ENERGY, EFFICIENCY, AND CITY SIZE: SOME NEW QUESTIONS*

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Working Paper No. 367
December 1981

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*Paper delivered at the First International Congress on the Planning of Great Cities, Mexico City, June 22-25, 1981.

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We have heard a great deal in this conference about urban growth in a regional context and about the prospects for transferring growth from one region to another. I would like to question an assumption articulated or implied in nearly all recent discussion of regional development in Mexico. Almost invariably it is assumed that Mexico City is too large and frequently, it is said, inefficient, and that growth must be directed elsewhere. I wish to point out that these inefficiency assumptions are still open to question. I shall report evidence below to suggest that Mexico City is very efficient from an energy standpoint, and that much more work needs to be done to understand the advantages and disadvantages of "gigantism."

In the course of research carried out over the past eighteen months,* data has been uncovered to show that Mexico City is energy efficient, perhaps far more than anyone has realized before (Campbell, 1980a). Compared to other cities and regions in Mexico, the capital region produces between two and ten times more dollars worth of output per unit of energy consumed than any other region or city in the country. I should be careful to note that in speaking of Mexico City I refer to the entire urbanized area inside the Valley of Mexico. Comparative data I shall report shortly

*As a part of the Resource-Conserving Urbanism Project, Institute of Urban and Regional Development, U.C. Berkeley, Berkeley CA, USA.

refer to states. Energy refers to all forms of "extrasomatic" (i.e., non-metabolic) energy. Output refers to estimated values of gross domestic product measured in U.S. dollars. The term efficiency as I use it refers to dollars of output per unit of energy input.

The question of energy efficiency is an important one in this decade and in the decades to come. Some studies have shown that a combination of population increase and rising incomes will yield 400 to 600 percent increases in the demands for energy in Third World cities by the turn of the century (Meier, Berman, and Dowall, 1978). What does this apparent efficiency in Mexico City tell us about the prospects for this increased demand? Are cities the size of Mexico City, as it sometimes thought, too fat, unbalanced, or somehow overgrown? Are their appetites for energy unquenchable? Is it inconceivable that the largest cities in the Third World might follow a development path drastically different from their predecessors in the post-industrial world? The answer to these questions at least based on the evidence of Mexico City is a qualified no, in each case. I shall suggest below that the economy of Mexico City is undergoing much more rapid transition than is customarily anticipated, and that the future prospects for meeting energy needs in large Third World cities may not be as dim as the Meier study suggests.

Productive Structure of Mexico City

Although we have little data since 1975 to describe the economic structure of Mexico City, data gathered in industrial and commercial censuses (GOM, 1978) and by the Bank of Mexico (1979) show that the greatest contributor to dollar output in Mexico City is in the services and

commercial sectors (see also Garza, 1979). Two thirds of the output of Mexico City and three quarters of employment is generated in these sectors.

Table 1

Mexico City and the Nation
Gross Domestic Product, 1970
(in 1950 pesos)

Sectors	Nation	MAMC	Percent Total
Agriculture	17,643	54	.1
Industry*	52,009	16,086	28.4
Transportation	4,778	2,775	4.9
Services	77,330	37,816	66.6
Total	151,760	56,731	100.0

Source: Garza, 1979
*Industry includes construction.

Many observers of other cities have been telling us that the services sector is the most important, but we are typically left with the impression that "services" are somehow either the domain of the educated professional elite, as in doctors, lawyers, government, or made up of low-paying, unskilled wage labor, or as persons operating in a "informal" manner receiving uncertain incomes (e.g. see Peattie, 1981). But we know very little else about Third World urban services. We have precious little information disaggregated at the city level to understand the full range and nature of these "services." I shall return to this point later in the paper.

Frequently our attention is drawn to the heavier industrial or manufacturing sectors of cities, partly I suppose because manufacturing is seen as a building block of growth, and a sign of modernization. It is

regarded as somehow a more legitimate form of output. Perhaps this is true because in the history of "Second World cities" industrialization played an important role in raising income and creating wealth. In the case of Mexico City the point is frequently made that the thirty thousand industries in the Valley of Mexico produce 40 to 50% of the total manufacturing output for the country (Garza, 1979). But in terms of total gross domestic product of the city, the manufactuing sector accounts for only 28%.

The balance of the gross domestic product of the city is made up of construction, and tiny amounts of mining and agriculture. Although there is evidence to suggest that the trend in Mexico City toward services is increasing, the city is already predominantly a place of services and commerce and a political seat of power. In terms of output, it is not the heavy industrial state we sometimes picture it to be.

Energy Use in the Valley of Mexico

The many forms of energy conveyed into the Valley of Mexico are in most respects not unlike those in any large major metropolitan area anywhere in the world. Most of the energy is in industrial fuels, diesel and gasoline with lesser amounts of aviation fuel and electricity as shown in Table 2.

A glance at energy consumption patterns in Table 3 reveals the driving force behind the efficiency mentioned earlier. Of the roughly 850 trillion joules used in the Valley of Mexico, industry and manufacturing accounts for almost half. Mexico City is unique in that a third of the total goes to transportation. This compares with 10 to 12% in Seoul, Manila, and Hong Kong (Meier, Berman, and Campbell, 1981). Commerce and services, which

Table 2

Energy Flows in the EVOM 1980 (est.)

Energy Form	Percent of Total
Industrial Fuels	31.9
Liquid Gas	9.4
Electricity	11.1
Diesel	14.3
Gasoline	25.5
Aviation Fuel	4.9
Kerosene	2.9
Biomass	neg.

Source: IMP, 1977 (Table A.8), projections to 1980 assume 8% growth rates.

account for two thirds of the gross domestic product, consume only eight percent of the energy. Finally, another seven percent roughly is consumed in the street lighting, pumping of water, and other public uses.

Energy Efficiency in Large Cities

I employ the term energy efficiency in this paper because we are concerned in the broadest sense with the operation of cities as large systems. The city may be thought of as an ecosystem which has certain important inputs, makes certain transformations of resources, and produces in turn a series of outputs, some to be used again as resources. For most cities, energy is one of the most critical of these resources. Measured in this narrow sense, we can see in Table 4 that Mexico City produces nearly six dollars for each unit of energy (J x 10^{-8}) it "consumes." This efficiency

Table 3

Energy Use in the MAMC, 1980 (est.)

(J x 10^{15})

Sector	Electrical	Combustibles	Total	%
Industrial	128	259	387	45
Commerce/Services	17	50	67	8
Transport	3	250	253	30
Domestic	33	50*	83	10
Public	51	10	61	7
Total	232	616	851	100%

Source: Campbell, 1980a
*Includes 3 of biomass.

Table 4

Output and Energy in Selected Cities

(1980 est.)

City	GDP/cap	Total Energy/cap (US $)	GDP/Energy (J x 10^9)
Seoul	2000	29	6.8
Manila	1200	35	3.4
Hong Kong	2500	63	3.9
Mexico	3500	59	5.9

Source: Meier, Berman, and Campbell, 1981.

compares favorably with Seoul, Korea and is substantially higher than in Hong Kong and Manila. But I make no attempt to draw conclusions from these comparisons because of the complicating factors of energy subsidies,

exchange rates, and different means of estimation that have been employed in deriving these statistics. I would point out however, that all consumers in Mexico enjoy a heavy energy subsidy.*

We can make comparisons using consistent product outputs and energy inputs for ten major areas in Mexico for 1975, as shown in Table 5. Here outputs are measured in 1960 pesos and inputs in Joules. By these measures the Federal District and the metropolitan area produce more than ten times the average output per unit of energy input than other city or region in the country. I would also point out that excluding the Central Region (which containes the MAMC) the levels of efficiency correlate roughly with the degree of urban population in each of the regions cited in the table. However this data needs to be explored in much greater detail before making assertions about city size and efficiency in Mexico.

The customary explanation for efficiency in cities relates to economies of scale, high per capita investments, the availability of the most modern technology, and the high quality of energy available in the cities. These explanations and more have been discussed in detail elsewhere (Alonso, 1968; Cecelski, 1979; Garza, 1979). My purpose in this paper is to draw attention to yet another possible explanation which has not recieved so much attention. This explanation, stated baldly, is that the large services sector in cities like Mexico City actually means that these cities are better organized than their smaller brethern, and that the evolution to a services economy brings with it greater opportunities for

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*To illustrate, the price of gasoline in mid-1980 was approximately US$0.47 per gallon, about one-fifth the world price. Natural gas and residual fuel oils cost Mexican industries 10% of the world price (Ronfeldt, 1980).

Table 5

Energy and Output in Mexican Regions, 1975

Area in Mexico	Percent of Total Urban Population 1975	GDP (Pesos x 10^{12})	Total Energy (J x 10^{11})	GDP/J
North-West	8.9	36.1	51.4	7.0
North	4.9	15.6	44.2	3.5
North-East	11.0	57.4	82.8	6.9
Central-North	3.4	11.3	57.3	2.0
Central-Pacific	12.2	30.6	49.1	6.2
Central-Gulf	6.5	21.0	146.8	1.4
Central	13.0	28.7	82.1	3.5
MAMC	31.5	173.6	32.8	52.9
Pacific-South	5.3	17.6	28.5	6.2
Peninsula	3.3	8.0	72.2	1.1
Average		21.4	53.3	4.0

Notes: These figures (taken from IMP, 1977 Table C-2, p. 464) differ from those in Table 4. Output figures for 1975 are expressed by Mexican sources in constant 1960 pesos.

increased energy efficiency elsewhere in the urban economy. This degree of organization affects efficiency in two ways.

First, as a services city, Mexico City employs a large fraction of its citizens in activities which are not energy intensive. This is quickly seen in data presented earlier. Services generate two-thirds of the capital's GDP while consuming less than 8% of the energy. Second, the services sector contains organized forms of information generation and management which help decision makers in government, industry, and commerce carry

out their business in a more efficient manner. As Alonso (1968) implied long ago, cities attract perhaps more than their share of educated people and knowledge. Thus, in the undifferentiated catch-all category of "services," there is an important knowledge component which serves the city by making it possible to create or clarify options, test knowledge and new technologies, diffuse information and other data. Businessmen and decision makers have readily available, regularly published lists of prices, inventories, spare parts, and the like. Alternative strategies can be elaborated and costed out with some degree of precision. These kinds of services are generally not as available in smaller towns.

The Information Infrastructure

I would suggest that perhaps we have too long ignored the informational and knowledge aspects of the services sector in large cities and that these aspects of the city economy and economic development deserve greater attention. Also, conventional sectoral definitions used to describe the economic structure in cities obscure or hide important activities that have to do with guidance and management of the city. By way of illustration I would point to few of the key commercial and services enterprises in Mexico City. Table 6 lists some of these enterprises and shows the remarkable growth they have experienced between 1973 and 1979. Electronic data processing, adaptation, and data processing services, are perhaps the most obvious of these knowledge-related services. Institutions of higher education and research also fit into this category. But one group of activities not so widely recognized are the institutions, chambers, and associations of one kind or another, whose business it is to promote and advance the interest of their clients, primarily the

Table 6

Information Generating and Processing Capacity
MAMC, 1973-1979

Firms or Establishments	Year 1973	1979
Electronic Data Processing (total phone outlets)	87	179
Chambers (construction, Industry, etc; total phone outlets)	104	137
Institutions of Higher Learning	89	103

Source: Telefonos de Mexico (yellow pages) 1973 and 1979 and GOM, Anuario Estadistico, 1975 and 1980.

manufacturing, industrial and construction industries. Only a fraction of these are reflected in Table 6.*

Supporting this informational infrastructure is a capacity in the larger cities to move messages from one place to another. Mexico City for instance has well over half the nation's telephones, total correspondence, and telegrams. In addition some 40% of the total television hours of broadcasting in 1977 had some sort of "news content," defined by Mexican authorities as news, roundtable discussions, cultural events, and the like. Informational services and supporting communications technologies constitute an informational infrastructure which helps inform planners and decision-makers and inevitably makes a contribution to the energy efficiency noted earlier. A wider array of options is available, more checking

*This is because they fall under many disguised categories in the data source (yellow pages) used here.

is possible, fewer false starts or dead end ventures are launched than in smaller cities where such information is not available. A well-developed informational infrastructure goes along with, and makes it easier to take advantage of, the many externalities of large city size.

Conclusion

I have merely tried to point out in this paper that the productive structure of the cities may be evolving much faster than we have anticipated. The growth of information and knowledge in cities is perhaps one of its most important products of cities and yet, as far as I know, there is no such thing as a sociology of urban knowledge in the Third World.* New technologies which can help advance this evolution--satellites, telecommunication devices, computers, and the like--are increasingly cheap and available everywhere in the world. One consequence may be a reduced demand for energy. This structural change, if in fact it is one, should open up again the debate on the advantages of large city size and present new challenges to planners in rapidly growing countries who feel their larger cities are too large and that growth should be directed elsewhere. Knowledge, like other key resources, seems to gravitate towards the center. This may make it harder to decentralize growth, but with a deeper understanding of this process, and now communications technologies that overcome space, it may also be easier to steer economic growth to the periphery.

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*See Campbell, 1980b for an exploration of this knowledge in the cases of squatters in Rio de Janeiro, Brazil.

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