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Creative Industries and Innovation in Mexican Cities

Industrias Creativas e Innovación en las Ciudades de México

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Abstract

Cities are the main productive space in Mexico. Metropolitan Areas (MA) constitute the urban space with the highest concentration of population and economic activity. Metropolitan Areas are also the privileged place for the concentration of talented people and highly creative economic activities. Creative industries represent more than 3% of employment and, if all creative activities are accounted, this figure exceeds 7% of national employment. Additionally, the rate of growth in these sectors is far superior than that of the national economy, their average annual growth almost doubles the whole economy’s growth rate. The aim of this study is to show empirical evidence that the creative activities sector contributes to the reduction of productive inefficiency through innovation, which leads to a productivity growth that improves the competitive situation of firms in cities with greater concentration of talent and creativity. We use the NESTA and UNCTAD methodology to classify creative sectors, then we use a stochastic frontier model to measure the impact that creative industries have on the efficiency, innovation and productivity of Mexican cities. To that end, we studied creative industries in 59 Metropolitan Areas of Mexico, using data from the Economics Census published by the National Institute of Statistics and Geography (INEGI). Our results show that Research & Development, as well as Software, are the creative sectors that generate strong spillover effects on the rest of the activities in Mexican cities, and lead to higher levels of productive efficiency in all productive sectors of the economy.

Keywords: Innovation, productivity, creativity, concentration, metropolitan areas

JEL Code: O30, O40, M54, Z10

Resumen

Las ciudades son el principal espacio productivo de México. Las Áreas Metropolitanas (AM) constituyen el espacio urbano con mayor concentración de población y actividad económica. Las Áreas Metropolitanas son también el lugar privilegiado para la concentración de personas con talento y actividades económicas altamente creativas. Las industrias creativas representan más del 3% del empleo y, si se contabilizan todas las actividades creativas, esta cifra supera el 7% del empleo nacional. Además, la tasa de crecimiento de estos sectores es muy superior a la de la economía nacional; su crecimiento anual promedio casi duplica la tasa de crecimiento de toda la economía. El objetivo de este estudio es mostrar evidencia empírica de que el sector de actividades creativas contribuye a la reducción de la ineficiencia productiva a través de la innovación, lo que conduce a un crecimiento de la productividad que mejora la situación competitiva de las empresas en las ciudades con mayor concentración de talento y creatividad. Utilizamos la metodología NESTA y UNCTAD para clasificar los sectores creativos, luego utilizamos un modelo de frontera estocástica para medir el impacto que tienen las industrias creativas en la eficiencia, innovación y productividad de las ciudades mexicanas. Para ello, estudiamos las industrias creativas en 59 Áreas Metropolitanas de México, utilizando datos del Censo Económico publicado por el Instituto Nacional de Estadística y Geografía (INEGI). Nuestros resultados muestran que Investigación y Desarrollo, así como Software, son los sectores creativos que generan fuertes efectos derrame sobre el resto de las actividades en las ciudades mexicanas, y conducen a mayores niveles de eficiencia productiva en todos los sectores productivos de la economía.

Palabras clave: Innovación, productividad, creatividad, concentración, áreas metropolitanas

Códigos JEL: O30, O40, M54, Z10

1. INTRODUCTION

An interview asked sixty-four of the most important Mexican businesspeople what factors could stimulate productivity growth in the country. They answered that talent was the first factor, infrastructure came second, and digital infrastructure or ICTs came third (Accenture, 2015).

These entrepreneurs were right; talented people have been, and are, a central factor in the development of any economy (Towse & Hernández, 2020; Comunian et al., 2021; Khlystova & Kalyuzhnova, 2023; Swords& Prescott, 2023). Richard Florida widely discussed this (2002) when formulating the concept of creative class. However, when the same Mexican businesspeople questioned how productivity could accelerate their growth, they mentioned that technology, customer connections, and innovation were the most critical levers. The same happens with entrepreneurs as with many scholars on the subject of innovation; they fail to establish a clear connection between talent, creativity, and innovation. Cultural and Creative Industries (CCIs) are fundamentally linked to culture and art as if they were only a part of the amenities of any city (Hesmondhalgh, 2002; Landry, 2008; Garcerán, 2012; Florida, 2014; Dellisanti, 2023), while its main effect is seen as an improvement in the quality of life (Florida, 2004; Pratt, 2008; Montanari, Scapolan, & Mizzau 2018; Pourzakarya, & Fadaei Nezhad Bahramjerdi, 2023; Kalfas et al., 2024).

An essential change in this traditional vision has been the contribution to measuring the impact of the CCIs on the countries' economy and their regions. The Department of Communications and the Arts (Creative Nation: Commonwealth cultural policy, 1994) of the Australian government pioneered the idea that creativity should be taken to economics because it is an essential source of wealth.

Measurements of the relevance of CCIs in the economy have also been made by the Department for Culture, Media and Sport (DCMS) in the United Kingdom (1998), the United Nations Conference on Trade and Development (UNCTAD, 2008), and the work of UNESCO (2005), among many other organizations and institutions.

Despite these crucial efforts to quantify the role of CCIs in the economy, the literature has been mostly limited to studying regional growth, employment, and international trade. Moreover, the products of the CCIs are complex goods due to their high degree of intangibility (UNESCO, 2005), so their benefits are not necessarily expressed in economic values (Hartley, 2005; Hesmondhalgh, 2007; Bakhshi, McVittie, & Simmie, 2008; O´Connor, 2010; Hearn, & McCutcheon, 2020; Burlina et al., 2023). Thus, like entrepreneurs, many economists link innovation and productivity only to traditional industries.

Notwithstanding these constraints from the economic mainstream, it has recently been recognized that CCIs can be highly relevant to innovation in all sectors of the economy (Innocenti & Lazzeretti, 2019). However, this has not translated into a large number of empirical studies, possibly due to what Miles and Green (2008) have called "hidden innovation", to reflect the fact that CCIs give rise to new products, new activities, new business forms, novel combinations of existing processes and technologies, all of which cannot be accounted for through common innovation indicators.

Cities are the main productive space in Mexico. Metropolitan Areas (MA) constitute the urban space with the highest population and economic activity; 85% of the urban population lives there, generating 77.1% of total gross production and 72.6% of total employment.

Metropolitan Areas are also privileged places for the concentration of talented people and highly creative economic activities. Creative industries represent more than 3% of national employment; if all creative activities are accounted for, this figure exceeds 7%. Additionally, the growth rate in these sectors is far superior to that of the national economy; their average annual growth almost doubles the whole economy's growth rate.

In this work, we subscribe to a nontraditional vision under which CCIs play an essential role in innovation. We incorporate our perspective based on stochastic frontier models, which allows us to discover the hidden innovation effect of CCIs through their contribution to greater efficiency in productivity in different sectors of the economy.

The document is divided into five sections. After the introduction presenting the research, section 2 reviews the literature on creativity, innovation, productivity, and efficiency. Section 3 presents the analytical model, and section 4 presents the research results. Finally, section 5 presents the final considerations and recommendations at the policy management level.

2. CREATIVITY, INNOVATION, PRODUCTIVITY AND EFFICIENCY

The link between creativity and innovation should not be the subject of much discussion, given that innovation requires high technical knowledge and creativity. However, mainstream conceptualizations have ignored the role of creative industries by considering that the basis of innovation is the production and demand of goods and leaving aside the role of services and the intangible element that constitutes them (Howkins, 2001; Caves, 2002; Pratt, 2011; Strazdas, Cemeviciute, & Jancoras, 2014).

New perspectives consider that creative industries fulfill three roles in innovation processes: they produce ideas that potentially generate new goods and services, offer services that are inputs of other companies, and are industries intensive in new technology, which promotes innovation (Howkins, 2001; Cunningham, 2002; Müller & Rammer, 2009; Hesmondhalgh & Pratt, 2013; Koch et al., 2023; Krisiukėnienė & Pilinkienė, 2023). This means that how creative industries give rise to innovation processes is quite complex, so not any product of CCIs leads to innovation. Although creative products may represent new ideas, they do not become innovative if they do not meet market needs, their relevance is not recognized socially, or they are not successfully accepted and implemented (Dowejko & Xiao, 2018; Huang & Zou, 2023).

The link between productivity growth and innovation has traditionally been discussed within approaches that take Solow's (1957) model as a starting point. Results from these studies suggest that changes in productivity are not only due to the increase in the factors of production (labor and capital) but also due to a residual part called technical change. In Solow's residual, practically anything fits, and empirical studies have included improvements in the quality of work and capital, as well as Research and Development, among other elements, in this residual (Hall, 2011). This has led to the argument that the residual part generates innovation. Consequently, studies on the subject have used Research and Development or patents as proxy variables for innovation processes. However, Barro and Sala-i-Martin (2003) point out that these approaches are simple accounting approaches, under which it is impossible to discern whether changes in productivity are generated by technical change or by improvements in efficiency.

Although productivity is defined simply as the quantity produced per input unit, its measurement is complicated. A central problem resides in the fact that the product is not reported as a quantity in national accounts but as the monetary value of the production; therefore, any ratio built with that indicator leads us to what could be called monetary productivity. Secondly, the inputs used in its measurement would only make some sense for incorporating work. Meanwhile, the aggregate production function, in which capital is used to measure Total Factor Productivity, has been criticized for lacking solid theoretical foundations and being considered fictitious (Felipe & McCombie, 2005; Block, 2022).

To overcome the limitations above, this research uses the most widely used and less-*questified* indicator, monetary labor productivity, defined as the ratio of value added per employed person. Either way, in any productivity indicator, the established ratio of output to inputs does not indicate anything about production efficiency. The consequence is that when efficiency is not considered, the analysis of productivity growth will be biased and lack precision, as pointed out by Grosskop (1993), Nordhaus (2003), and Gordon (2016). To circumvent these shortcomings, we calculate the monetary labor productivity of the 59 metropolitan areas of Mexico[1] but also generate an efficiency measure through stochastic frontier models (Kumbhakar, Denny & Fuss, 2000). The advantage of these models is that efficiency can be conditioned to its causal factors, within which we can include CCIs.

In this way, it will be possible to evaluate whether CCIs contribute to reducing productive inefficiency in cities with the highest concentration of talent and creativity. The evidence for Mexican cities is very scarce; the only precedent for Mexico is the works of Borrayo and Quintana (2017) and Valdivia et al. (2020), who apply the stochastic border method and condition the efficiency indicator to an aggregate of creative activities.

This study extends the work above by Borrayo and Quintana to study the technical efficiency of the 59 metropolitan areas of Mexico and updates the proposal of Valdivia et al. (2020). We expand on the disaggregation of creative sectors since some have different weights on cities' productivity, competitiveness, and efficiency. In particular, we incorporate CCI segmentation into Arts, Services (creative), Software, Research and Development (R&D), and Entertainment. This segmentation, in turn, is a proxy for the concentric classifications of CCIs, where Arts would form the central circle and "furthest" from the market, while the (creative) service segment and software would be located on the outermost circles.[2]

3. ANALYTIC MODEL

Productive differences between companies, even in the same sector and product, can be explained in terms of efficiency, and the presence of CCIs in this research will express part of this.

To this end, we specify a stochastic production frontier model with panel data using the procedure of Kumbhakar et al. (2015) and the routines of Belotti et al. (2013). The model defines a vector x_i of input variables that determine the levels of monetary labor productivity. Even if the input vector x_i were

[1] We use all 59 metropolitan areas of Mexico as defined by CONAPO (2010) (see Annexes 1 and 2).
[2] Throsby (2008) proposed the idea of concentric circles. Creative arts would locate at the core circle, while more commercial disciplines would move away in concentric circles, gradually reducing the extent of the cultural.

precisely the same for different producers, it is still possible and likely that differences exist between the observed product y_i and the potential product. That difference is defined as the technical efficiency (ET), while technical inefficiency would be described as $IT = 1 - ET$.

To estimate these models, we formulate a labor productivity function such as the following (Battese & Coelli, 1995):

$$\ln (y_{it}/po_{it}) = ln\, f\left(x_{it,}\delta_{it}; \beta\right) - u_{it} + v_{it} \ldots (1)$$

Where y_i is the value added of metropolitan area i, po_i is employed population in metropolitan area i, x_i is the capital-labor ratio, and δ_i is a productive diversification indicator that accounts for the effects of Jacobs-type externalities on the productivity of cities.3

The error term has two components, a random disturbance term v_{it} with a normal distribution that complies with the assumptions of being independent, identically distributed, and having zero mean and constant variance $[iid\ N(0,\, \sigma_v^2)]$, and a random variable u_{it} that captures the effects of technical inefficiency in production and is distributed independently according to a normal distribution truncated in negative values, with a mean m_{it} that has the characteristic of existing between zero and one, and with a constant variance $N(m_{it},\, \sigma_u^2)$.

The Battese and Coelli (1995) methodology allows specifying the levels of expected or average inefficiency $E(u_{it}) = m_{it}$ as a function of a set of variables z_{it} among which is the presence of the creative sectors and the effect of sectoral diversification:

$$E(u_{it}) = z_{it}\delta + \varepsilon_{it} \qquad (2)$$

We use equations (1) and (2) to analyze the relevance of the creative sectors in technical efficiency and in determining labor productivity in the 59 metropolitan areas of Mexico. The variables used to condition equation (2) of inefficiency are disaggregated according to the five creative sectors defined. We introduce a diversification index to capture the effect of Jacob-type externalities.

Table 1 shows the classification used for CCIs, following the North American Industrial Classification System used in the Mexican Economic Census. The classification is based on the one proposed by the Orange Economy (Buitrago & Duque, 2013), which is more closely linked to the conditions of the creative sectors in Latin America. We exclude gastronomy and include R&D to broaden the classification beyond the limits imposed by the cultural sector. This broader classification encompasses technological sectors that are essential for understanding innovation processes in production (Bakhshi, Benedikt & Osborne, 2015; Valdivia et al., 2020).

[3] For Jacobs (1970) a high productive diversification will lead to further growth, due to increasing sectoral competition.

Table 1. Classification of Cultural and Creative Industries

Subsector/Group/Industry*	
ART	
512	Film and video industry and sound industry
7111	Artistic and cultural entertainment companies and groups
7115	Freelance artists, writers, and technicians
51912	Libraries and archives
54131	Architecture
71211	Museums
71212	Historical sites
71213	Botanical gardens and zoo
SERVICES	
511	Publishing of newspapers, magazines, books, software and other materials, and editing of these publications integrated with printing
515	Radio and television
5414	Specialized design
5418	Advertising services and related activities
7113	Promoters of artistic, cultural, sports and similar shows
51911	News agencies
54191	Market research and public opinion polling services
SOFTWARE	
518	Electronic information processing, hosting and other related services
5415	Computer systems design services and related services
51913	Editing and dissemination of content exclusively through the Internet and online search services
R+D	
5413	Architectural, engineering and related activities services
5417	Scientific research and development services
54162	Environmental consulting services
54169	Other scientific and technical consulting services
ENTERTAINMENT	
7114	Agents and representatives of artists, athletes and the like
7131	Parks with recreational facilities and electronic games houses
7132	Casinos, lotteries and other games of chance
7139	Other recreational services

* Subsector=3 digits, Group=4 digits, Industry=6 digits

Source: Prepared by the authors based on the North American Industrial Classification System (INEGI, 2020), Nathan, Kemeny, Pratt, & Spenser (2016), Valdivia et al. (2020), and UNCTAD (2008).

Equation (1) is estimated in terms of labor productivity, which is specified using a Cobb-Douglas function, linearized using natural logarithms:

$$\ln\left(VACB_{it}/PO_{it}\right) = \alpha_0 + \beta_1{}'\ln\left(ABKF_{it}/PO_{it}\right) + \beta_2{}'\ln\left(Diver_{it}\right) + \left(v_{it} - u_{it}\right) \ldots (3)$$

The dependent variable is the monetary labor measured by the logarithm of the ratio between real gross value added (VACB) and employed population (PO) for 2003, 2008, 2013, and 2018. The input variable was calculated as the ratio of gross fixed capital stocks (ABKF) to the employed population of each MA for the same years. Finally, the variable that allows us to capture the effect of Jacobs-type externalities is a diversification index (Divers) calculated as the inverse of the Hirshcman-Herfindal index (IHH).4

The technical inefficiency model (Eq. 2) associated with the stochastic boundary (Eq. 1) is specified as follows:

$$u_{it} = \gamma_0 + \gamma_1 \cdot AR_{it} + \gamma_2 \cdot SER_{it} + \gamma_3 \cdot SOFT_{it} + \gamma_4 \cdot R\&D_{it} + \gamma_4 \cdot ENTR_{it} + \gamma_5 Diver_{it} \cdot \ldots (4)$$

Where AR_{it} is the population employed in creative art activities in metropolitan area i in year t; SER_{it} is the population working in creative services; $SOFT_{it}$ is employed population in the software sector; $R\&D_{it}$ is employment in the research and development sector, $ENTR_{it}$ is employed population in entertainment activities and $Diver_{it}$ is the diversification index.

[4] The IHH was calculated using all subsectors (three-digit classification) of the manufacturing industry for each of the 59 metropolitan areas. Through the sum of the squared shares of these subsectors, the IHH indicates the degree of sectoral concentration in each metropolitan area, while 1-IHH represents the degree of manufacturing sectoral diversification.

4. LABOR MONETARY PRODUCTIVITY AND PRODUCTIVE EFFICIENCY

4.1 Trends in labor productivity

Labor productivity in the 59 metropolitan areas of Mexico (MA), measured as the ratio of real gross value added (VACB) to employed population (PO), has had a decreasing trend throughout the period 2003-2018. This trend is due to the consistent reduction in productivity during the periods between the economic censuses, 2003-2008, 2003-2013, and 2003-2018 is shown as negative growth rates of -2.4%, -1.9%, and -0.8 for each inter-census period respectively; See Table 2. These results are not surprising for the country; labor productivity in Mexico is the lowest of all OECD countries. According to this organization, 24 dollars is produced for each hour of work in Mexico, while the average for all OECD countries is $67.5 (OECD, 2024).

Table 2 establishes that most metropolitan areas have low productivity and negative growth rates. It also shows that the regions with above-average productivity, at 75% (3rd quintile) of the distribution, presented the smallest decreases in productivity and even improved their productivity levels in the last period. However, the latter contrasts with the fact that the sharpest drop in productivity occurred in the MA with the highest level of productivity.

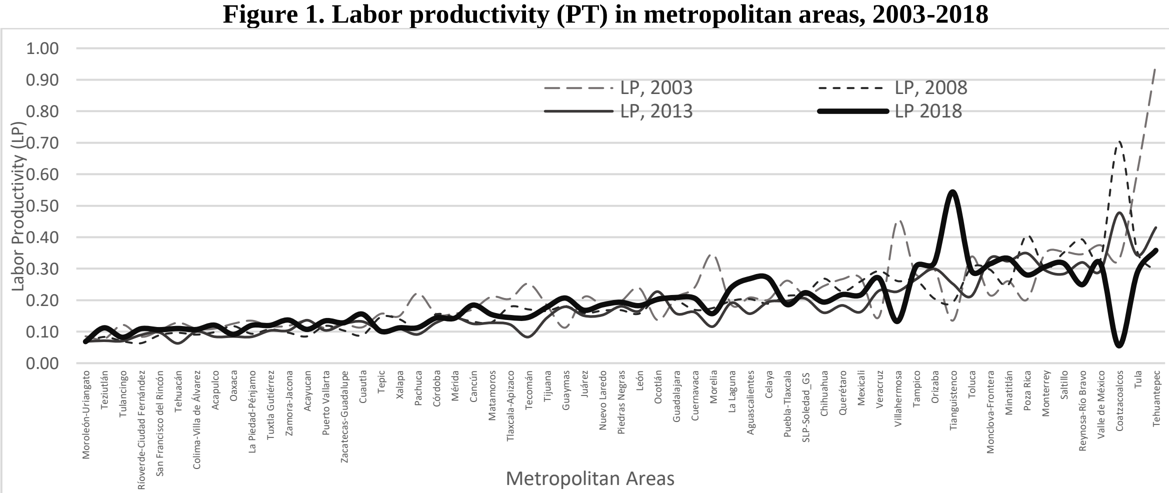
Table 2. Stylized facts of labor productivity ($VACB_{it}/PO_{it}$) 2003-2018

	2003	2008	2013	2018	2003-2008	2003-2013	2003-2018
					average annual rate (%)		
minimum	0.08	0.06	0.06	0.06	-3.4	-1.8	-1.9
1st quintile	0.10	0.08	0.07	0.09	-3.9	-3.1	-0.8
mean	0.22	0.20	0.18	0.19	-2.4	-1.9	-0.8
median	0.20	0.17	0.16	0.18	-3.0	-2.2	-0.6
3rd quintile	0.26	0.26	0.23	0.27	-0.2	-1.3	0.2
maximum	0.95	0.70	0.48	0.54	-5.2	-5.0	-2.9
standard dev.	0.14	0.11	0.09	0.09	-4.3	-3.2	-2.3

Source: Author's estimates were based on the data from the Economic Censuses of 2004, 2009, 2014, and 2019.

To analyze these results in greater detail, we sorted MAs from lowest to highest on labor productivity, according to the 2018 census indicators. Figure 2 shows the productivity reference levels for 2018 (black line), compared to the observed productivity in the 2013 census (red line), the 2008 census (blue line), and the 2003 census (green line).

Figure 1. Labor productivity (PT) in metropolitan areas, 2003-2018



Source: Authors using data from the Economic Censuses of 2004, 2009, 2014, and 2019.

The graph shows that no single leader has the highest productivity value over the entire period: Tehuantepec was the leader in 2003, Coatzacoalcos in 2008 and 2013, and Tianguistenco in 2018. These cities traditionally have significant industrial developments, such as the oil industry in Coatzacoalcos or the automotive sector in Tianguistenco, or they produce energy and agricultural products, such as Tehuantepec.

There is a clear pattern in the behavior of productivity among metropolitan areas; in those with the lowest levels of productivity, the trend over time has been towards growth over the years, as can be seen in the first fifteen metropolitan areas that go from Moroleón to Cuautla in Figure 1; it can be seen that, in general, productivity in 2018 is higher than in previous years. A second group with intermediate productivity levels deteriorated slightly between 2003 and 2013, ranging from the metropolitan areas of Tepic to Mexicali. Finally, a group with high levels of productivity whose current levels are well below those that prevailed in previous years are the areas that go from Poza Rica to Tehuantepec.

In conclusion, the general trend of declining labor productivity in the metropolitan areas of Mexico is characterized by three groups: one of low labor productivity and negative growth rates (between the minimum and 1st quintile), another of productivity around the mean (3rd quintiles) with moderate decreasing trends in productivity and recovery in the last period, and a last group of areas with high labor productivity and sharp declines between the years 2003 and 2018.

4.2 Econometric results of the productive frontier and technical efficiency model

As discussed in the first section of this chapter, productivity growth does not necessarily indicate an efficient evolution, nor does it imply innovation in production.

To evaluate the efficiency levels of labor productivity in the country's metropolitan areas, we estimated the stochastic production frontier model corresponding to equations (3) and (4). To evaluate the effects of innovation from the creative sectors, we conditioned equation (4) on the size of the creative sectors in the different metropolitan areas to account for the intangible effects of these sectors on productive innovation and efficiency.

In the results of Table 3 for the production frontier function, we confirmed that labor productivity is positively related to capital density (capital per employed person or capital-labor ratio). Thus, increases (decreases) in the capital-labor ratio will result in increases (decreases) in output per employed person or monetary labor productivity in metropolitan areas. Since the coefficient is statistically different from zero or significant, it is interpreted as follows: at a 10% increase in capital density, labor productivity will increase by 4.6%. This means that the capital investment capacity in cities is the fundamental engine for labor productivity growth.

Also, in Table 3, we observe that the effect of Jacobs-type externalities, although negative, was insignificant since the coefficient of the diversification variable could be considered zero. This means that Mexican cities fail to fully exploit agglomeration economies, and, therefore, there is a potential level of productivity that needs to be exploited.

In the part of the model where the average behavior of inefficiency is explained (Mu in Table 3); the coefficients of the five creative segments determining the level of technical efficiency of each MA are highly significant. Furthermore, the effect of the variable Diversification is significant, indicating that Jacobs-type economies operate on productivity efficiency levels. The inference of these results suggests that research and development in metropolitan areas, together with software development and productive diversification, are the factors that contribute to reducing technical inefficiency in cities and, consequently, to improving their efficiency as a competitive position, which is verified by the negative sign obtained in both coefficients. Art and creative services have a positive effect on increasing productive inefficiency, which could be explained by the low linkage of these sectors with manufacturing in Mexican cities.

Regarding the results for the variances, it was found that the creative activity of entertainment was significant and negative for both the production frontier and the technical inefficiency of the model. From an analytical point of view, these results imply that entertainment activities have a positive effect in reducing inequality in labor productivity and inefficiency among Mexican MAs. The positive role of entertainment can be understood as a positive effect on the quality of life. Creating entertainment zones in cities encourages local culture and attracts talented people looking for new ways of life in urban areas (Stevenson, 2006).

Table 3. Impact of creative sectors on productive efficiency 2003-2018

Endogenous Variable: Ln(VACB/PO)				
Frontier	**Coefficient**	**P>z**	**Coefficient**	**P>z**
Ln(AKF/PO)	0.460	0.00	0.489	0.00
Ln(Diversification)	-0.106	0.61		
Constant	-0.733	0.00	-0.675	0.00
Inefficiency measure (Mu)				
Ln(Art)	0.401	0.38	-0.762	0.00
Ln(Entertainment)	0.744	0.00	0.459	0.00
Ln(R&D)	-1.005	0.16	-0.872	0.07
Ln(Services)	1.211	0.01	0.598	0.02
Ln(Software)	-1.253	0.14	-1.180	0.05
Ln(Diversification)	-2.525	0.01		
Inefficiency Variance (Sigma_U)				
Ln(Art)	1.967	0.00	2.620	0.00
Ln(Entertainment)	-3.681	0.00	-4.023	0.00
Frontier Variance (Sigma_V)				
Ln(Art)	0.738	0.12	0.725	0.17
Ln(Entertainment)	-5.254	0.00	-5.488	0.00
E(sigma_u)	0.595		0.646	
E(sigma_v)	0.306		0.289	

Source: Authors' estimates were based on the 2004, 2009, 2014, and 2019 Economic Census data.

4.3 Technical efficiency Analysis

We observed that average technical efficiency levels increased slightly from 77% to 78% from 2003 to 2018. However, they had decreased in the intervening periods (see the mean in Table 4), where part of the increasing trend in average labor productivity is explained by productive investment in medium-sized cities. Thus, there is a chance to improve productivity in all the cities by promoting creative and cultural industries and taking advantage of the economies of scale generated by the diversification of local economies.

Drawing from our results, work productivity has an overall average efficiency level of 78%, equivalent to an inefficiency of 22% in cities. At the same time, we found that both minimum and maximum efficiency levels tend to decrease over time, in such proportion that the standard deviation tends to be relatively stable between cities during the study period.

Table 4. Stylized facts of technical efficiency, 2003-2018

	2003	2008	2013	2018	2003-2008	2003-2013	2003-2018
					average annual rate (%)		
minimum	0.48	0.40	0.41	0.25	-3.4	-1.6	-3.3
1st quintile	0.54	0.51	0.53	0.59	-1.2	-0.3	0.5
mean	0.77	0.76	0.75	0.78	-0.3	-0.2	0.1
median	0.80	0.80	0.77	0.83	0.0	-0.3	0.3
3rd quintile	0.88	0.88	0.86	0.89	-0.1	-0.3	0.1
maximum	0.97	0.96	0.96	0.95	-0.2	-0.1	-0.2
standard dev.	0.13	0.14	0.13	0.14	1.3	-0.6	0.2

Source: Authors' estimates using the efficiency component of the stochastic frontier model.

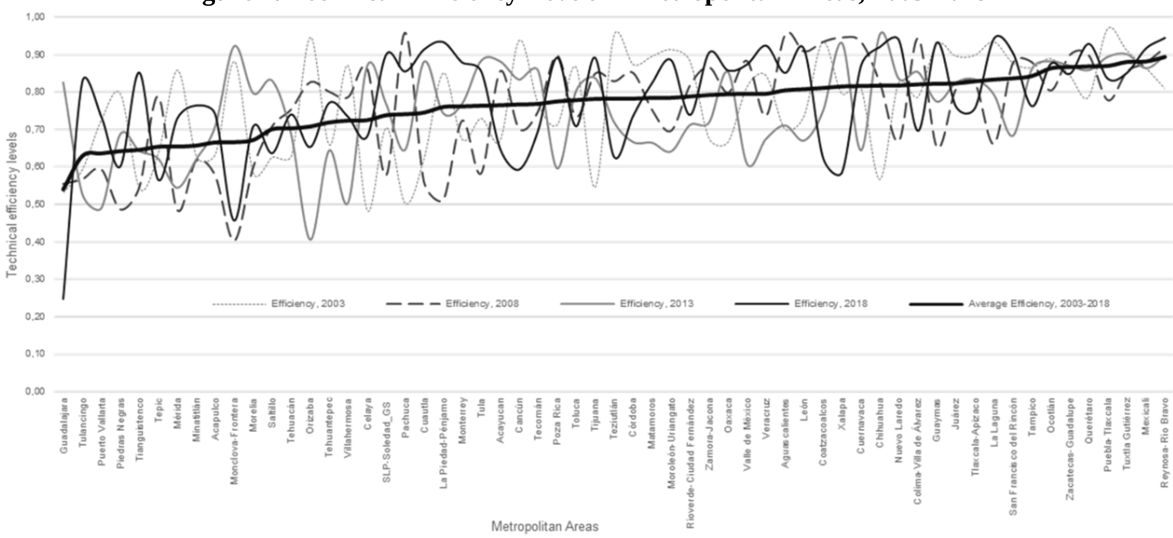
Figure 2 shows the hierarchical ordering (ranking) of efficiency levels in the average 2003-2018 and the levels corresponding to the years 2018, 2013, 2008, and 2003. With the ranking of the average 2003-

2018, it can be seen that the highest levels of efficiency occurred in cities in the north of the country (Mexicali & Reynosa) and in some industrial towns (Queretaro, Puebla & Zacatecas), which are linked to the export trade route with the United States and have a highly industrial component. The higher urban concentrations in the country, Mexico City, and the Monterrey Metropolitan Area have an intermediate position.

Notably, the most efficient metropolitan area is Reynosa, a city strategically located in the north region, with an excellent export activity of the electronics and auto parts industries to the United States.

Figure 2 shows that the least efficient city is Guadalajara, one of the country's large industrial areas. This result would point to the effect of the international crisis on Mexico after 2008, which devastated the economy by reducing the GDP growth rate by more than 5%, representing one of the worst economic collapses in recent years. The anti-crisis plans designed by the Mexican government in 2009 (Program to Promote Growth and Employment and the National Agreement in Favor of Employment and the Family Economy) were insufficient. They were described as a lesser effort than those carried out in other Latin American economies, which achieved a faster recovery (Isaac & Quintana, 2010).

Figure 2. Technical Efficiency Levels in Metropolitan Areas, 2003-2018



Source: Authors' estimates using the efficiency component of the stochastic frontier model.

5. FINAL CONSIDERATIONS

The contribution of CCIs to Mexico's GDP and value-added growth is still modest, especially compared with the United Kingdom, Australia, and other Asian countries, where an advanced sector of CCIs has been consolidated. However, this work has shown that the CCIs in Mexico could play a highly relevant role in the immediate future of cities, being a determining factor in innovation, efficiency, and productive growth.

The CCIs do not perform homogeneously; therefore, in this study, we segmented them into five groups to analyze their impacts on efficiency and productivity throughout the fifty-nine metropolitan areas of Mexico. The results clearly showed a heterogeneous behavior of the CCIs, led by the creative Services segment and followed by Entertainment.

One of our main conclusions is that, despite the considerable variability and decreasing trends in technical efficiency and labor productivity in Mexico's metropolises, a boost to the production activities of Software and Research and development would significantly increase technical efficiency and labour productivity in Mexican cities.

The country's metropolitan areas concentrate 85% of the urban population, 77.1% of its gross production, and 72.6% of employment. Consequently, what happens with their economies at the local level will have a high impact on the whole country's economic processes.

Our results allow us to infer that the primary determinant of productivity is capital density, which implies that capital investment is crucial to increasing the productive capacity of the country: a 10% increase in the capital-labor ratio becomes a 5% increase in urban productivity. However, for this investment effort to achieve high levels of efficiency, it requires the drive of innovation processes linked to CCI since these are the ones to achieve a high concentration of talented people and new ideas.

The results of our efficiency model point out that, in particular, the Software and Research and Development segments are potential drivers through which CCIs could generate innovation processes and increase productive efficiency in cities. We have also found that a sector traditionally linked to leisure, such as the Entertainment segment, plays a crucial role in improving the quality of life in cities and contributes to reducing inequality in the processes of productive growth by attracting talented people.

Productivity and growth have been associated with how agglomeration economies operate in cities. This work shows that economic diversification, with Jacobs-type externalities, is relevant in reducing productive inefficiency by harnessing economies of scale. However, diversification does not directly impact productivity levels, suggesting an untapped potential for city economic growth.

In sum, it is possible to affirm that CCIs will become a key element in the immediate future of Mexican cities. Therefore, public policy should strive to create the best conditions for talent, innovation, and the creative processes associated with these industries to flourish in the country. Implementing public policies to improve the conditions for talent, innovation, and creative processes in Mexico's Cultural and Creative Industries (CCI) requires a multi-faceted approach. Fiscal and financial incentives, such as credits, grants, and tax exemptions, are essential to support startups and small companies in the Software, Research and Development (R&D) and Entertainment sectors. In addition, creating innovation funds can facilitate access to venture capital for innovative projects. Education and training should be strengthened through training programs in digital and creative skills, promoting STEAM education (Science, Technology, Engineering, Art, and Mathematics) and providing continuous courses and workshops for sector professionals. Improving technological infrastructure, such as high-speed internet access, and establishing technology parks and innovation centers are crucial to providing technical support.

Furthermore, fostering networks and collaborations, both nationally and internationally, can enhance exchanging ideas and resources. Creative clusters and public-private partnerships are effective strategies for developing sustainable CCI projects. Through legislative strengthening and legal advice, intellectual property protection ensures that creators can benefit from their innovations. Promotion and visibility of CCIs through festivals, fairs, marketing campaigns, and digital platforms are fundamental to highlighting their impact on the economy. Finally, a favourable regulatory environment, the simplification of bureaucratic procedures, and urban revitalization that integrates art and culture can improve the quality of life and attract talent, consolidating CCIs as a critical element in the future development of Mexican cities.

Despite the robustness and applicability of the stochastic production frontier model with panel data following the procedures of Kumbhakar et al. (2015) and the routines of Belotti et al. (2013), its use has several inherent limitations. One of the main restrictions lies in the specific assumptions about the distribution of the inefficiency term, which, if not met, may lead to biased and inconsistent estimates. In addition, the choice between fixed or random effects may significantly influence the results, and unbalanced panel data may affect the robustness of the estimates. An additional challenge in our study is the temporal limitation of the data, which covers only 2003 to 2018. This temporal constraint is significant given that we are in the year 2024, and the lack of recent data in the database may prevent an up-to-date and relevant assessment of efficiency, omitting possible changes in technology and the economic environment that have occurred in recent years. Therefore, it is crucial to consider these limitations when interpreting the results obtained and designing future research.

Our research underscores the significance of creative industries and innovation in Mexican cities. It is crucial to consider various factors such as the creative classes (Florida, 2002 and 2004), the Orange Economy, the cultural industry, human capital, management, entrepreneurship, and business models (Rodríguez-Insuasti, Homero et al., 2022; Rodríguez-Insuasti, Homero et al., 2023) in forthcoming research.

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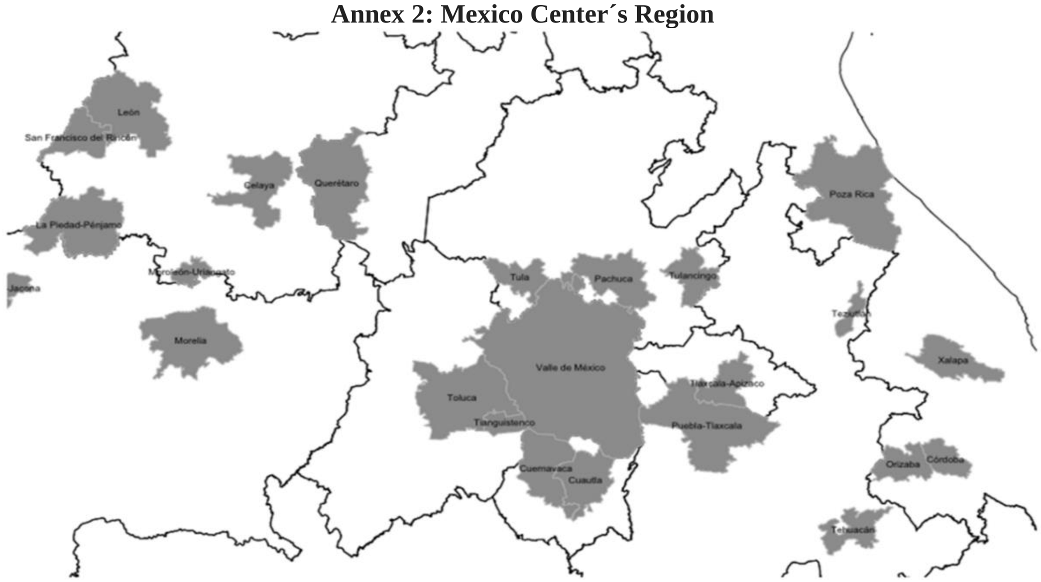
Annex 1: Mexican Cities

Source: Author's elaboration based on CONAPO (2010)

Annex 2: Mexico Center´s Region



Source: Author's elaboration based on CONAPO (2010)

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