Exploratory analysis of the use of a multi-regional Input-Output Matrix for the analysis of the main urban impacts of the new Mexico City International Airport[1].

(Working Paper)

Author: Karina Garduño Maya

Co-authors: Normand Asuad and Jose Manuel Sanchez

Abstract

The New Mexico City International Airport (NMCIA) will have different economic and social impacts generated in the stages of both construction and operation. It is expected that this new airport will not only be an important node in terms of economic benefits, but also in terms of the urban impacts it will generate within the urban area of Mexico City, highlighting among others, housing, transport infrastructure and road works.

Thus, the question that guides this research is: What will be the main urban impacts generated by the new Mexico City International Airport, in housing and transport infrastructure within the city? Hence, it pretends to understand and analyze the urban impacts of the construction of the NMCIA, through the use of the multi-regional Input-Output Matrix, using investment amounts destined for urban infrastructure projects and their multiplier effects.

The construction of regional Input-Output matrices, is done with the bottom-up approach, because even though this new airport is a project of national importance, its immediate impact during the construction stage will have a more important effect in the surrounding region and local influence area. Therefore, it is required a methodology that "spatializes" the effects and impacts of this new investment and also emphasizes its connection with the functioning and spatial structure of the city, particularly the areas where impacts are concentrated.

The "spatialization" of the Input-Output matrix requires its construction to come from the elaboration of a system of regional and local accounts, and the identification of sectors of economic activity and its transactions, so as to build matrices by economic subregions of the city that will be integrated in a multi-regional input-output matrix.

Subsequently, there is an exploration of the methodologies available for the analysis of impacts, from which the closest are those related to environmental impacts, given that the review of the literature did not revealed any application of the methodology of Input-Output at the intra-urban level. So, according to the design of functional economic regions and particularly urban economic regions and their interactions, as well as through the construction of Input-Output matrix via bottom-up and with the methodological principles of analysis Input-Output more akin to the urban study, a methodological proposal will be integrated for the purpose of observing its results and

[1] The authors thank Adrian Garcia, Researcher of Center for Regional Studies and Sustainable Urban Development (CEDRUS), from UNAM, for the support of research calculations.

scope, in order to, subsequently develop a more systematic and rigorous methodology based on the Input-Output approach so as to analyze the economic composition and spatial structure of cities.

Thus, this research is an exploratory analysis, where economic factors are combined with the economic functionality in urban regions and the input-output analysis. It is expected that the results achieved will get close to the measurement of the urban impacts that the region of study will have and more specific, Mexico City´s Metropolitan Area as it is the local impact area with an area of influence, in accordance with the new demands of employment and urban infrastructure in the subregions.

The research methodology has the following steps: 1. Identification of the subregions in the central region of Mexico and in the urban economic region of Mexico City, where this new project is to be implemented; 2. Elaboration of the system of regional and local accounts of the area of study; 3. Construction of the subregional Input-Output Matrix and multi-regional matrix, considering the established investment for urban infrastructure projects in the relevant sectors; 4. Identification and analysis of urban impacts on the region of interest, resulting from the use of the input-output methodology.

For the construction of the regional input-output matrix, the data comes from the most recent economic census where there is availability of the main macroeconomic variables at the level of basic spatial units and those missing variables will be estimated through the bottom-up approach and with the use of interaction indices that validate intersectoral relationships within the multi-regional Input-Output Matrix.

Keywords: subregional, regional accounts, multi-regional input-output matrix, urban impacts.

1. Economic context

The Mexico City International Airport (AICM) will be relocated in the same region. Construction of New Mexico City International Airport (NMCIA) is in the midst of a debate on its location and the main economic impacts that would be generated through this. As the project's most ambitious infrastructure in recent years, it is expected to generate impacts at local, regional and national levels.

The location of both the current and the new airport is in the center region of the country. Regionally, the most important part of the country, in economic terms, is the downtown area, whose agglomerating is 66% of the total employed population in the country; highlighting the 60% of manufacturing employment, 68% of employment in business and 70% of employment in services, according to the 2009 Economic Census (INEGI, 2013). It also generates 51% of total value added; 56% of value added in manufacturing, 61% in trade and 73% of value added services. The center region of the country contains the City of Mexico, which represents the main node of this area because it concentrates 26% of value added in manufacturing activities of the central region and 78% of services, where that generates more than 50% of total employment.

This is the most important city in the country -following Guadalajara and Monterrey- in terms of population and employment, concentration of production and income generation and added value. So that the growth of the centerl region resulted in changes in the productive vocation of the City of Mexico, favoring specialization in services and the fact of having the most developed infrastructure of the country. The population growth of Mexico City and the various services offered not only in their area of influence, but in general across the country, make an important connection point of commercial, trade and population flows, this increases the demand infrastructure of all kinds, especially in transport infrastructure.

The creation of the new airport comes from the need to expand the operating capacity to Respond to Increases in the flow of passengers and merchandise, same as it is no longer possible to cover with the current airport. The combination of positive factors in Mexico City and a project of this magnitude will allow regional exploitation as a point of connectivity both the country and with the rest of the world. Only with the current airport, Mexico City receives a significant flow of tourists and people traveling on business purpose. It concentrates the 56% of goods traded with foreign air, in addition to "operational airport saturation significantly restricts the possibility of maintaining a high and sustained through increased productive growth. Mexico ranks 55 in competition and 49 in airport infrastructure, well below its potential as the twelfth economy in the world" (SCT, 2014).

However, being a project of national importance not only would promote efficiency in the commercial flow of passengers, but suggests the existence of job creation, income, output and value added, so that even these flows would increase. This assumption is implicit in the two stages which requires the implementation of NMCIA: construction and operation.

The period of work the new project warns that there will be a strong boost in the various sectors of the economy, based on the sectors of construction and related air transport services, suggesting the operation of a cluster of airport services from NAICM, exploiting all the competitive advantages.

Then the process of implementing the NAICM considers two main stages: its construction and operation. The first covers the period from 2014 to 2018, while the second goes from 2019 to 2062; in these stages are different production processes.

On the macro scale, airport services to be provided by NAICM are characterized by nationwide coverage, in addition to meeting local and regional demand around in Mexico City. Being the most important city in the country, Mexico City absorbs the largest number of passengers, compared with the other 10 major airport nodes in the country. In the passengers national flow the city absorbs 65% of this, while in the flow of international passengers absorbs 36% of these. Considering the total passenger flow, Mexico City receives 51%. Regionally, the construction of NMCIA generates impacts on total production with an increase of 6% in the intermediate consumption of 8%, in value added 5% 3% GDP and final demand an increase of 5%. It expects that the employment creation in the region will increase in 1.4% in 2014, 7.2% in 2015, 17% in 2016, 29.6% in 2017 and 36.8% in 2018, this depending on the amount of investment. The employment generated is divided in 41% as direct jobs and the 59% will be induced jobs (Garduño, 2015).

However, employment generation and demand requirements do not occur exclusively in the area of local impact. The new airport not only propels to Mexico City as an economically dominant node, but also involves a reconfiguration within the center region of the country, especially in the construction stage of the airport. The increase in demand for jobs for the project, it is assumed population flows within the region, with this mobility, is expected a increase demand for housing infrastructure, road works and social projects.

The new requirements of employment and demand for housing infrastructure, roads and social projects not distributed evenly across the center region, but arise according to economic and demographic functionality as well as the productive specialization of the various key sites throughout the region, and its connectivity to Mexico City (main node). So it is necessary to identify the different functional economic spatial units (FESU) within the region, economic interactions between these and the productive linkages that are formed based on the demand for urban infrastructure.

2. Identification of subregions in the Region Center of Mexico

The concentration of economic activities is distributed inhomogeneously in space, given that there are different natural characteristics that predispose the pattern of population concentration and therefore their activities. The regions are set by the government are bounded to the political and administrative boundaries delimitation can not display the true performance of the economy in space. Thus, decisions translated into policies and support programs for developing regions fail to succeed because first they are designed without taking into account the behavior of the territory where they have implemented, or those decisions are informed solely by interests politicians who do not allow dealing with real problems in the regions.

Therefore, it is important to identify regions that the criteria to be used is deslinden of such interests and adopt functional criteria. The analysis begins with the identification of main nodes and areas of

influence, their formation is determined by the main economic activities and interactions between them.

A main node is defined as a place where there is great economic concentration (economic activities generate large amount of value added, total gross production, income and employment) and population importance; besides being specialized services and have good infrastructure and transport networks (increasingly absorbing population and trade flows).

Economic activities and living standards in the dominant node have a great impact on neighboring sites, same that make up its area of influence, whose complementarity is given by the market, competition and direct connections. Integration between key nodes and their respective areas of influence, create funtional economic spatial units units (FESU), same which in turn comprise regions (Asuad, 2013).

In the case of Mexico, the political division is given by states, which in turn are divided into municipalities. That said, it is not appropriate to use all the states to consolidate the regions, however the alternative in this case, use the delimitation of the municipalities because the economic information more breakdown is at this level, what the municipal division must adhere to the economic and functional criteria.

This methodology[2] consists of the following stages:

i. Identification of the urban system in the region (cities and metropolitan areas, same as set CONAPO). This system uses a criterion of importance population, paying special attention to those sites agglomerating a larger population to 100,000 habitants.

ii. To the sites identified as most important in the urban system, it must to associate economic information, mainly the employment variables, total gross production and added value.

iii. Estimate the participation rates of economic variables in the set of selected nodes.

iv. Using a 80-20[3] approach, the dominant nodes are identified by a hierarchy in the sites, from less to high value, it means the sites that concentrate around 80% of value added, total gross output and employment over the total. This can determine the pattern of economic and population concentration.

v. With the identified nodes, it is important to view these on a map[4], adding the transport system (free federal highways and toll) that allows to see the connection between nodes and other sites. Additional should also be represented on the map urban localities, in order to know the pattern of concentration among them from the dominant nodes.

[2] This methodology is a proposal of Center for Regional Studies and Sustainable Urban Development (CEDRUS), from UNAM.

[3] Based on the statistical distribution of Pareto optimality, reading of this approach is: "about 80% of X, is content about 20% of Y".

[4] Using Geographic Information System (GIS).

vi. Establish the areas of influence for each of the key nodes. This it must validate using Reilly Index[5]:

$$BP = \frac{\Sigma D_{AB}}{1 + \sqrt{\frac{P(B)}{P(A)}}}$$

Where:

$BP = Break\ Point$

$D_{AB} = Total\ distance\ of\ the\ point\ of\ indifference\ to\ A\ and\ B$

$P(A) = Population\ of\ the\ site\ A$

$P(B) = Population\ of\ site\ B$

This methodology was applied to the center region of Mexico to identify its FESU. The region is made up of 548 municipalities from ten states. Its urban system is characterized by 13 metropolitan áreas (MA) and 6 cities, which form the economically dominant nodes in the region. With the analysis of economic variables that the region, highlights the MA Valle of Mexico, whose agglomerating is more than 60% of economic units and population, as well as more than 70% of value added, total gross production and employment in the region. These data validate the importance of this area, as the main node of the region and which is located both current and the new airport. Although the rest of the nodes have a small share of the regional total, these nodes are connected to the primary node as its area of influence, but they also have an important impact area.

Table 1. Economic nodes in the center region of Mexico, 2013 (thousands of pesos).

Economic Nodes	Economic Units*	Employment**	Total Gross Production	Value Added	Population**
MA of Valle de Mexico	813,836	5,083,414	3,675,453,780	1,795,572,003	20,760,239
MA of Puebla-Tlaxcala	128,250	577,848	408,706,324	140,921,564	2,802,773
MA of Toluca	78,771	388,087	325,361,254	103,894,516	1,994,045
MA of Queretaro	45,618	355,386	267,694,866	81,932,872	1,202,157
MA of Cuernavaca	41,367	179,507	109,372,596	34,972,767	924,625
MA of Tula	9,925	48,777	213,430,373	20,811,523	219,689
San Juan del Rio	10,108	61,383	54,326,559	15,475,977	264,134
MA of Tlaxcala-Apizaco	27,231	95,574	46,016,995	14,375,105	527,140
MA of Pachuca	25,281	105,295	26,498,104	11,996,153	581,502
MA of Cuautla	21,771	69,188	28,551,852	10,808,839	468,550
MA of Tianguistenco	7,759	27,235	22,437,013	8,556,283	172,049

[5] Reilly Index calculates a boundary point between the site of indifference and competition sites. Considers the population between the points competition and the distance of these to the point of indifference.

MA of Tehuacan	16,648	67,038	19,614,047	5,188,219	308,062
MA of Tulancingo	11,123	34,845	5,871,822	3,056,217	263,315
MA of Puebla	5,302	21,808	4,096,248	1,916,230	127,336
Atlixco	6,596	17,156	2,260,388	1,193,821	130,104
Ixtlahuaca	4,797	15,314	3,565,958	1,158,550	151,306
Taxco de Alarcon	8,972	18,563	1,475,463	829,306	107,303
San Felipe del Progreso	2,342	4,675	290,964	154,044	136,208
Total	**1,265,697**	**7,171,093**	**5,215,024,606**	**2,252,813,989**	**31,140,538**
*Number of units **Number of people					

Source: Authors' calculations based on data from INEGI.

Table 2 Economic nodes in the center region of Mexico, 2013 (percentages).

Economic Nodes	Economic Units	Employment	Total Gross Production	Value Added	Population
MA of Valle de Mexico	64.3	70.9	70.5	79.7	66.7
MA of Puebla-Tlaxcala	10.1	8.1	7.8	6.3	9.0
MA of Toluca	6.2	5.4	6.2	4.6	6.4
MA of Queretaro	3.6	5.0	5.1	3.6	3.9
MA of Cuernavaca	3.3	2.5	2.1	1.6	3.0
MA of Tula	0.8	0.7	4.1	0.9	0.7
San Juan del Rio	0.8	0.9	1.0	0.7	0.8
MA of Tlaxcala-Apizaco	2.2	1.3	0.9	0.6	1.7
MA of Pachuca	2.0	1.5	0.5	0.5	1.9
MA of Cuautla	1.7	1.0	0.5	0.5	1.5
MA of Tianguistenco	0.6	0.4	0.4	0.4	0.6
MA of Tehuacan	1.3	0.9	0.4	0.2	1.0
MA of Tulancingo	0.9	0.5	0.1	0.1	0.8
MA of Puebla	0.4	0.3	0.1	0.1	0.4
Atlixco	0.5	0.2	0.0	0.1	0.4
Ixtlahuaca	0.4	0.2	0.1	0.1	0.5
Taxco de Alarcon	0.7	0.3	0.0	0.0	0.3
San Felipe del Progreso	0.2	0.1	0.0	0.0	0.4
Total	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**

Source: Authors' calculations based on data from INEGI.

Once economically dominant nodes are identified, their impact area using Index Reilly is identified, they are also considered the connections of the transport system and natural barriers. Of the 18 nodes 9 were identified as the major centers, while the rest were incorporated as part of the area of influence of the main nodes:

• San Juan del Rio as part of the area of influence of the ZM Queretaro

• MA of Cuautla and Taxco as part of the area of influence of the MA Cuernavaca
• MA Tianguistenco, San Felipe del Progreso and Ixtlahuaca as part of the area of influence of the MA Toluca
• MA of Tulancingo as part of the area of influence of the MA Pachuca
• Atlixco as part of the area of influence of the MA Puebla-Tlaxcala
• MA of Puebla as part of the area of influence of Tlaxcala-Apizaco

Thus FESU are made up of a central node and its area of influence is integrated by municipalities. FESU has the same name that the node that governs them. The most important FESU is the Valley of Mexico, containing more than 50% of economic units and population, more than 60% of the total gross output and employment, and generates 77% of the value added of the regional total.

Table 3 Funtional Economic Spatial Units in the center region of Mexico, 2013 (thousand of pesos).

Economic Nodes	Economic Units*	Employment**	Total Gross Production	Value Added	Population**
Valle de Mexico	813,836	5,083,414	3,675,453,780	1,795,572,003	20,760,239
Puebla-Tlaxcala	182,158	698,230	431,060,051	149,574,016	4,120,912
Toluca	129,253	548,033	390,367,975	129,667,917	3,935,633
Queretaro	72,183	470,545	336,526,974	103,807,237	2,172,978
Cuernavaca	93,935	320,239	146,493,527	50,553,189	2,052,965
Tula	29,995	121,518	244,736,811	34,748,641	963,526
Tlaxcala-Apizaco	65,130	200,521	61,836,080	21,644,767	1,782,976
Pavhuca	62,582	216,686	53,531,499	21,336,091	1,916,318
Tehuacan	38,730	122,425	33,370,439	10,460,971	944,457
Total	1,487,802	7,781,611	5,373,377,136	2,317,364,832	38,650,003

*Number of units
**Number of people

Source: Authors' calculations based on data from INEGI.

Table 4 Funtional Economic Spatial Units in the center region of Mexico, 2013 (percentages).

Economic Nodes	Economic Units	Employment	Total Gross Production	Value Added	Population
Valle de Mexico	55	65	68	77	54
Puebla-Tlaxcala	12	9	8	6	11
Toluca	9	7	7	6	10
Queretaro	5	6	6	4	6
Cuernavaca	6	4	3	2	5
Tula	2	2	5	1	2
Tlaxcala-Apizaco	4	3	1	1	5
Pavhuca	4	3	1	1	5
Tehuacan	3	2	1	0	2
Total	100	100	100	100	100

Source: Authors' calculations based on data from INEGI.

The new airport (and current) are in the Valley of Mexico FESU, which as shown is the most important area of the region. The remaining 8 FESU adopts a new territorial configuration according to the construction phase of the airport, each will have different flows of population and employment, in the same way you will have different requirements of housing infrastructure, roads and housing. Therefore it is necessary to know the interactions given within each given FESU and interactions between other FESU.

Because each of the FESU has different characteristics and whose employment needs are based on the new project aims to identify sectoral transactions within the FESU and including highlighting the construction sector, as this is are the activities related to urban infrastructure, using a model of multi-regional input product. This model uses the bottom-up approach, from the construction of a system of regional accounts.

3. Construction of a system of accounts

Under the approach of the spatial dimension and economic functionality of the study area, there is the need to know the economic aggregates and balances Within the region and Its distribution by FESU. So They Have an economic accounting system That Allows see sectoral and productive interactions That same accounting identity meet the production-income-spending.

In the case of Mexico, the available information is presented in economic and population censuses, some are available to the Local level. However no data found only in macroeconomic aggregates, which do not allow to know Where spatially located or the Importance of the regions. For these cases it is necessary to estimate the aggregate for local translating information and thereby validate the Importance of economic nodes and their areas of influence.

With the creation of a regional system of accounts it is possible to establish a basis for consolidating components of supply and demand of production; which in turn is the basis for the development of the multi-regional input output matrix.

National accounts differ from regional accounts in the framework of an open economy. In the regional accounts it is considered an open economy, ie, no tax or trade barriers, flows of goods and services, financial and immigration are not regulated, it is a similar situation between countries. The system can be simplified regional accounts in an accounting scheme (Asuad, 2001), which consists of four accounts:

i. Product Account: It is calculated as the production of goods and services produced locally, resulting from the use of regional resources. The sources refer to the consumption of households, businesses and government (C), local investment (I), exports from the region (X) and imports (M) that the region requires:

$$Y = C + I + X - M$$

ii. Income and Expenditure Account: It is calculated as the difference between the product (Y) and private consumption and government (C), that is as personal and government (S) savings:

$$S = Y - C$$

iii. Savings and investment account: It is calculated using local investment (I), as the difference between personal savings (S) and less government investment remains the country (IR):

$$I = S - IR$$

iv. Account of the rest of the country: It is calculated as the interactions between the region and the rest of the country. Is the difference between exports (X) and imports (M).

$$IR = X - M$$

The other variables such as value added, total gross output, intermediate consumption, gross fixed capital formation are obtained directly from economic censuses available.

4. Construction of the multi-regional input-output matrix

The methodology for the construction of the multi-regional input-output matrix consists of the following stages:

i. Matrices internal transactions are calculated using regional accounts and using a traditional method of location quotients. With these arrays conform the main diagonal.
ii. The level of activity breakdown to be used is identified. In this case it is required to open a branch activity level for interactions and impacts on sectors affecting demand for urban infrastructure.
iii. The interaction between economic activities through sectoral indices and weight correlation is identified.
iv. Key sectors identified in the activities, both as sellers and buyers.

v. FESU interactions are identified by type of economic activity.

vi. Intersectoral interactions are weighted by matrices interaction between FESU. Thus the coefficients are obtained to meet intersectoral interactions purchases and sales.

vii. Finally the multi-regional matrix is obtained by the method of RAS.

5. Preliminary results

Preliminarily calculating labor demand derived from the requirements of urban infrastructure was obtained using the planned investment for this and weighting with chains forward, matrices obtained from the transaction between FESU.

Table 5 Investment in urban infraestructura, 2014-2018 (million of pesos)

	2014	2015	2016	2017	2018
Growth Rate	2.3	2.3	2.6	4	4
Roadworks Investment	509.67	2,175.77	3,947.84	5,344.67	4,422.05
Social works	146	624	1,131	1,532	1,267

Source: Plan Master of the New Airpor.

Table 6 Employment in the stage of construction of the airport, 2014-2018, using the investment in urban infrastructure.

2013		2014		2015		2016		2017		2018	
With investment	Without Investment	With investment	Without Investment	With investment	Without Investment	With investment	Without Investment	With investment	Without Investment	With investment	Without Investment
931,047	-	952,461	1,018,034	952,461	1,232,392	955,254	1,463,178	968,289	1,655,927	968,289	1,537,223

Source: Authors' calculations based on data from INEGI.

References

- Asuad Sanen Normand Eduardo (2014) Pensamiento económico y espacio- Economic Thinking and space-, Colección economía regional y urbana, Volumen Primero, Facultad de Economía de la UNAM.

- Asuad Sanen Normand Eduardo (2001) Economía regional y urbana . Introducción a las teorías, técnicas y metodologías básicas. – Urban and Regional Economics. An introduction to the theories, technics and basic Methodologies- Benemérita Universidad Autónoma de Puebla, Colegio de Puebla, Asociación de Ex alumnos de economía de la FE-UNAM.

- Flegg A. T., Webber C.D. & Ellliot M. (1995). On the appropriate use of location quotients in generating regional imput –output tables. Regional Studies, Vol. 29, No 8. Flegg A. T. &Webber C.D. (1997). On the Appropriate Use of Location Quotients in Generating Regional Input-Output Tables: Reply. Regional Studies, 1997, vol. 31, issue 8, pages 795-805.

- Miller y Blair (2009), Input-Output Analysis, Cambridge University.

Web Pages:

• *National Institute of Statistics, Geography and Informatics, www.inegi.org.mx*
• Ministry of Finance and Public Credit, www.shcp.gob.mx/
• Ministry of Communications and Transport, www.sct.gob.mx/
• Industrial Classification System of North America, www.inegi.org.mx/sistemas/scian/
• Program PyIO, www.real.illinois.edu/pyio/