in manufacturing

S = investment in services

H = investment in housing

I = number of inhabitants

WM = number of workers in manufacturing

FWM = number of workers in manufacturing and their families

WS = number of workers in the service sector

FWS = number of workers in the service sector and their families

FWC = number of workers in construction and their families

NIM = net internal migration to the new city

NR = natural rate of growth of the population

RM = rate of growth of the manufacturing sector

Δ = change

t = time

a = the average number of construction workers needed for each pound spent on investment in manufacturing.

b = the average number of construction workers needed for each pound spent on investment in services.

c = the average number of construction workers needed for each pound spent on investment in housing.

d = investment in services required for each individual.

e = investment in housing required for each individual.

f = the number of manufacturing workers needed for each pound spent on investment in manufacturing.

g = the number of services workers needed for each pound spent on investment in services.

A — The Variables Used in the Model

The exogenous variables are : M (t), RM, RI, NR, NIM (t), Δ a, b, c, d, e, f, g.

The endogenous variables are : WC (t-1), S(t), H(t), I(t), FWM(t), FWS(t), FWC (t), WM (t), WS (t), WC (t), ΔM(t+1), Δ S (t+1), Δ H (t+1), Δ I (t+1), Δ WM (t+1), Δ FWM (t+1), Δ WS (t+1), Δ FWS (t+1), Δ FWC (t+1), Δ WC (t+1).

B — The Solution of the Model

Substituting equations (2), (5), (6), (7), (8) & (9) into equation (4) ; and substituting equations (11), (12), (13), (14) into equation (10) we get two following equations :

$$(1—5\,gd)\ I\ (t) = 5\ hM\ (t) + 5\ WC(t) + NIM\ (t) \qquad I$$

and $$WC\ (t) = a\,RM \times M\ (t) + (bd + ce)\ RI \times I\ (t) \qquad II$$

Solving equations I and II simultaneously, we get the values of I (t) and WC (t) as follows :

$$I(t) = [5(h+RM)\ M(t) + NIM(t)]\ /$$

$$[1—5gd—5(bd+ce)\ RI]\ \&\ WC(t) = aRM \times M(t) +$$

$$[(5(h+RM)M(t)+NIM(t))\ (bd+ce)RI]\ /$$

$$[1—5gd — 5(bd+ce)\ RI]$$

Knowing I(t) and WC (t), we shall be able, then, to solve for the rest f the endogenous variables in the model.

C — Model Operation and Extension :

The model can be extended to cover any additional number of years, i.e. year (t+2), year (t+3) ..., year (t+n). For each additional year, the equations from (10) to (20) will be repeated after adjusting them to the relevant period, consequently, the model can be used to project the sectoral levels of investments and employments, and the inhabitants of the new city at any year in the foreseeable future.

Finally, it should be mentioned that the assumption regarding a one year length of the construction period of the buildings can be changed allowing a relatively longer or shorter construction period without distrobing the functioning of the model (after making the appropriate adjustments in the relevant variables of course).