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The aggregation of Total Factor Productivity (TFP) from micro to macro: evidence from Mexico, 1998-2023

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Abstract

This study examines Total Factor Productivity (TFP) in Mexico using establishment-level estimates from 1998 to 2023 and analyses two productivity aggregates: TFP in levels and TFP growth. These aggregates reflect the productivity transition from the micro to the macro level. Aggregate TFP (in levels) gives evidence across three productivity dimensions: temporal, geographical, and sectoral. Over time, aggregate TFP shows a fluctuating pattern, with the deepest decline during the 2008 global financial crisis and a further contraction in 2023. This pattern suggests a link between TFP and business cycle fluctuations. Aggregate TFP also shows substantial geographical and sectoral variation: states with higher productivity are supported by three sectors: (i) retail trade, (ii) wholesale, and (iii) mining, quarrying and oil and gas extraction. These sectors consistently maintained high productivity levels throughout 1998-2023. To analyse aggregate TFP growth, this study applies decomposition methodologies to measure the contributions of establishments that survive, enter, and exit the market. The results indicate that surviving establishments contributed negatively to average TFP growth between 1998 and 2023, while net entrants contributed positively. During the 2008 financial crisis, TFP growth of surviving and net-entrant establishments was severely affected. Although net entrants later improved TFP growth, surviving establishments did not fully recover from the 2008 crisis. This research provides empirical evidence on TFP that can serve for the design and implementation of industrial strategies in Mexico.

Keywords: Total Factor Productivity, Aggregate Productivity, Spatial Distribution, Industrial Structure

JEL: D24, O47, R12, L16

1. Introduction

Mexico, like other middle-income economies, has experienced sluggish economic growth over the past two decades, a pattern often described as the middle-income trap (Ros-Bosch, 2013; Tran, 2013). In this context, weak Total Factor Productivity (TFP) growth reflects structural problems in the Mexican economy that constrain long-term economic growth (Chen, 1997). For this reason, improving TFP performance should be a central public policy objective to strengthen the Mexican economy. However, effective policies require robust empirical evidence on how productivity evolves over time, across geographic locations, and across sectors. To address this need, this research provides new evidence on TFP in Mexico, enabling policymakers to incorporate productivity considerations into policy design and evaluation.

To generate productivity evidence in Mexico, this paper uses establishment-level TFP estimates to measure aggregate productivity and productivity growth from a micro to macro perspective.¹ These aggregates provide evidence on geographical locations, sectors, and groups of establishments that push up and pull down TFP in Mexico. The analysis aims to support the design and implementation of industrial strategies oriented towards improving productivity in Mexico. For example, industrial strategies can use evidence of productivity disparities across regions to incentivise a regional rebalance of productivity by improving the performance of low-productivity locations (Gardiner et al., 2013). At the sector level, industrial strategies can improve the global competitiveness of key sectors (Bakhshi et al., 2015). Furthermore, evidence on the contribution of firm entry and exit to TFP growth can reveal whether resources are being efficiently reallocated through market selection, providing insights into strategies that improve the growth and survival of productive firms (Haltiwanger, 1997; Melitz & Polanec, 2015).

This study recognises the challenges of aggregating productivity, as the literature continues to refine alternative approaches (Dias & Robalo, 2021; Dosi et al., 2021). Despite these challenges, this paper's empirical evidence is based on productivity aggregation approaches used in the literature to measure aggregate productivity and productivity growth (Haltiwanger, 1999; Harris, 2021; Harris & Moffat, 2022; Melitz & Polanec, 2015). Thus,

¹ TFP at the establishment level was estimated using microdata from the Economic Census of Mexico. For three decades, Mexico's National Institute of Statistics (INEGI) has had longitudinal establishment-level data on production and inputs in the Economic Census, which was published every five years between 1993 and 2023.

this research focuses on the transition of TFP analysis in Mexico through the micro-meso-macro channel, reflecting the economic 'pointillism' of productivity analysis in the Mexican economy.² This research aims to contribute to the empirical literature on productivity analysis using unusually granular TFP data from a middle-income economy (Maue et al., 2020). This document has four additional sections: literature review, data and methodology, results, and conclusion.

2. Literature review

The literature argues that micro-level TFP performance drives macro performance (Bartelsman & Wolf, 2017). Consistent with this view, this paper aggregates micro-level TFP to the macro level and analyses productivity across geographical locations, sectors and market selection (i.e. the role of entry/exit). This literature review explains why some geographical locations, sectors, and groups of firms (survivors, entrants, or exiters) are more productive than their counterparts.

Geographical dimension of productivity

The spatial distribution of TFP highlights regional productivity differences. Brulhart (1998) identifies three key economic theories explaining the geographic concentration of economic activity: (i) Neoclassical Theory (NCT), (ii) New Trade Theory (NTT), and (iii) New Economic Geography (NEG). These theories describe how firms make location decisions, leading to high-TFP clusters. The factors contributing to TFP disparities across regions are outlined below.

- According to NCT, there are comparative advantages in locations with higher TFP. For instance, the Heckscher-Ohlin model attributes these advantages mainly to differences in endowment levels of the production process. NCT explains that capital-intensive locations are more efficient and productive than employment-intensive locations.
- The NTT explains that some regions produce with increasing Returns to Scale (RTS), mainly in the manufacturing sector (Krugman, 1979). This theory argues that some regions concentrate a higher share of manufacturing production; as a result, these regions produce with increasing RTS, making them more productive than their counterparts.
- The NEG sustains that there are more efficient locations due to increasing RTS and cost minimisation. These locations are more productive and agglomerate economic activity, spontaneously shaping the geographic core-periphery pattern between high- and low-productivity locations. NEG argues that productivity drives the concentration of economic activity (Krugman, 1991). Therefore, productivity, firms' geographic concentration, and economic activity are linked.

The common theme across NCT, NTT, and NEG is that, in a well-functioning market economy with minimal frictions, resources tend to reallocate towards more productive producers. These producers make decisions aimed at maximising benefits and efficiency; thus, they survive in the market and increase their optimal firm size (Jovanovic, 1982; Hopenhayn, 1992). For that reason, some geographical locations become more productive than others because more efficient firms concentrate in specific locations. Public policy can influence aggregate efficiency across economies by creating or reducing distortions that encourage or discourage resource reallocation (Hsieh & Klenow, 2009; Restuccia & Rogerson, 2008).

Furthermore, geographical locations with higher TFP concentrate establishments with better supply-side attributes. For example, Ramirez-Guerra (2026) found that variables associated with Endogenous Growth Theory, Non-Competitive Markets, and Spatial Economics are supply-side attributes that positively affect TFP at the establishment level. Highly productive locations create conditions through externalities that improve productivity in establishments' production processes, and those externalities also encourage high-productivity establishments to cluster in specific locations.

An alternative explanation for TFP disparities across geographical locations relates to institutions and initial conditions. In the Mexican case, institutions promoted current urban disparities, which stem from a historical process triggered by unequal land distribution during Spanish colonialism. Thus, regional inequalities persisted

² 'Pointillism' is a painting technique in art that links dots to a big picture. Economic 'pointillism' is a metaphor that refers to how micro-level measurements can be linked to calculate macro-level measurements. Economic 'pointillism' is the micro-meso-macro channel in economic analysis. The term meso refers to an intermediate stage, which includes the analysis of regions, sectors, etc.

because of historic inertia driven by a heritage of extractive institutions (Acemoglu et al., 2002; Frankema, 2010; Ezcurra & Rodríguez-Pose, 2014).

One branch of the literature argues that higher productivity levels lead to better living standards (Klenow & Rodríguez-Clare, 1997). For that reason, Gardiner et al. (2013) argue that reducing spatial inequalities is necessary to increase aggregate economic efficiency and improve social equity.

Sectoral dimension of productivity

Two explanations may account for why some sectors are more productive than others. The first is the inter-industry perspective, which argues that some sectors are more productive than their counterparts because they incorporate technological advantages in their production processes. For example, it is argued that the manufacturing sector is more productive because some firms in this sector have increasing RTS, which can result from technological advantages (Krugman, 1979). The second explanation is the intra-industry perspective, which argues that highly productive sectors have a higher share of highly productive firms. The intra-industry perspective takes an empirical approach and explains that some sectors are more productive because they concentrate a larger share of efficient firms (Krugman, 1991).

Structural shifts represent episodes of change in firms' behaviour in response to the environment, leading to resource reallocation from one sector to another. In Mexico, like other economies, firms have reallocated resources from manufacturing to the services sector (Berlingieri, 2014; Pitelis & Antonakis, 2003). Empirical evidence of aggregate TFP at the sectoral level can shed light on how resource reallocation across sectors has evolved alongside sectoral productivity. For instance, Padilla-Perez & Villarreal (2017) concluded that labour has shifted from activities with faster productivity growth to those with slower productivity growth. Then, structural change in Mexico has reallocated labour to less productive activities. As a result, the Mexican economy has experienced two parallel processes: structural change with a growing share of services and a decline in aggregate productivity.

Market selection and productivity growth

The literature highlights the importance of market selection in shaping aggregate productivity. Market selection is a dynamic process through which firms enter, survive, and exit markets, thereby influencing the allocation of resources across firms. Theories of industry dynamics emphasise the role of entry and exit in “creative destruction”, in which more productive entrants replace less productive firms. Consistent with this view, empirical evidence shows that entering firms tend to be more productive than exiting firms (Foster et al., 2008). More broadly, Haltiwanger (1997) argues that heterogeneity in firm-level productivity is a key determinant of aggregate TFP fluctuations, as changes in firms' productivity and their market shares can generate substantial variation in aggregate productivity growth.

The theoretical selection models of Hopenhayn (1992) and Jovanovic (1982) were precursors for including firm heterogeneity and firm-specific productivity shocks, in which the selection process leads to an equilibrium framework. Overall, these theoretical models highlight the interplay between market selection and productivity. In this context, the TFP growth decomposition proposed by Haltiwanger (1997) is relevant for understanding, empirically, how aggregate TFP fluctuations are driven by tracking microeconomic changes. One of the main findings of Haltiwanger (1997) is that entering plants displace less productive plants, which eventually exit the market, but entering plants have a TFP level similar to firms that remain in the market.

Foster et al. (2008) analysed the role of entry and exit in firm-level prices and TFP. The results indicated that entering firms have higher TFP and lower prices than exiting firms and incumbents.³ Additionally, the findings show that entering firms have lower prices because prices and TFP are crucial for young firms to survive. Another relevant result of Foster et al. (2008) is that the Haltiwanger (1997) decomposition understates the contribution of entering firms and overstates the contribution of continuing firms in TFP growth. Empirical studies comparing the Haltiwanger (1997) and Melitz & Polanec (2015) decompositions have confirmed this result (Harris, 2021; Harris & Moffat, 2019).

A branch of the productivity literature on Mexico argues that low productivity growth results from the entry and survival of unproductive establishments in the Mexican economy, which creates dysfunctional firm dynamics

³ For instance, Ding et al. (2016) found that entering plants contributes to a larger extent to the increase of TFP in large and medium-sized industrial firms in China.

(Levy Algazi, 2019; Ros-Bosch, 2019). Establishments that survived in the Mexican economy are characterised as informal, small in employment, and with a low stock of capital per worker. As a result, resource misallocation in Mexico allocates workers and capital to low-productivity activities, particularly in the informal service sector (Levy Algazi, 2018).

3. Methodology and data

This paper uses TFP estimates at the establishment level from Ramirez-Guerra (2026) and aggregates TFP in Mexico using two orientations: TFP in levels and TFP growth. TFP in levels are analysed by geographical and sectoral dimensions, capturing productivity variations across states, municipalities, economic sectors, and main subsectors. For TFP growth, the analysis emphasises the contribution of establishments entering, surviving, and exiting the market based on methodologies by Haltiwanger (1997) and Melitz & Polanec (2015).

Data

The primary data source is the Economic Census of Mexico, which provides microdata on production and inputs at the establishment level. Table 1 presents the data structure of the Economic Census of Mexico, showing the number of establishments by economic sector and year from 1993 to 2023. The data structure comprises 22 sectors classified under the North American Industry Classification System (NAICS), and the National Institute of Statistics and Geography (INEGI) conducts the census every 5 years. The microdata are linked longitudinally to form an unbalanced panel database, allowing tracking of establishments that enter, remain, and survive in the market (Busso et al., 2019). The Economic Census of Mexico is an unusual database with granular information for a middle-income economy. This database was used to estimate TFP at the establishment level, the primary productivity metric in this research.

Table 1. Number of establishments in the Economic Census of Mexico by economic sector and year, 1993-2023.^{a/}

NAICS 2-digits	Economic Sector	1993	1998	2003	2008	2013	2018	2023	Total
11	Agriculture	258	21,456	21,252	19,443	20,407	24,372	24,984	132,172
21	Mining, quarrying, oil and gas extraction	2,835	2,905	3,075	2,956	3,032	3,123	2,960	20,872
22	Utilities	37	2,435	2,433	2,586	2,721	2,961	3,139	16,312
23	Construction	-	14,612	13,438	18,637	17,063	19,501	17,438	100,703
31	Manufacturing (consumer goods)	133,914	172,477	170,706	235,362	274,485	342,438	378,980	1,708,362
32	Manufacturing (materials and chemicals)	42,898	72,423	67,654	84,663	88,360	104,933	115,108	576,531
33	Manufacturing (industrial and technological)	76,060	97,705	90,354	116,824	126,685	132,457	140,160	779,753
43	Wholesale	-	110,756	86,997	118,027	130,348	155,545	159,741	761,414
46	Retail trade	-	1,331,718	1,493,588	1,740,522	1,912,293	2,092,770	2,426,012	10,996,903
48	Transportation	29	37,044	38,048	15,261	16,488	20,489	21,575	148,953
49	Postal services and warehouse	-	3,670	3,818	2,441	1,501	1,756	3,286	16,472
51	Information	11,956	7,164	7,586	11,353	9,338	8,828	7,999	64,224
52	Finance and Insurance	-	6,630	10,410	18,706	23,761	26,593	27,260	113,382
53	Real estate, rental and leasing	-	36,469	45,577	54,188	62,815	68,010	78,541	345,561
54	Professional, scientific, and technical services	-	71,200	68,587	84,695	89,254	100,098	106,064	519,915
55	Management of companies and enterprises	-	650	348	204	357	366	339	2,264
56	Administrative support and waste management	-	23,558	43,151	80,921	91,611	76,059	54,858	370,139
61	Educational services	-	33,493	30,891	43,286	46,882	53,524	53,534	261,610
62	Health care and social assistance	-	106,915	102,940	146,532	170,937	196,089	245,034	968,447
71	Arts, entertainment, and recreation	-	31,194	31,790	41,821	50,392	51,352	55,889	261,966
72	Accommodation and food services	-	246,161	277,435	392,242	501,448	637,124	749,918	2,804,328
81	Other services (except public administration)	-	373,993	395,013	493,337	590,567	681,769	795,361	3,330,512
Total		267,987	2,804,628	3,005,091	3,724,007	4,230,745	4,800,157	5,468,180	24,300,795

^{a/} Observations with revenue values different from null values.

Source: Own elaboration using microdata from the Economic Census of Mexico

TFP estimates at the establishment level in Mexico were obtained from Ramirez-Guerra (2026). That paper applied the production function proposed by Klette & Griliches (1996) to estimate TFP. This production function is derived from a supply-demand model that estimates consistent elasticities when output prices are unobserved (i.e., price bias). In practice, the Klette & Griliches (1996) production function separates mark-up effects from

elasticities to overcome omitted price bias. Appendix A extends the explanation and estimation of the production function.

Equation (1) is the production function of Klette & Griliches (1996), which can be labelled as the revenue-based production function. In equation (1), the dependent variable $\tilde{r}_{it}$ is the real revenue of the establishment i in the year t . The production function is output-oriented as it includes three factors of production: m , l , and k , which refer to the intermediate inputs, employment and capital stock, respectively. Variables in x' are the drivers of TFP (i.e. TFP determinants). The variable t is a time trend that reflects changes in neutral technical efficiency over time (i.e., Hicks-neutral technical change). See Table A1 for further details of variables.

$$\tilde{r}_{it} = \left(\frac{\sigma-1}{\sigma}\right)(\alpha_m m_{it} + \alpha_l l_{it} + \alpha_k k_{it} + x'_{it}\alpha_x + \alpha_T t) + \frac{1}{\sigma}(r_{st} - p_{st}) + u_{it} \quad (1)$$

Equation (1) also expresses the real revenue $\tilde{r}_{it}$ as a function of three components. The first component expresses the output at the firm level (q_{it}) as a log-linear Cobb-Douglas production function $q_{it} = (\alpha_m m_{it} + \alpha_l l_{it} + \alpha_k k_{it} + x'_{it}\alpha_x + \alpha_T t)$ multiplied by the inverse of the mark-up $(\sigma - 1)/\sigma$. The second component is the deflated revenue at the sector level in $\ln(q_{st})$, represented as $q_{st} = (r_{st} - p_{st})$, and multiplied by the inverse of the CES of the establishment's demand $1/\sigma$.⁴ The third component is the stochastic shocks of supply and demand $u_{it} = [(\sigma - 1)/\sigma]u_{it}^s + [1/\sigma]u_{it}^d$.

The revenue-based production function was applied to each sector in the panel data presented in Table 1 (i.e., homogeneity of the production function at the industry level). The exceptions were sectors 22 and 55, which were excluded because of potential output mismeasurement and sample-size issues, which reduced data quality compared with the other sectors. The production functions were parametrised using the Wooldridge (2010) panel-data model to address simultaneity bias. Table 2 presents the main parameters of the revenue-based production function by sector. Tables A2 and A3 present additional details about the parametric estimation.

Table 2. Elasticities of the factors of production, the inverse of the CES demand, mark-up, and weighted-average parameters in revenue-based production functions.^{a/}

Economic sector (NAICS 2-digits)		α_m ln intermediate inputs	α_l ln employment	α_k ln capital	$1/\sigma$ Inverse of the elasticity of demand	$\sigma/(\sigma - 1)$ Mark-up correction	Y_s/Y Weight
11	Agriculture	0.58	0.322	0.191	0.255	1.342	0.002
21	Mining, quarrying, oil and gas extraction	0.791	0.282	0.017	0.186	1.228	0.098
23	Construction	0.79	0.228	0.025	-0.02	0.979	0.030
31	Manufacturing (consumer goods)	0.84	0.15	0.023	0.003	1.004	0.115
32	Manufacturing (materials and chemicals)	0.888	0.155	0.015	0.001	1.002	0.167
33	Manufacturing (industrial and technological)	0.893	0.186	0.004	-0.00	0.995	0.206
43	Wholesale	0.52	0.474	0.079	0.049	1.052	0.055
46	Retail trade	0.576	0.444	0.071	0.164	1.196	0.070
48	Transportation	0.673	0.425	0.058	0.102	1.113	0.041
49	Postal services and warehouse	0.56	0.35	0.035	0.049	1.052	0.003
51	Information	0.713	0.324	0.044	0.076	1.083	0.037
52	Finance and Insurance	0.676	0.402	0.040	0.07	1.078	0.056
53	Real estate, rental and leasing	0.812	0.226	0.050	0.115	1.13	0.009
54	Professional, scientific, and technical services	0.77	0.519	0.087	0.245	1.325	0.017
56	Administrative support and waste management	0.887	0.383	0.028	0.164	1.197	0.026
61	Educational services	0.442	0.605	0.059	0.069	1.074	0.011
62	Health care and social assistance	0.876	0.431	0.062	0.228	1.295	0.008
71	Arts, entertainment, and recreation	0.665	0.338	0.047	0.048	1.051	0.005
72	Accommodation and food services	0.811	0.227	0.017	0.014	1.014	0.029
81	Other services (except public administration)	0.691	0.36	0.043	0.055	1.059	0.014
Total (weighted-average elasticities)		0.786	0.271	0.030	0.057	1.068	1.000

^{a/} Table A2 presents these parameters with their statistical significance and standard errors.

Source: Own estimates using microdata from the Economic Census of Mexico

⁴ This factor expresses the inverse of demand between quantity and price in the relation firm-industry from the supply-demand model of Klette & Griliches (1996).

Harris (2021) proposes weighting and aggregating the elasticities of the revenue-based production functions across sectors to compute a single elasticity for intermediate inputs, labour, and capital, as well as for the CES inverse demand and the mark-up factors. The last column in Table 2 presents sectoral weights, measured as each sector's share of aggregate output for 1998-2023. The last row of Table 2 presents the weighted-average elasticities and production-function parameters across sectors (i.e. production function with homogeneity at the national level). Equation (2) presents the TFP specification using weighted-average elasticities and mark-ups.

$$\ln(\overline{TFP}_{it}) = \left(\frac{\hat{\sigma}}{\hat{\sigma}-1}\right) \left[\hat{r}_{it} - \left(\frac{\hat{\sigma}-1}{\hat{\sigma}}\right) (\hat{\alpha}_m m_{it} + \hat{\alpha}_l l_{it} + \hat{\alpha}_k k_{it}) - \left(\frac{1}{\hat{\sigma}}\right) (r_{st} - p_{st}) \right] \quad (2)$$

The values of aggregated weighted-average elasticities and mark-up are equivalent to $\hat{\alpha}_m = 0.786$, $\hat{\alpha}_l = 0.271$, $\hat{\alpha}_k = 0.030$. The common output inverse of demand and the mark-up factor were $1/\hat{\sigma} = 0.057$ and $(\hat{\sigma} - 1)/\hat{\sigma} = 0.936$. The mark-up factor corrector is the inverse equivalent to $\hat{\sigma}/(\hat{\sigma} - 1) = 1.068$ (See last row of Table 2). The common parameters were applied to the microdata to calculate establishment-level TFP in Mexico from 1993 to 2023. For simplicity, TFPQ will be referred to as TFP throughout this paper (See Coyle et al. (2024), for an explanation of the difference between TFPR and TFPQ using the revenue-based production function).

TFP estimates derived from Equation (2) constitute the primary data and productivity measure used throughout this study. Although TFP estimates are available for the period 1993 to 2023, only the manufacturing sector (NAICS 31-33) has complete coverage from 1993 onwards (Table 1). To ensure consistent time coverage across sectors, the TFP analysis focuses on the period 1998-2023. Table 3 presents the distributions of TFP at the establishment level in Mexico for the whole period 1998-2023. Data from Table 3 can be used to examine TFP in Mexico in three dimensions: temporal, sectoral and geographical. For this purpose, Tables A4, A5, and A6 present TFP distributions across these three dimensions, showing the evolution of TFP distributions over time, across sectors, and across Mexican states for the period of analysis.

Table 3. Distribution of TFP at the establishment level in Mexico, 1998-2023.^{a/}

Distribution	1%	25%	50%	Mean	75%	99%	Observations	Establishments
TFP	0.03	0.12	0.19	0.39	0.35	3.10	20,224,671	24,014,269

^{a/} Observations are the number of establishments with a TFP estimate, as they reported output and inputs for the TFP estimation.

Source: Own estimates using microdata from the Economic Census of Mexico

Methodology

Aggregation of TFP in levels

The literature accounts for weights when deriving productivity measurements from the micro to the macro level. There are two options for aggregation: average and weighted-average TFP. The average TFP implies that establishments have the same relative importance in the TFP aggregation. The weighted average includes weights that reflect the relative importance of establishments compared with their counterparts (Schreyer & Pilat, 2001).⁵

Two types of weights can be used to measure weighted-average TFP. The first type sums to 1 across establishments in the same year, and the second type uses the "Domar" weights. The first type of weight is usually used in the literature that analyses TFP growth decomposition. This literature uses weights based on each firm's share of aggregated gross output (Foster et al., 2001). The second type of weights is also labelled the revenue-based Domar weights and is usually used in TFP aggregation using the KLEMS model (Schreyer & Pilat, 2001). These weights measure the relative importance of an establishment's sales to total added value. The sum of the Domar weights across establishments over a year is larger than one (Baqae & Farhi, 2019; p. 5).

This research uses weights based on each establishment's gross output to reflect its relative importance.⁶ This weighting scheme aligns with the extensive literature on TFP decomposition (Foster et al., 2001; Haltiwanger,

⁵ This study measures weights as the firm's share of output. In the literature, weights matter because their changes over time reflect patterns of output reallocation across firms, with significant implications for calculating aggregate productivity growth (Foster et al., 2021).

⁶ Foster et al. (2001) note that weights can also be based on employment or man-hours. That paper argues that gross-output and employment weights yield broadly similar results for aggregate TFP. However, value-added weights have received less attention, partly because many establishments have very low or near-zero value added. Consequently, value-added weighting may overemphasise high-value-added establishments in the weighted-average TFP and underestimate the contribution of low-value-added establishments.

1997; Melitz & Polanec, 2015). The departure for the analysis of TFP in levels is the estimation of the weighted-average TFP presented in equation 3.

$$\widehat{TFP}_t = \sum_{i=1}^{N_t} \theta_{it} \widehat{TFP}_{it} \quad (3)$$

According to Melitz & Polanec (2015), equation 3 describes the weighted average TFP, where $\theta_{it} > 0$ and $\sum_{i=1}^{N_t} \theta_{it} = 1$. The literature presents various approaches to TFP aggregation, and no clear consensus exists on the best aggregate metric. This study uses the weighted-average TFP as a descriptive measure of aggregate productivity. Using the weighted-average TFP in levels, rather than its logarithmic form, aims to facilitate a more intuitive economic interpretation of aggregate productivity by preserving the scale of the original productivity measure. The aggregation approach in equation 3 is not intended to replace or compete with the aggregate TFP indices in their logarithmic form, as in other studies. For instance, Harris (2021) and Harris & Moffat (2022) used weighted means of TFP, expressed in logarithmic form, to examine productivity differences across regions in New Zealand and Great Britain, respectively.⁷ In contrast, the weighted average of TFP used in this productivity analysis provides a descriptive summary of aggregate TFP in levels.

The weights in equation 3 have an output orientation $\theta_{it} = Y_{it}/Y_t$, in which the variable Y_{it} is the firm's output, and Y_t is the firms' output in the aggregated (national) economy by year $Y_t = \sum_{i=1}^{N_t} Y_{it}$, as a result, the weights at the national level are normalised $\sum_{i=1}^{N_t} \theta_{it} = 1$. Other methodologies for measuring aggregate productivity use alternative weight schemes and productivity metrics. For example, Dosi et al. (2021) proposed the use of weights with input orientation and a firm productivity metric based on output–input vectors measured with a geometric approach (i.e., a tangential-based productivity metric). However, Dosi et al. (2021) use a different approach than this paper. Dosi et al. (2021) specifically designed their methodology to combine input-based weights with the tangential-based productivity measure.⁸ As a result, the measurement of Aggregate Productivity (AP) and Aggregate Productivity Growth (APG) in Dosi et al. (2021) is not comparable to the productivity-aggregation specifications defined in this paper.

Equation 4 presents the aggregate TFP at different delimitations. The variable $\widehat{TFP}_t^j$ is the weighted-average TFP in the aggregation j in the year t . The superscript index j can represent states, municipalities, sectors, subsectors, etc., depending on the aggregation delimitation. Then, TFP at the establishment level $\widehat{TFP}_{it}$ is aggregated from $i = 1, 2, \dots, N_t^j$ where N_t^j is the total number of establishments N in j during the year t .

$$\widehat{TFP}_t^j = \sum_{i=1}^{N_t^j} \theta_{it}^j \widehat{TFP}_{it} \quad (4)$$

In Equation 4, the weights are measured as $\theta_{it}^j = Y_{it}^j/Y_t^j$, where the variable Y_t^j is the aggregated output $Y_t^j = \sum_{i=1}^{N_t^j} Y_{it}^j$ in the subsample j . The weights are normalised in the subsample j as $\sum_{i=1}^{N_t^j} \theta_{it}^j = 1$ (e.g. states, municipalities, sectors, subsectors). Normalised weights allow for comparing aggregated TFP across geographical locations or sectors j and over time t .

TFP growth decomposition

TFP growth can be measured using weighted average TFP in natural logarithms (ln) by year and applying first differences (see equations 5 and 6).

$$\ln(\widehat{TFP}_t) = \sum_{i=1}^{N_t} \theta_{it} \ln(\widehat{TFP}_{it}) \quad (5)$$

The calculation of the first difference of $\ln(\widehat{TFP}_t)$ between the year t and $t - k$ is equivalent to TFP growth (equation 6). The data used is from the Mexican Economic Census, and it has a 5-years gap, thus, $k = 5$.

⁷ In those studies, the weighted means of TFP in ln across regions were derived from TFP estimates at the firm and plant levels in New Zealand and Great Britain.

⁸ The methodology proposed by Dosi et al. (2021) for calculating AP and APG is internally consistent only when firm-level productivity is measured using the tangential-based productivity measure (i.e. $\text{tg}()$ in the paper) and aggregated with input-based weights. Applying the methodology of Dosi et al. (2021) to output-based weights or replacing $\text{tg}()$ with individual Total Factor Productivity (TFP) leads to discrepancies in the calculation of AP and APG.

$$\Delta \ln(\widehat{TFP}_t) = \ln(\widehat{TFP}_t) - \ln(\widehat{TFP}_{t-k}) \quad (6)$$

The methodology for TFP growth decomposition quantifies the contribution of establishments entering, surviving and exiting the market to productivity growth. According to Melitz & Polanec (2015), the aggregation of $\ln(\widehat{TFP}_t)$ can be decomposed by the contribution of establishments entering and surviving in the market while the aggregation $\ln(\widehat{TFP}_{t-k})$ can be decomposed as the contribution of establishments surviving and exiting the market. Then, equations 7 and 8 measure the contribution of the firm selection on the aggregated ln TFP for the years t and $t - k$.

$$\ln(\widehat{TFP}_t) = \sum_{i \in E} \theta_{it} \ln(\widehat{TFP}_{it}) + \sum_{i \in S} \theta_{it} \ln(\widehat{TFP}_{it}) \quad (7)$$

$$\ln(\widehat{TFP}_{t-k}) = \sum_{i \in S} \theta_{i,t-k} \ln(\widehat{TFP}_{i,t-k}) + \sum_{i \in X} \theta_{i,t-k} \ln(\widehat{TFP}_{i,t-k}) \quad (8)$$

Establishments are divided into market selection groups in equations 7 and 8. For instance, the group of establishments entering the market are described as $i \in E$, the group of establishments surviving is $i \in S$, and the group of establishments exiting the market is $i \in X$. Equations 7 and 8 are the basic accounting of the TFP growth decomposition, including firm selection. Appendix B presents the framework for quantifying the number of establishments by entry, survival, and exit groups, using data from the Economic Census of Mexico. Taking the difference of equations 7 and 8 is the basic specification of weighted-average TFP growth with firm selection, as shown in equation 9.

$$\Delta \ln(\widehat{TFP}_t) = [\sum_{i \in E} \theta_{it} \ln(\widehat{TFP}_{it}) + \sum_{i \in S} \theta_{it} \ln(\widehat{TFP}_{it})] - [\sum_{i \in S} \theta_{i,t-1} \ln(\widehat{TFP}_{i,t-1}) + \sum_{i \in X} \theta_{i,t-1} \ln(\widehat{TFP}_{i,t-1})] \quad (9)$$

Equation 9 quantifies the contribution to the weighted-average TFP growth from establishments that enter, survive, and exit the market. However, the TFP growth decomposition in Equation 9 is limited because it does not account for resource reallocation between and within establishments that survive in the market, as the Haltiwanger (1997) and Melitz & Polanec (2015) decomposition does.

The two aggregation methods in Equations 3 and 5 serve different analytical purposes. The weighted-average TFP in Equation 3 describes and compares the evolution of aggregate TFP in levels across groups. In contrast, the weighted mean of TFP in ln, in Equation 5, quantifies TFP growth and subsequently analyses its decomposition. The following subsections specify how TFP growth is measured using decomposition methodologies.

(a) Haltiwanger (1997) decomposition

The TFP growth decomposition proposed by Haltiwanger (1997) disaggregates the weighted-average TFP ln in first differences into five components, as specified in equation 10.

$$\Delta \ln(\widehat{TFP}_t) = \sum_{i \in S} \theta_{i,t-k} [\ln(\widehat{TFP}_{it}) - \ln(\widehat{TFP}_{i,t-k})] + \sum_{i \in S} [\ln(\widehat{TFP}_{i,t-k}) - \ln(\widehat{TFP}_{t-k})] [\theta_{it} - \theta_{i,t-k}] + \sum_{i \in S} [\ln(\widehat{TFP}_{it}) - \ln(\widehat{TFP}_{i,t-k})] [\theta_{it} - \theta_{i,t-k}] + \sum_{i \in E} \theta_{it} [\ln(\widehat{TFP}_{it}) - \ln(\widehat{TFP}_{t-k})] - \sum_{i \in X} \theta_{i,t-k} [\ln(\widehat{TFP}_{it}) - \ln(\widehat{TFP}_{t-k})] \quad (10)$$

The first term in the Haltiwanger (1997) decomposition measures the increase in ln TFP over time of the establishments that continue in the market (establishments surviving: within). The second term measures the dispersion between the lagged ln TFP at the establishment level $\ln(\widehat{TFP}_{i,t-k})$ in relation to the average ln TFP in the period, $t - k$ expressed as $\ln(\widehat{TFP}_{t-k})$ multiplied by the change of weights over time $\theta_{it} - \theta_{i,t-k}$ (establishments surviving: between). The third term complements the second term, as it represents the covariance of establishments with continuation in the market, considering the effect of the change in output weight on the increase in ln TFP (establishments surviving: cross). The sum of the first, second, and third components measures the contribution of establishments with continuity in the Mexican market to national TFP growth. The fourth term measures the contribution of entering establishments to TFP growth. The fifth term measures the contribution of establishments that exit the market to national TFP growth.

(b) Melitz & Polanec (2015) decomposition

Melitz & Polanec (2015) proposed an extension of the Olley & Pakes (1996) productivity growth decomposition with the basic concept from equation 11.

$$\ln(\overline{TFP}_t) = \frac{1}{N_t} \sum_{i=1}^{N_t} \ln(\overline{TFP}_{it}) + \sum_{i=1}^{N_t} \{(\ln(\overline{TFP}_{it}) - \ln(\overline{TFP}_t))(\theta_{it} - \bar{\theta}_t)\} \quad (11)$$

In equation 11, the weighted average TFP ln is expressed as the sum of the mean of the unweighted TFP ln by year, and the covariance of the weights and the unweighted TFP, which can be expressed as $cov(\theta_{it}, \ln(\overline{TFP}_{it}))$.⁹ Melitz & Polanec (2015) extended equation 11 to the basic accounting of firm selection presented in Appendix B. The Melitz & Polanec (2015) decomposition that measures the contribution of surviving, entering and exiting establishments is presented in equation 12.

$$\begin{aligned} \Delta \ln(\overline{TFP}_t) = & \sum_{i \in S} \Delta \ln(\overline{TFP}_{it}) + \sum_{i \in S} \Delta cov(\theta_{it}^S, \ln(\overline{TFP}_{it})) + \\ & \sum_{i \in E} \theta_{it} \{ \sum_{i \in E} \theta_{it}^E \ln(\overline{TFP}_{it}) - \sum_{i \in S} \theta_{it}^S \ln(\overline{TFP}_{it}) \} - \\ & \sum_{i \in X} \theta_{i,t-k} \{ \sum_{i \in X} \theta_{i,t-k}^X \ln(\overline{TFP}_{i,t-k}) - \sum_{i \in S} \theta_{i,t-k}^S \ln(\overline{TFP}_{i,t-k}) \} \end{aligned} \quad (12)$$

The first term of equation 12 measures the contribution within surviving establishments and the second term measures the contribution between establishments.¹⁰ The sum of the first and the second terms is the total contribution of surviving establishments to TFP growth. The third and fourth terms measure the contribution of entering and exiting establishments to TFP growth, respectively. The weights between groups in equation 12 are crucial for the Melitz & Polanec (2015) decomposition. The necessary condition is that the sum of the weights of entrants and survivors in the year t is equal to one: $\sum_i \theta_{it}^E + \sum_i \theta_{it}^S = \sum_i \theta_{it} = 1$ and the sum of weights of exiters and survivors in the year $t - k$ is also equal to one: $\sum_i \theta_{i,t-k}^X + \sum_i \theta_{i,t-k}^S = \sum_i \theta_{i,t-k} = 1$. This condition measures the output contribution of each group within each year. In addition, the weights at the start of the third and fourth terms are normalised within the entering and exiting groups to maintain consistency in the decomposition. These weights are expressed as $\sum_{i \in E} \theta_{it} = \sum_{i \in E} (Y_{it} / \sum_{i \in E} Y_{it}) = 1$ and $\sum_{i \in X} \theta_{i,t-k} = \sum_{i \in X} (Y_{i,t-k} / \sum_{i \in X} Y_{i,t-k}) = 1$.

4. Results

TFP in levels

National

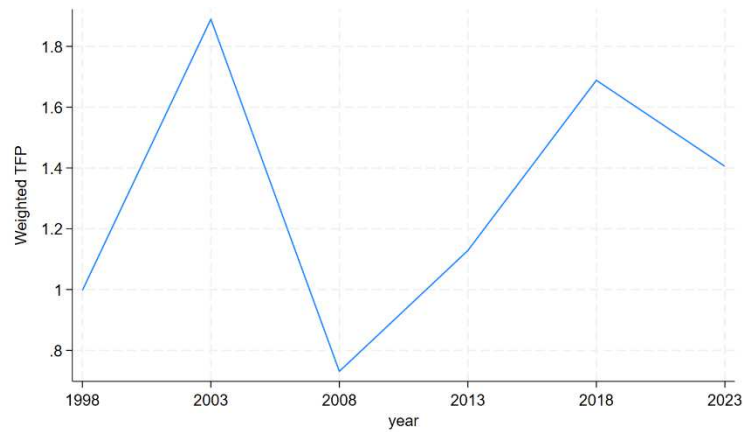
Figure 1 displays the time-series of the weighted average TFP ---henceforth weighted TFP--- in Mexico from 1998 to 2023 with a 5-year interval. The weighted TFP at the national level in Mexico is calculated with equation 3.

The weighted TFP time series shows how the aggregate efficiency of establishments in Mexico has evolved over time. Each census year reflects an economic context that either deteriorated or improved establishments' aggregate efficiency. The weighted TFP in 1998 was low because the Mexican economy was recovering from the "Mexican Peso crisis" of 1994. In 2003, Mexico's TFP rose to its peak. In the following period of 2008, TFP in Mexico dropped to its minimum level during the global financial crisis in 2008. From 2008 to 2018, TFP in Mexico had an upward trend, recovering from the negative impact of the 2008 crisis. In 2023, the weighted TFP decreased, potentially reflecting the negative impact of the Covid-19 crisis on TFP. This suggests that TFP in Mexico declines during a crisis period and then recovers in subsequent periods. However, the weighted TFP has not yet returned to its pre-2008 crisis level. This result shows that TFP cyclicalities influence the recession and expansion phases of the business cycle (Kydland & Prescott, 1982).

⁹ In equation 11, the variable $\bar{\theta}_t$ is the mean of the weights measured as $\bar{\theta}_t = \sum_{i=1}^{N_t} \theta_{it} / N_t$

¹⁰ The first term and the second term include $i \in S = 1, 2, \dots, N_t^S$. In particular, the first term is the difference between periods of the average TFP of surviving firms, expressed as $\sum_{i \in S} \Delta \ln(\overline{TFP}_{it}) = 1/N_t^S \sum_{i \in S} \ln(\overline{TFP}_{it}) - 1/N_{t-k}^S \sum_{i \in S} \ln(\overline{TFP}_{i,t-k})$.

Figure 1. Time series of weighted average TFP in Mexico, 1998-2023

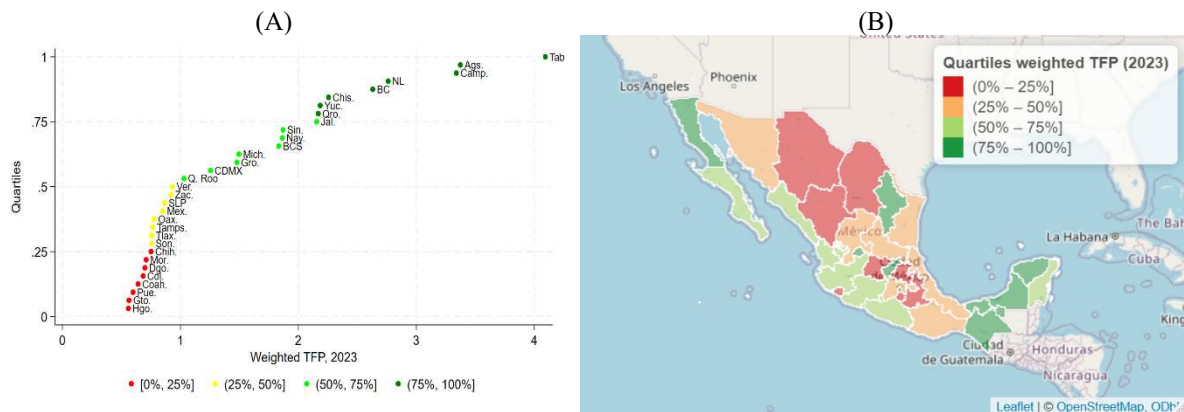


Source: Own estimates using microdata from the Economic Census of Mexico

States

Figure 2 presents the calculation of the weighted TFP at the state level using equation 4 for 2023, categorised into quartiles.

Figure 2. Weighted average TFP at the state level (A) by quartiles and (B) its spatial distribution, 2023.^{a/}



^{a/} Names of the Mexican states in alphabetical order (abbreviation of the name in parenthesis): Aguascalientes (Ags.) | Baja California (BC) | Baja California Sur (BCS) | Campeche (Camp.) | Chiapas (Chis.) | Chihuahua (Chih.) | Coahuila De Zaragoza (Coah.) | Colima (Col.) | Durango (Dgo.) | Guanajuato (Gto.) | Guerrero (Gro.) | Hidalgo (Hgo.) | Jalisco (Jal.) | Mexico City (CDMX) | Michoacan De Ocampo (Mich.) | Morelos (Mor.) | Nayarit (Nay.) | Nuevo Leon (NL) | Oaxaca (Oax.) | Puebla (Pue.) | Queretaro (Qro.) | Quintana Roo (Q. Roo) | San Luis Potosi (SLP) | Sinaloa (Sin.) | Sonora (Son.) | State of Mexico (Mex.) | Tabasco (Tab.) | Tamaulipas (Tamps.) | Tlaxcala (Tlax) | Veracruz De Ignacio De La Llave (Ver.) | Yucatan (Yuc.) | Zacatecas (Zac.)

Source: Own estimates using microdata from the Economic Census of Mexico

Table C1 in Appendix C extends the analysis in Figure 2 by measuring sectoral contributions to weighted TFP at the state level. The results of states with high weighted TFP in the top quartile (Q4) from Figure 2 and Table C1 can be summarised in two groups of states:

- i. The first group comprise the states located in the Southeast of Mexico: Tabasco, Campeche, and Chiapas. These states are characterised by intensive oil extraction activities, reflecting a high weighted TFP due to the high contribution of Mining, Quarrying, and Oil and Gas Extraction (NAICS 21). According to the NCT, the high weighted TFP in those states can be explained by comparative advantages created by their natural resources (oil reserves). In addition, this group of states also has a high contribution from Wholesale and Retail trade (NAICS 43 and 46).
- ii. The second group comprises the states of Aguascalientes, Nuevo Leon, Baja California, Yucatan, and Queretaro, which have high weighted TFP, driven by dynamic markets reflected in the high contribution from Wholesale and Retail trade (NAICS 43 and 46) and, to a lesser extent, from the Manufacturing

sector (NAICS 31 and 33). These states may reflect economies of agglomeration in the service sector and manufacturing, as the NEG and NTT suggest.

Figures C1 and C2 (in Appendix C) show that weighted TFP across states in Mexico varies widely over time (1998-2023). States frequently shift across productivity quartiles between census years. The fluctuating pattern of weighted TFP across locations can be explained by regional productivity being subject to the economic cycle and resource reallocation (i.e., changes in weights within states).

Weighted TFP exhibits a fluctuating spatial pattern across Mexican states over time (Figures C1 and C2). Despite these variations, productivity patterns persist in specific states. For instance, Campeche, Tabasco, Chiapas, Mexico City, Guerrero, and Sinaloa consistently ranked among the states with the highest productivity levels throughout 1998-2023. Table C2 (in Appendix C) identifies these six states as having weighted TFP in the top quartiles above the median (Q3 and Q4) in each census year from 1998 to 2023.

Municipalities

Figure 3 shows the spatial distribution of weighted TFP at the municipality level, categorised into quartiles in 2023. Figures 2 (weighted TFP across states) and 3 (weighted TFP across municipalities) are incomparable. For instance, Baja California Sur (BCS) has a weighted TFP in the third quartile (Q3) in Figure 2, whereas in Figure 3, most of the municipalities that comprise BCS (i.e., Los Cabos, La Paz, Comondu, and Mulege) are in the fourth quartile (Q4) of TFP levels. The contrast (and lack of consistency) in the picture depicting the geographical dimension of TFP in Mexico stems from the large difference in geographical delimitation between the state and municipal levels.

Figure 3. Spatial distribution of weighted TFP at the municipal level, classified by quartiles, 2023.

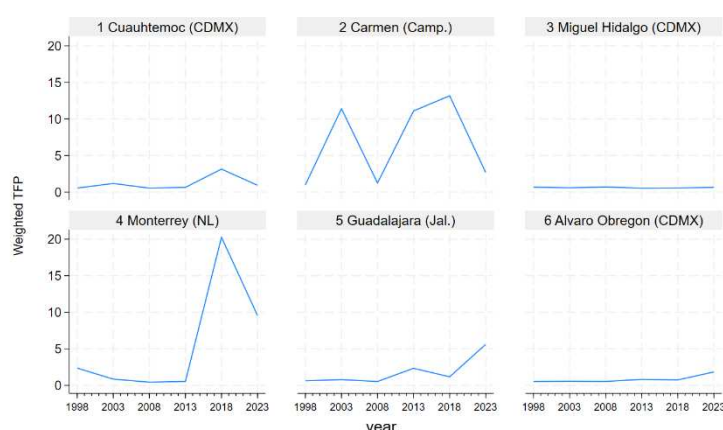


Source: Own estimates using microdata from the Economic Census of Mexico

Figure C3 and Table C3 (in Appendix C) extend the TFP analysis to the municipal level. Table C3 aims to reconcile the discrepancy between productivity at the state and municipality levels (from Figures 2 and 3). The evidence shows that states with higher weighted TFP tend to be lifted by their high-productivity municipalities (Table C3). Finally, Figure C3 shows a spatial pattern when weighted TFP is analysed across municipalities, reinforcing evidence that TFP fluctuates strongly across geographical locations over time.

Figure 4 presents the time-series of weighted TFP in the municipalities with the highest production levels in Mexico, as these concentrate a significant proportion of output and inputs in Mexico (i.e. labour, capital and intermediate inputs). Figure 4 shows that weighted TFP is significantly higher in Carmen (Campeche) compared to its counterparts. Notably, the evolution of weighted TFP in Carmen (Campeche) follows a pattern similar to that of the national level in Figure 1. However, the correlation between weighted TFP in Carmen (Camp.) and weighted TFP at the national level is not explained by the municipality-to-national weights (See Figure C4 and C5 in Appendix C).

Figure 4. Time series of weighted TFP in selected municipalities, 1998-2023.

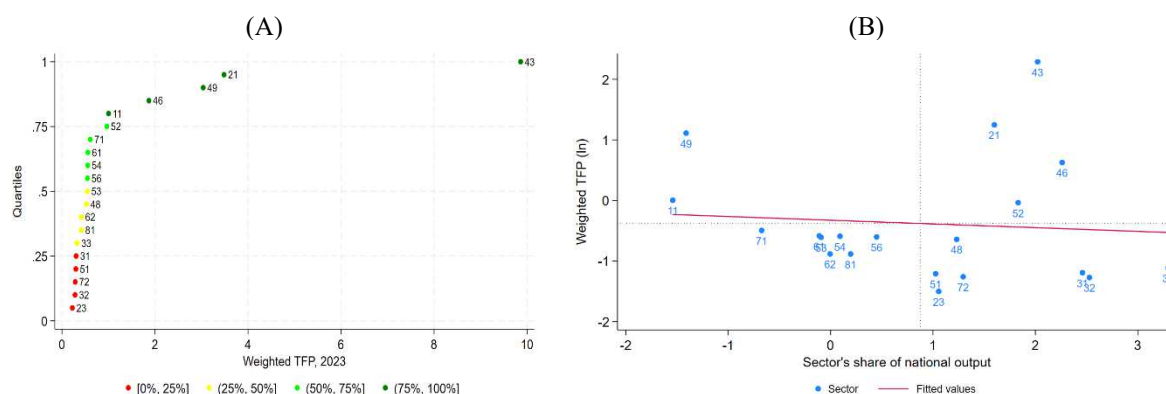


Source: Own estimates using microdata from the Economic Census of Mexico.

Sectors

Figure 5A presents the weighted TFP at the sector level during 2023, categorised by quartiles. Wholesale (NAICS 43), Mining, quarrying, and oil and gas extraction (NAICS 21), Postal services and warehousing (NAICS 49), Retail trade (NAICS 46), and Agriculture (NAICS 11) were in the top quartile of weighted TFP. However, the manufacturing sector (NAICS 31-33) was in the lowest quartile of weighted TFP. Figure 5B is a scatterplot of weighted TFP across sectors versus the sector's share of national output. The results show no correlation, suggesting that sector-to-nation share does not explain why some sectors have high weighted TFP. At the same time, Figure 5B divides the scatterplot into four quadrants. Wholesale (NAICS 43), Mining, quarrying, and oil and gas extraction (NAICS 21), Retail trade (NAICS 46), and Finance and insurance (NAICS 52) contribute substantially to national output and have high weighted TFP.

Figure 5. Weighted TFP at sector level by quartiles (A), and its correlation with the sector's share of national output (B), 2023. ^{a/ b/}



^{a/} North American Industrial Classification System (NAICS) at 2 digits (economic sectors): 11 Agriculture, etc. | 21 Mining, Quarrying, and Oil and Gas Extraction | 22 Utilities | 23 Construction | 31 Manufacturing (food, beverage and tobacco, etc.). | 32 Manufacturing (wood, paper, printing and related support activities, etc.) | 33 Manufacturing (primary metals, machinery, computers and electronics, etc.). | 43 Wholesale | 46 Retail trade | 48 Transport | 49 Postal services and warehousing | 51 Information | 52 Finance and Insurance | 53 Real Estate and Rental and Leasing | 54 Professional, Scientific, and Technical Services | 55 Management of Companies and Enterprises | 56 Administrative and Support and Waste Management and Remediation Services | 61 Educational Services | 62 Health Care and Social Assistance | 71 Arts, Entertainment, and Recreation | 72 Accommodation and Food Services | 81 Other Services (except Public Administration)

^{b/} The four quadrants are divided by the mean of the sectoral shares and the mean of the weighted TFP across sectors.

Source: Own estimates using microdata from the Economic Census of Mexico.

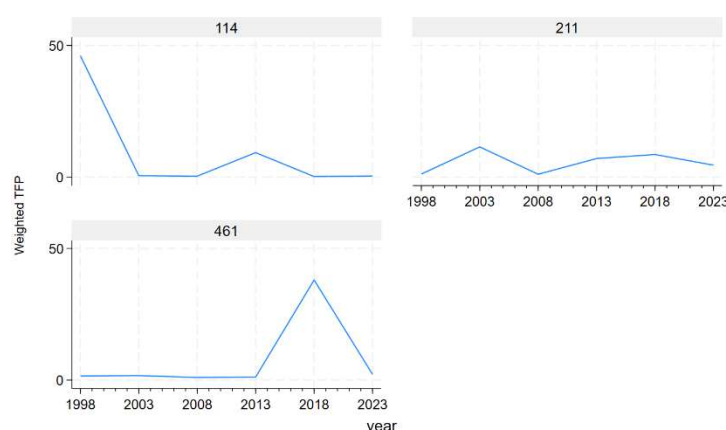
TFP at the sector and subsector levels generate relevant economic policy implications in three industries: manufacturing, trade, and oil extraction. Appendix D extends the analysis of the evolution of weighted TFP across sectors from 1998 to 2023. The following outcomes are the main results and their policy implications.

- Wholesale and retail trade (NAICS 43 and 46) were identified as high-productivity sectors that have maintained high levels of weighted TFP from 1998 to 2023 (Table D1 in Appendix D). Within the trade sector, high weighted TFP masks substantial dispersion of TFP across establishments. This disparity may be particularly pronounced in highly populated areas such as Mexico City. Figures D1 and D2, and Table F2, show a positive correlation between the 90:10 TFP ratio and population density across states in the wholesale and retail trade sectors (NAICS 43 and 46). The productivity disparity across trade establishments suggests comparing TFP at a large supermarket in Mexico City (assumed high TFP) with that at a small informal grocery shop on the city's periphery (assumed low TFP). Therefore, the challenge for economic policy is to design industrial strategies to compensate establishments in the trade sector with low TFP.
- The Mining, Quarrying, and Oil and Gas Extraction (NAICS 21) maintained high productivity throughout the period 1998-2023 (Table D1). The sector's high weighted TFP is driven primarily by oil extraction. Decisions to increase production in Mexico's oil sector are heavily influenced by the state-owned company PEMEX. As a result, government decisions at PEMEX could have contributed to the oil sector's high productivity; however, oil reserves and extraction have declined significantly in recent years, which could compromise future productivity in this sector (Romo, 2015). In addition, emerging technologies suggest the oil industry will be less dominant in the energy sector in the coming years. Therefore, there will be less scope for arbitrary decisions to deliberately increase (or reduce) oil extraction. Mexico's oil extraction industry may lose its dominance as a driver of TFP growth. The Mexican government must establish a path for the energy transition so that TFP growth depends not only on oil extraction but also on emerging technologies.
- The weighted TFP in the manufacturing sector was in the bottom quartile of the TFP distribution across sectors (Table D1). This finding supports the argument that the Mexican economy has undergone structural change in favour of services, alongside low productivity in manufacturing (Padilla-Perez & Villarreal, 2017). Loria et al. (2019) propose that low economic growth in Mexico results from stagnation in the manufacturing sector.

Subsectors

Figure 6 presents the three most productive subsectors in the Mexican economy, based on weighted TFP from 1998 to 2023. These subsectors are identified by the NAICS codes 114 (Fishing, Hunting and Trapping), 211 (Oil and Gas Extraction), and 461 (Retail trade of groceries, food, drinks, ice and tobacco).

Figure 6. Selected subsectors with the highest average weighted TFP, 1998-2023



Source: Own estimates using microdata from the Economic Census of Mexico

The weighted TFP in subsector 114 (Fishing, Hunting and Trapping) describes the importance of primary activities in Mexico during the 1990s. Since 1998, the weighted TFP in subsector 114 has decreased. The wholesale and retail trade of groceries, food, beverages, etc. (NAICS 461) reflects the importance of trade as a high-productivity economic activity, which may be linked to Mexico's recent structural shift toward services. The weighted TFP of oil and gas extraction (NAICS 211) is highly correlated with the national weighted average TFP (Figure 1). The evolution of the weighted TFP for the oil and gas extraction subsector is consistent with the

evolution of oil production in Mexico, particularly in 2003. In 2003, the state-owned petroleum company PEMEX had one of the highest oil production levels in the world, driven by higher production from the Cantarell oil field. Therefore, the large increase in Mexico's weighted average TFP in 2003 was driven by the oil and gas extraction subsector through PEMEX production, ultimately due to the rise in oil extraction at Cantarell (Romo, 2015).

TFP growth

Haltiwanger (1997) decomposition

Table 4 presents the results of the Haltiwanger (1997) decomposition of TFP growth in Mexico from 1998 to 2023 in 5-year intervals. Column (1) of Table 4 displays TFP growth at the national level. The last row of Table 4 shows that average annual TFP growth per annum (p.a.) was 0.55% from 1998 to 2023. Equation 10 decomposes TFP growth by the contributions of surviving, entering, and exiting establishments. The last row of Column (2) shows that the contribution of surviving establishments to average TFP growth was -0.18% p.a. The contribution of survivors to TFP growth is divided into two components: within and between surviving establishments, in Columns (3) and (4), respectively. Within surviving establishments, the average contribution to TFP growth p.a. was -1.06% and 0.89% for the category between survivors. The average contribution of entering establishments to TFP growth p.a. was 0.33%, and -0.39% for exiting establishments (Columns 6 and 7). The contribution of net entrants to TFP growth is measured by entering establishments, with the contribution of exiting establishments discounted. The last row in Column (5) shows that net entrants' contribution to TFP growth was 0.72% p.a.

Table 4. Haltiwanger (1997) decomposition of TFP growth in Mexico, 1998-2023.^{a/}

Period	(1)=(2)+(5)	(2)=(3)+(4)	(3)	(4)	(5)=(6)-(7)	(6)	(7)
	TFP growth (%) p.a. by period	Surviving	Surviving (within)	Surviving (between)	Net entrants	Entering	Exiting
1998-2003	4.90	0.83	0.48	0.36	4.06	2.85	-1.21
2003-2008	-4.51	-3.47	-5.73	2.26	-1.04	-0.62	0.42
2008-2013	0.57	0.75	0.37	0.38	-0.18	-0.37	-0.19
2013-2018	0.05	0.15	0.03	0.12	-0.10	-0.62	-0.52
2018-2023	1.72	0.85	-0.47	1.32	0.88	0.41	-0.47
Total 1998-2023	0.55	-0.18	-1.06	0.89	0.72	0.33	-0.39

^{a/}Negative rates of growth in red

Source: Own estimates using microdata from the Economic Census of Mexico

Table 4 shows that surviving establishments contributed negatively while net entrants contributed positively to average TFP growth in Mexico. Therefore, the Haltiwanger (1997) approach shows that surviving establishments pull TFP growth downward, whereas net entrants push it upward. During 2003-2008, surviving and net-entrant establishments contributed significantly negatively to TFP growth. The financial crisis of 2008-2009 may have contributed to negative TFP growth from both surviving and net-entrant establishments.

The results in Table 4 can be related to the empirical evidence in Levy-Algazi (2018), which argues that the Mexican economy exhibits pervasive dynamics, with establishments of low (or negative) TFP entering and remaining in the market. According to the aggregated results in Table 4, evidence suggests dysfunctional business churning in Mexico, with surviving establishments pulling down aggregate TFP growth. However, this dysfunctional business churning may reflect a temporary shock from the 2008-2009 financial crisis, which affected TFP growth contributions from surviving establishments during 2003-2008, with a decline of -3.47%, while net entrants also had a declining TFP growth contribution of -1.04%. As a result, surviving establishments have not fully recovered their contribution to TFP growth since 2008.

Appendix E calculates the contribution to national TFP growth from states and sectors using the Haltiwanger (1997) approach (Tables E1 and E2). The results show that 26 of 32 states contributed positively to TFP growth. Mexico City, Tabasco, and Veracruz contributed more to TFP growth, while Quintana Roo, San Luis, and Guanajuato contributed less. It was also estimated that 10 of 20 sectors contributed positively to TFP growth. Mining, Quarrying, and Oil and Gas Extraction (NAICS 21), Finance and Insurance (NAICS 52), and Manufacturing of food, beverages, and tobacco (NAICS 31) contributed more to TFP growth.

Melitz & Polanec (2015) decomposition

Table 5 presents the results of Melitz & Polanec (2015) decomposition during 1998-2023. Column (1) of Table 5 presents TFP growth by census year. TFP growth is disaggregated by the contribution of surviving (within and between), entering and exiting establishments (Columns 2-7 in Table 5). The surviving establishments contributed -0.19% to TFP growth (Column 2), while the contribution of the net entrants to TFP growth is 0.73% p.a. for the period 1998-2023.

Table 5. Melitz & Polanec (2015) decomposition of TFP growth in Mexico, 1998-2023.^{a/}

Period	(1)=(2)+(5)	(2)=(3)+(4)	(3)	(4)	(5)=(6)-(7)	(6)	(7)
	TFP growth (%) p.a. by period	Surviving	Surviving (within)	Surviving (between)	Net entrants	Entering	Exiting
1998-2003	4.90	0.87	-0.11	0.98	4.03	3.92	-0.10
2003-2008	-4.51	-4.08	-7.43	3.35	-0.43	-0.79	-0.36
2008-2013	0.57	1.04	2.68	-1.64	-0.47	-0.51	-0.04
2013-2018	0.05	0.26	2.74	-2.48	-0.21	-0.82	-0.61
2018-2023	1.72	0.98	1.75	-0.78	0.75	0.49	-0.26
Total 1998-2023	0.55	-0.19	-0.07	-0.11	0.73	0.46	-0.27

^{a/}Negative rates of growth in red

Source: Own estimates using microdata from the Economic Census of Mexico

The similarity between the Haltiwanger (1997) and Melitz & Polanec (2015) decompositions is that both approaches conclude that surviving establishments pull TFP growth downwards while net entrants push TFP growth upwards.¹¹ Like the Haltiwanger (1997) decomposition, the Melitz & Polanec (2015) approach also shows that during 2003-2008 there was a significant negative contribution to TFP growth (Table 5). Therefore, the negative economic shock of the financial crisis (2008-2009) mainly affected the TFP growth of surviving establishments. Since then, the TFP growth of surviving establishments has not recovered from the severe decline.

Appendix E calculates the contribution of states and sectors to national TFP growth using the Melitz & Polanec (2015) approach (Tables E3 and E4). The results indicate that 23 of 32 states contributed positively to TFP growth. Mexico City, Tabasco, and Veracruz contributed more to TFP growth, while San Luis, Querétaro, and Campeche contributed less. Furthermore, 8 of the 20 sectors contributed positively to TFP growth. Finance and Insurance (NAICS 52), Manufacturing of food, beverage, and tobacco products (NAICS 31), and Manufacturing of wood, paper, printing, and related supporting activities (NAICS 32) contributed more to TFP growth.

The estimated contributions of states and sectors to national (average) TFP growth (1998-2023) differ between the Haltiwanger (1997) and Melitz & Polanec (2015) approaches.¹² These differences arise because each methodology rebalances weights differently across sectors and states when decomposing TFP growth. The similarity between the two approaches is that both the Haltiwanger (1997) and Melitz & Polanec (2015) approaches estimate that many states contribute positively to TFP growth (26 and 23 of 32 states, respectively), whereas fewer sectors contribute positively (10 and 8 of 20 sectors, respectively). As a result, many sectors contribute negatively to TFP growth, mainly because their surviving establishments contribute negatively.

There is an additional line of future research regarding the TFP growth decomposition in Mexico and related to the work of Dias & Robalo (2021), which pointed out a substantial difference when productivity is weighted and aggregated in levels compared to the aggregation of weighted productivity in natural logarithms due to the Jensen's inequality. For example, the discrepancy between Figure 1 and Tables 4 and 5 can reflect the Jensen's inequality. On the one hand, the period 2018-2023 shows a decline in TFP in levels, while the TFP growth (derived

¹¹ The time frequency of the data is an important characteristic for quantifying the contribution of net entry to productivity growth. Foster et al. (2001) note that studies using higher-frequency data (e.g., annual) typically find a relatively small contribution of net entry to aggregate productivity growth, whereas studies using longer time horizons tend to find a larger contribution. Therefore, the low frequency of the Mexican Economic Census (i.e., a 5-year gap) may help explain a larger contribution of net entry to aggregate productivity growth.

¹² For instance, the Haltiwanger (1997) approach estimates that the Mining, Quarrying, and Oil and Gas Extraction sector (NAICS 21) contributes substantially to TFP growth, whereas the Melitz & Polanec (2015) approach estimates that it contributes less. (See Tables E2 and E4).

from TFP in logs) shows positive growth for the same period. For this reason, future research can extend TFP growth decomposition using TFP in levels.

5. Conclusion

This paper uses establishment-level TFP estimates and analyses their aggregation in levels and growth. The empirical aggregation examines TFP (in levels) across three dimensions: temporal, geographical, and sectoral. The main findings are as follows:

- i. The temporal dimension of TFP identifies a fluctuating pattern from 1998 to 2023. The deepest TFP drop was identified during the global financial crisis of 2008-2009 in Mexico. TFP also declined in 2023, which may reflect the Covid-19 crisis. These results suggest that TFP is linked to business cycle fluctuations.
- ii. In the geographical dimension, TFP also shows a changing pattern in its spatial distribution across states in Mexico from 1998 to 2023. In 2023, states with higher TFP had a larger productivity contribution from three sectors: (i) retail trade, (ii) wholesale, and (iii) mining, quarrying, and oil and gas extraction. Furthermore, states with higher TFP tend to be lifted by their high-productivity municipalities.
- iii. In the sectoral dimension, the same three sectors have maintained high TFP levels over time: (i) retail trade, (ii) wholesale, and (iii) mining, quarrying, and oil and gas extraction. In particular, wholesale and retail trade are highly productive sectors, but they also exhibit high TFP disparities within the sector, which are more pronounced in highly populated areas. The oil industry is the most productive activity within the mining, quarrying, and oil and gas extraction sector. However, this activity is expected to be less dominant in the coming years because of emerging technologies. The Mexican government must initiate an energy transition path so that high TFP does not depend primarily on oil extraction.

In the TFP growth analysis, this paper applies two TFP growth decomposition methodologies proposed by Haltiwanger (1997) and Melitz & Polanec (2015) to examine the contributions of establishments that survive, enter and exit the market. The main findings are as follows:

- i. The average TFP growth from 1998 to 2023 was 0.55%, and its decomposition indicates that surviving establishments contribute negatively to TFP growth, whereas net entrants contribute positively. This finding may relate to the concept of dysfunctional firm dynamics in Mexico, which suggests that firms with low or negative productivity enter the market and survive, thereby pulling aggregate TFP growth downward (Levy, 2018; Ros-Bosch, 2019).
- ii. However, when TFP growth is analysed between periods, the TFP growth decomposition shows that during the financial crisis of 2008, the TFP growth of surviving firms and net entrants was severely affected. Although net entrants later improved TFP growth, surviving establishments did not fully recover. Thus, the structural shock of the 2008 crisis had a long-lasting effect on TFP growth in the Mexican economy.
- iii. The TFP growth decomposition estimates that only a small number of states contributed negatively to TFP growth from 1998 to 2023 (between 6 and 9 of 32 states). This is small compared with the sectors that contributed negatively to TFP growth (10 to 12 of 20 sectors). Therefore, implementing industrial strategies is a plausible option to strengthen a broader range of low-productivity sectors and to focalise action in specific states with low productivity performance.

This research provides empirical evidence on TFP across different levels of aggregation and dimensions of analysis. This evidence can support the design and implementation of industrial strategies in Mexico to identify sectors and geographical areas that require targeted interventions to enhance productivity. Industrial strategies form part of the institutional framework that influences productivity performance from the micro level of establishments to the macro level of the economy (Rodrik, 2008). In the long-run, sustained TFP growth is crucial to improve economic performance and living standards in Mexico (Klenow & Rodriguez-Clare, 1997).

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Appendix

Appendix A. Additional details on estimating production functions

Equation A1 is the simplified expression of equation 1, which is a linear equation suitable for parameterisation. Retrieving the parameter σ^{-1} allows calculating the markup $(\sigma - 1)/\sigma$. Then, it is possible to separate the effect of the markup and the elasticities from equation A1 and present them as equation 1: $\hat{\alpha} = \alpha (\sigma - 1)/\sigma$. Table A1 presents the descriptive statistics and further details of the variables used to estimate the production function.

$$\hat{r}_{it} = \hat{\alpha}_m m_{it} + \hat{\alpha}_l l_{it} + \hat{\alpha}_k k_{it} + x'_{it} \hat{\alpha}_x + \hat{\alpha}_T t + \sigma^{-1} q_{st} + u_{it} \quad (A1)$$

Tables A2 and A3 present the estimated production function parameters by sector. In total, there was estimated 20 production functions using the specification in equation (1). Table A2 includes the elasticities of the factors of production, the inverse of the CES demand and the mark-up. Table A3 presents parameters measuring the effects of TFP determinants and the time trend. Ramirez-Guerra (2026) presents Tables A1, A2, and A3, along with an extensive analysis of TFP determinants in Mexico. One conclusion is that some firms perform more efficiently than others due to their TFP determinants. Then, TFP determinants cause TFP heterogeneity across establishments in Mexico. Tables A4, A5, and A6 show the percentile distributions of establishment-level TFP estimated with equation 2 by years, states and sectors, respectively.

Table A1. Description of variables included in the revenue-based production functions, 1993-2023

Variable	Disaggregation	Notation	Description	N	μ	σ
<i>ln</i> real revenue	Firm-specific	$\hat{r}_{it}$	<i>ln</i> revenue (one hundred million) in real terms (MXP, 2018 prices)	23,722,942	-8.79	1.83
<i>ln</i> intermediate inputs	Firm-specific	m_{it}	<i>ln</i> intermediate inputs (one hundred million) in real terms (MXP, 2018 prices)	23,169,587	-9.83	1.97
<i>ln</i> employment	Firm-specific	l_{it}	<i>ln</i> employed persons.	24,188,099	0.72	0.87
<i>ln</i> capital	Firm-specific	k_{it}	<i>ln</i> real net tangible fixed assets (one hundred million) in real terms (MXP, 2018 prices)	21,569,691	-9.68	2.02
<i>ln</i> establishment's age	Firm-specific		<i>ln</i> of firms' age, measured as the number of years in activity.	24,281,675	1.74	1.14
Establishment's size class	Firm-specific		A nine-category firm size (i.e. categorical) variable based on employee counts, following the U.S. Bureau of Labor Statistics classification	24,282,219	1.23	0.73
<i>ln</i> HHI	Industry-specific		HHI is calculated by year and industry group (4 digits of NAICS) and converted to <i>ln</i> .	24,282,209	1.78	2.08
<i>ln</i> fixed costs ratio.	Firm-specific	x_{it}	<i>ln</i> % of expenses in marketing, accessories, rent and professional services on total expenses.	24,282,205	-3.29	7.73
<i>ln</i> agglomeration index.	Geography-specific		<i>ln</i> % of industry group output (4-digit NAICS) by municipality –MAR-spillovers–	24,258,200	-1.88	2.27
<i>ln</i> diversification index.	Geography-specific		<i>ln</i> proportion of 4-digit NAICS industries by year (maximum 275) within the municipality (in total 2,461) –Jacobian spillovers–	24,282,219	4.35	0.45
<i>ln</i> population density	Geography-specific		<i>ln</i> of population density, measured as the ratio of population and km ² at the municipality level.	24,134,782	6.21	2.08
Time-trend	Year-specific	T	Linear trend of the year 1993=1, 1998=2, 2003=3, 2008=4, 2013=5, 2018=6, 2023=7	24,282,219	4.86	1.71
<i>ln</i> industrial gross output.	Industry-specific	$(r_{st} - p_{st})$	<i>ln</i> gross production (one hundred million) in real terms, 4-digits of NAICS (MXP, 2018 prices).	24,282,209	4.22	1.26

Source: Own elaboration using microdata of the Economic Census of Mexico

Table A2. Elasticities of the factors of production, inverse of the CES demand and mark-up in the revenue-based production functions. ^{a/}

NAICS (2 digits)	Economic Sector	α_m ln intermediate inputs	α_l ln employment	α_k ln capital	$1/\sigma$ Inverse of the CES demand	$\sigma/(\sigma - 1)$ Mark-up	NT Obs.
11	Agriculture	0.58*** (0.011)	0.322*** (0.011)	0.191*** (0.005)	0.255*** (0.010)	1.342*** (0.019)	63,008
21	Mining	0.791*** (0.031)	0.282*** (0.032)	0.017** (0.008)	0.186*** (0.028)	1.228*** (0.043)	7,595
23	Construction	0.79*** (0.003)	0.228*** (0.007)	0.025*** (0.001)	-0.02*** (0.002)	0.979*** (0.001)	34,842
31	Manufacturing (consumer goods)	0.84*** (0.001)	0.15*** (0.001)	0.023*** (0.001)	0.003*** (0.001)	1.004*** (0.001)	540,025
32	Manufacturing (materials and chemicals)	0.888*** (0.001)	0.155*** (0.002)	0.015*** (0.001)	0.001 (0.001)	1.002*** (0.001)	178,278
33	Manufacturing (industrial technological)	0.893*** (0.001)	0.186*** (0.001)	0.004*** (0.001)	-0.001*** (0.001)	0.995*** (0.001)	274,057
43	Wholesale	0.52*** (0.003)	0.474*** (0.005)	0.079*** (0.001)	0.049*** (0.001)	1.052*** (0.001)	237,902
46	Retail trade	0.576*** (0.001)	0.444*** (0.001)	0.071*** (0.001)	0.164*** (0.001)	1.196*** (0.001)	3,840,424
48	Transportation	0.673*** (0.005)	0.425*** (0.008)	0.058*** (0.003)	0.102*** (0.002)	1.113*** (0.003)	46,904
49	Postal services and warehouse	0.56*** (0.017)	0.355*** (0.034)	0.035*** (0.009)	0.049*** (0.015)	1.052*** (0.016)	3,005
51	Information	0.713*** (0.011)	0.324*** (0.018)	0.044*** (0.004)	0.076*** (0.006)	1.083*** (0.007)	11,857
52	Finance and Insurance	0.676*** (0.006)	0.402*** (0.010)	0.040*** (0.003)	0.072*** (0.005)	1.078*** (0.006)	33,651
53	Real estate, rental and leasing	0.812*** (0.004)	0.226*** (0.005)	0.050*** (0.001)	0.115*** (0.002)	1.13*** (0.003)	97,986
54	Professional, scientific, and technical services	0.77*** (0.005)	0.519*** (0.005)	0.087*** (0.001)	0.245*** (0.003)	1.325*** (0.006)	181,586
56	Administrative support and waste management	0.887*** (0.006)	0.383*** (0.006)	0.028*** (0.001)	0.164*** (0.005)	1.197*** (0.008)	107,935
61	Educational services	0.442*** (0.003)	0.605*** (0.006)	0.059*** (0.001)	0.069*** (0.002)	1.074*** (0.002)	100,471
62	Health care and social assistance	0.876*** (0.003)	0.431*** (0.003)	0.062*** (0.001)	0.228*** (0.002)	1.295*** (0.003)	382,071
71	Arts, entertainment, and recreation	0.665*** (0.004)	0.338*** (0.006)	0.047*** (0.001)	0.048*** (0.003)	1.051*** (0.004)	70,657
72	Accommodation and food services	0.811*** (0.001)	0.227*** (0.001)	0.017*** (0.001)	0.014*** (0.001)	1.014*** (0.001)	894,684
81	Other services (except public administration)	0.691*** (0.001)	0.365*** (0.001)	0.043*** (0.001)	0.055*** (0.001)	1.059*** (0.001)	1,265,371

Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

^{a/} / Dependent variable: ln real revenue

Source: Own estimates using microdata from the Economic Census of Mexico

Table A3. Elasticities of TFP determinants in the revenue-based production functions. ^{a/}

NAICS (2 digits)	Economic Sector	ln establishme nt's age	Firm size stratification	ln HHI	α_x ln fixed costs ratio	ln agglomerat ion index	ln diversificati on index	ln population density	α_T Time- trend	NT Observation s
11	Agriculture	-0.001 (0.006)	-0.001 (0.009)	0.244*** (0.008)	0.001 (0.001)	0.097*** (0.002)	0.079*** (0.009)	-0.02*** (0.002)	-0.03*** (0.003)	63,008
21	Mining	-0.04*** (0.013)	0.141*** (0.027)	-0.03 (0.024)	-0.01*** (0.001)	0.064*** (0.007)	0.053* (0.031)	0.033*** (0.005)	-0.02*** (0.010)	7,595
23	Construction	0.002 (0.003)	-0.04*** (0.005)	0.001 (0.001)	0.002*** (0.001)	0.017*** (0.001)	-0.02*** (0.006)	-0.001*** (0.001)	0.004*** (0.001)	34,842
31	Manufacturing (consumer goods)	0.015*** (0.001)	0.069*** (0.001)	-0.001*** (0.001)	-0.001 (0.001)	0.013*** (0.001)	-0.001** (0.001)	0.001** (0.001)	-0.001** (0.001)	540,025
32	Manufacturing (materials and chemicals)	0.005*** (0.001)	0.013*** (0.002)	0.004*** (0.001)	-0.001*** (0.001)	0.006*** (0.001)	0.034*** (0.002)	-0.01*** (0.001)	-0.001*** (0.001)	178,278
33	Manufacturing (industrial and technological)	0.009*** (0.001)	0.067*** (0.002)	0.014*** (0.001)	-0.001*** (0.001)	0.012*** (0.001)	0.006*** (0.001)	-0.001*** (0.001)	0.004*** (0.001)	274,057
43	Wholesale	0.011*** (0.002)	-0.001* (0.005)	0.04*** (0.002)	-0.04*** (0.001)	0.08*** (0.001)	-0.15*** (0.007)	-0.02*** (0.001)	0.106*** (0.001)	237,902
46	Retail trade	0.060*** (0.001)	0.161*** (0.002)	0.072*** (0.001)	-0.01*** (0.001)	0.053*** (0.001)	-0.13*** (0.004)	0.013*** (0.001)	0.048*** (0.001)	3,840,424
48	Transportation	-0.001 (0.004)	-0.05*** (0.007)	0.083*** (0.003)	0.007*** (0.001)	0.076*** (0.001)	-0.03*** (0.005)	-0.01*** (0.001)	0.047*** (0.002)	46,904
49	Postal services and warehouse	0.093*** (0.015)	0.021 (0.028)	-0.13*** (0.010)	0.017*** (0.003)	0.066*** (0.008)	-0.01 (0.031)	-0.001 (0.006)	-0.01** (0.008)	3,005
51	Information	0.062*** (0.008)	-0.02 (0.015)	0.007* (0.004)	0.001 (0.002)	0.092*** (0.004)	-0.08*** (0.014)	-0.03*** (0.003)	0.159*** (0.004)	11,857
52	Finance and Insurance	0.047*** (0.006)	0.037*** (0.010)	-0.07*** (0.004)	0.010*** (0.001)	0.060*** (0.002)	-0.16*** (0.014)	-0.02*** (0.002)	0.055*** (0.004)	33,651
53	Real estate, rental and leasing	0.053*** (0.003)	0.024*** (0.006)	0.076*** (0.002)	0.002*** (0.001)	0.063*** (0.001)	-0.07*** (0.009)	-0.001*** (0.001)	0.029*** (0.002)	97,986
54	Professional, scientific, and technical services	0.066*** (0.002)	0.089*** (0.005)	0.017*** (0.002)	0.001 (0.001)	0.072*** (0.001)	-0.05*** (0.009)	-0.02*** (0.001)	0.047*** (0.001)	181,586
56	Administrative support and waste management	0.072*** (0.003)	0.127*** (0.005)	0.165*** (0.004)	-0.001*** (0.001)	0.03*** (0.001)	0.013*** (0.004)	-0.01*** (0.001)	-0.02*** (0.002)	107,935
61	Educational services	0.069*** (0.002)	0.059*** (0.005)	0.027*** (0.002)	-0.001*** (0.001)	0.053*** (0.001)	-0.18*** (0.011)	-0.001** (0.001)	-0.001*** (0.001)	100,471
62	Health care and social assistance	0.040*** (0.001)	-0.01*** (0.004)	0.063*** (0.001)	-0.001*** (0.001)	0.093*** (0.001)	-0.21*** (0.007)	-0.02*** (0.001)	-0.04*** (0.001)	382,071
71	Arts, entertainment, and recreation	0.031*** (0.003)	-0.01 (0.007)	0.014*** (0.001)	0.001 (0.001)	0.064*** (0.002)	-0.07*** (0.009)	-0.001*** (0.001)	-0.001 (0.002)	70,657
72	Accommodatio n and food services	0.027*** (0.001)	0.068*** (0.001)	0.036*** (0.001)	0.001*** (0.001)	0.024*** (0.001)	-0.01*** (0.002)	-0.001*** (0.001)	0.036*** (0.001)	894,684
81	Other services (except public administration)	0.048*** (0.001)	0.053*** (0.002)	0.016*** (0.001)	-0.001*** (0.001)	0.035*** (0.001)	-0.02*** (0.005)	-0.001*** (0.001)	0.005*** (0.001)	1,265,371

Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

^{a/} Dependent variable ln gross output

Source: Own estimates using microdata from the Economic Census of Mexico

Table A4. Distribution of the TFP at the establishment level in Mexico by year, 1998-2023.^{a/}

Year	1%	25%	50%	Mean	75%	99%	Observations	Establishments
1998	0.04	0.14	0.21	0.41	0.39	2.98	2,430,553	2,801,543
2003	0.05	0.14	0.21	0.43	0.40	3.41	2,656,672	3,002,310
2008	0.02	0.10	0.16	0.31	0.28	2.48	3,051,697	3,721,217
2013	0.03	0.11	0.18	0.33	0.30	2.65	3,617,427	4,227,667
2018	0.04	0.12	0.19	0.41	0.34	3.16	3,958,649	4,796,830
2023	0.05	0.13	0.20	0.43	0.38	3.61	4,509,673	5,464,702

^{a/} Observations are the number of establishments with a TFP estimate, as they reported output and inputs for the TFP estimation.

Source: Own calculation using microdata from the Economic Census of Mexico.

Table A5. Distribution of the TFP at the establishment level in Mexico by states, 1998-2023.^{a/b/}

State	Abv	1%	25%	50%	Mean	75%	99%	Observations	Establishments
Aguascalientes	Ags.	0.03	0.12	0.18	0.34	0.32	2.49	236,433	270,574
Baja California	BC	0.04	0.14	0.21	0.36	0.35	2.44	459,007	523,150
Baja California Sur	BCS	0.04	0.13	0.19	0.33	0.32	2.23	133,322	149,505
Campeche	Camp.	0.03	0.12	0.19	0.41	0.35	3.06	142,478	182,266
Coahuila	Coah.	0.03	0.13	0.20	0.36	0.34	2.70	423,243	499,575
Colima	Col.	0.04	0.12	0.18	0.32	0.31	2.18	141,647	164,397
Chiapas	Chis.	0.03	0.12	0.18	0.42	0.35	3.45	665,102	861,083
Chihuahua	Chih.	0.04	0.13	0.20	0.40	0.36	3.27	504,532	571,510
Mexico City	CDMX	0.04	0.13	0.21	0.47	0.40	4.16	2,034,399	2,336,190
Durango	Dgo.	0.03	0.12	0.19	0.37	0.33	2.78	249,778	290,408
Guanajuato	Gto.	0.03	0.13	0.19	0.37	0.35	2.91	1,044,911	1,205,345
Guerrero	Gro.	0.03	0.11	0.18	0.37	0.34	3.06	555,056	757,599
Hidalgo	Hgo.	0.03	0.11	0.18	0.35	0.32	2.69	485,653	558,894
Jalisco	Jal.	0.04	0.13	0.20	0.39	0.36	3.04	1,475,868	1,695,251
State of Mexico	Mex.	0.04	0.12	0.19	0.43	0.38	3.78	2,617,829	3,053,853
Michoacan	Mich.	0.03	0.12	0.18	0.37	0.34	3.00	939,448	1,129,025
Morelos	Mor.	0.03	0.12	0.18	0.35	0.33	2.75	409,261	480,031
Nayarit	Nay.	0.03	0.12	0.18	0.32	0.32	2.31	227,611	266,120
Nuevo Leon	NL	0.04	0.14	0.21	0.38	0.35	2.75	690,981	814,094
Oaxaca	Oax.	0.03	0.11	0.17	0.37	0.33	3.12	735,649	1,000,595
Puebla	Pue.	0.03	0.11	0.17	0.34	0.32	2.70	1,215,787	1,453,526
Queretaro	Qro.	0.04	0.13	0.19	0.39	0.34	2.69	341,872	382,993
Quintana Roo	Q. Roo	0.04	0.13	0.20	0.37	0.35	2.63	221,325	251,471
San Luis Potosi	SLP	0.03	0.12	0.18	0.33	0.32	2.47	428,514	500,317
Sinaloa	Sin.	0.04	0.13	0.19	0.36	0.34	2.55	456,158	528,526
Sonora	Son.	0.04	0.13	0.20	0.35	0.33	2.44	434,616	514,702
Tabasco	Tab.	0.04	0.13	0.20	0.58	0.38	3.59	293,256	353,951
Tamaulipas	Tamps.	0.04	0.13	0.20	0.35	0.34	2.45	534,195	617,228
Tlaxcala	Tlax.	0.03	0.10	0.16	0.31	0.28	2.39	289,206	336,616
Veracruz	Ver.	0.03	0.12	0.18	0.34	0.32	2.58	1,180,306	1,418,271
Yucatan	Yuc.	0.03	0.12	0.19	0.37	0.34	2.86	389,036	543,873
Zacatecas	Zac.	0.03	0.12	0.18	0.34	0.32	2.60	268,192	303,330

^{a/} Sorted by the state name. The acronym abv refers to the state name abbreviation.

^{b/} Observations are the number of establishments with a TFP estimate, as they reported output and inputs for the TFP estimation.

Source: Own calculation using microdata from the Economic Census of Mexico.

Table A6. Distribution of the TFP at the establishments level in Mexico by sectors, 1998-2023.^{a/b/}

NAICS	Sector	1%	25%	50%	Mean	75%	99%	Observations	Establishments
11	Agriculture, Forestry, Fishing and Hunting	0.04	0.12	0.19	0.37	0.34	2.56	123,211	131,914
21	Mining, Quarrying, and Oil and Gas Extraction	0.04	0.11	0.18	0.32	0.30	2.45	15,086	18,037
23	Construction	0.07	0.15	0.18	0.21	0.23	0.70	95,068	100,703
31	Manufacturing (food, beverage and tobacco etc.).	0.05	0.11	0.15	0.18	0.19	0.69	1,140,643	1,574,448
32	Manufacturing (wood, paper, printing and related supporting activities etc.)	0.05	0.12	0.16	0.18	0.21	0.52	435,483	533,633
33	Manufacturing (primary metals, machinery, computers and electronics, etc.).	0.06	0.12	0.16	0.18	0.20	0.53	613,358	703,693
43	Wholesale	0.03	0.18	0.32	0.85	0.65	7.08	641,770	761,414
46	Retail trade	0.03	0.14	0.27	0.54	0.54	4.23	9,008,300	10,996,903
48	Transportation	0.07	0.15	0.20	0.29	0.27	1.77	143,092	148,924
49	Postal services and warehouse	0.06	0.18	0.26	0.47	0.40	2.87	13,041	16,472
51	Information	0.03	0.11	0.17	0.29	0.29	1.67	43,678	52,268
52	Finance and Insurance	0.04	0.16	0.23	0.39	0.37	2.31	97,327	113,382
53	Real estate, rental and leasing	0.04	0.12	0.18	0.30	0.30	1.95	297,197	345,561
54	Professional, scientific, and technical services	0.05	0.14	0.22	0.33	0.35	1.93	488,607	519,915
56	Administrative and support of waste management and remediation services	0.04	0.11	0.17	0.29	0.26	1.73	342,915	370,139
61	Educational services	0.05	0.16	0.25	0.38	0.42	2.21	241,360	261,610
62	Health care and social assistance	0.04	0.14	0.20	0.28	0.31	1.42	868,910	968,447
71	Arts, entertainment, and recreation	0.04	0.12	0.18	0.28	0.29	1.88	230,868	261,966
72	Accommodation and food services	0.05	0.11	0.14	0.17	0.18	0.69	2,406,226	2,804,328
81	Other services (except public administration)	0.04	0.11	0.16	0.22	0.24	1.23	2,978,531	3,330,512

^{a/} Sorted by the state NAICS ID at 2-digits.

^{b/} Observations are the number of establishments with a TFP estimate, as they reported output and inputs for the TFP estimation.

Source: Own calculation using microdata from the Economic Census of Mexico.

Appendix B. Accounting framework for firm dynamics in Mexico

Tables B1 and B2 present the classification of establishments by firm selection groups. Table B1 describes the number of establishments in the Economic Census of Mexico categorised by the number of periods remaining in the market during 1998-2023. Column 1 shows that establishments in the Economic Census can have at least one period in the market and up to six periods. For instance, Column 2 indicates that 1,360,044 establishments entered in 1998 and remained in the market for only one period; 536,592 establishments entered in 1998 and survived in the market for two periods; 241,709 survived for three periods; 147,273 survived for four periods; while 102,622 and 416,388 establishments remained for five and six periods, respectively. The same description applies to the subsequent years 2003-2023. Table B2 classifies the establishments in Table B1 into groups that enter, survive, and exit the market. Table B2 is the main classification framework for firm dynamics in Mexico and is applied to the TFP growth decomposition.

Table B1. The number of establishments in the Mexican market by period (1998-2023).

Number of periods in the market	1998	2003	2008	2013	2018	2023	Total by periods
One period	1,360,044						1,360,044
		945,921					945,921
			1,105,875				1,105,875
				979,398			979,398
					942,947		942,947
Two periods						2,312,364	2,312,364
	536,592	536,592					1,073,184
		216,622	216,622				433,244
			356,433	356,433			712,866
				347,755	347,755		695,510
Three periods					1,215,119	1,215,119	2,430,238
	241,709	241,709	241,709				725,127
		105,550	105,550	105,550			316,650
			186,622	186,622	186,622		559,866
				743,791	743,791	743,791	2,231,373
Four periods	147,273	147,273	147,273	147,273			589,092
		64,395	64,395	64,395	64,395		257,580
			552,499	552,499	552,499	552,499	2,209,996
Five periods	102,622	102,622	102,622	102,622	102,622		513,110
		228,019	228,019	228,019	228,019	228,019	1,140,095
Six periods	416,388	416,388	416,388	416,388	416,388	416,388	2,498,328
Total by years	2,804,628	3,005,091	3,724,007	4,230,745	4,800,157	5,468,180	24,032,808

Source: Own calculation using microdata of the Economic Census of Mexico.

Table B2. The number of establishments by group: exiting, surviving and entering (1998-2023).^{a/}

Group of establishments	1998	2003	2008	2013	2018	2023	Total by group
Exiting $i \in X$	1,360,044	1,482,513	1,564,206	1,588,654	1,644,341		7,639,758
Surviving $i \in S$	1,444,584	1,522,578	2,159,801	2,642,091	3,155,816		10,924,870
Total by years	2,804,628	3,005,091	3,724,007	4,230,745	4,800,157		18,564,628
Group of establishments	1998	2003	2008	2013	2018	2023	Total by group
Entering $i \in E$		1,560,507	2,201,429	2,070,944	2,158,066	2,312,364	10,303,310
Surviving $i \in S$		1,444,584	1,522,578	2,159,801	2,642,091	3,155,816	10,924,870
Total by years		3,005,091	3,724,007	4,230,745	4,800,157	5,468,180	21,228,180

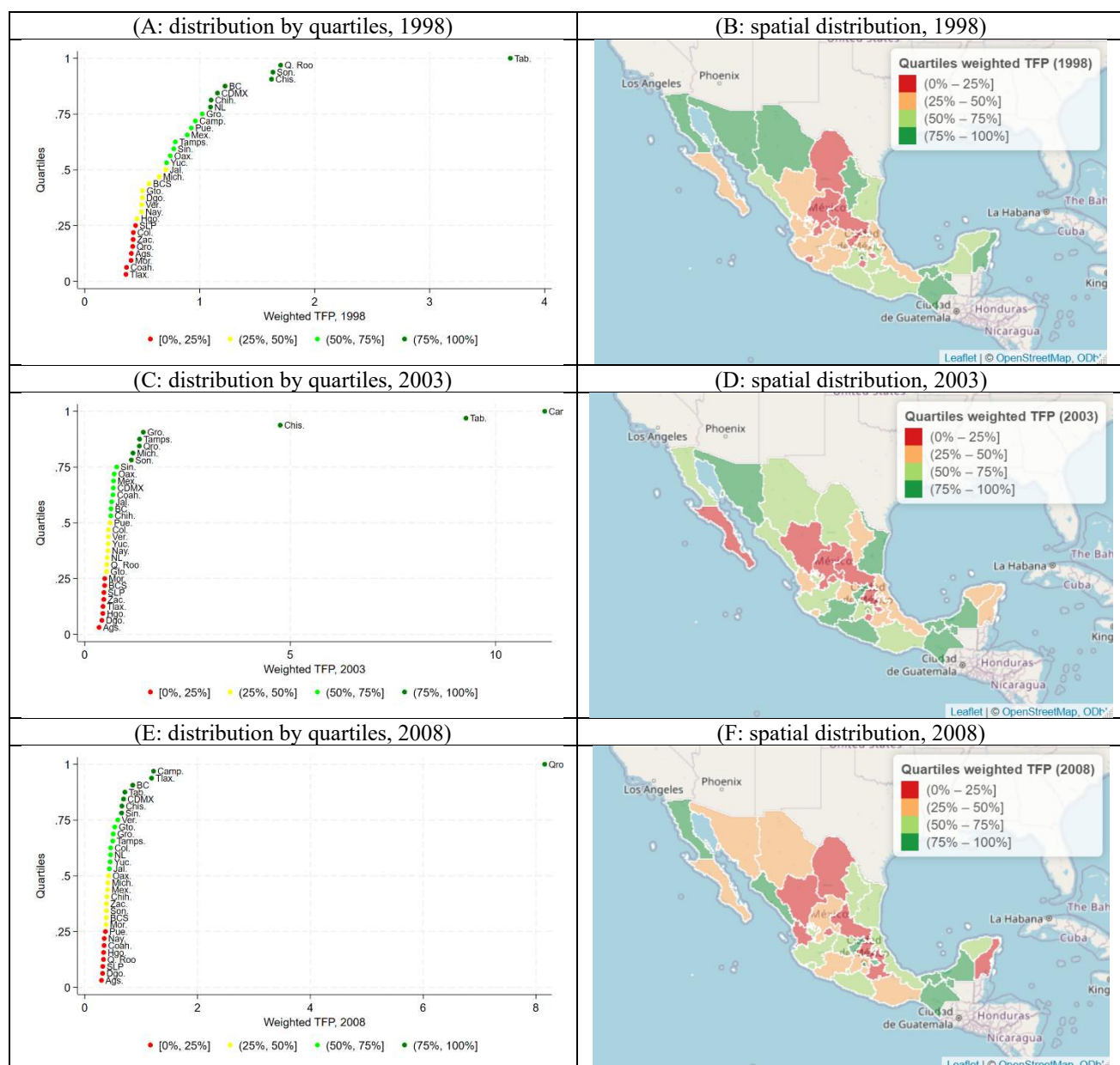
^{a/}Total observations by year are equivalent to Table B1

Source: Own calculation using microdata from the Economic Census of Mexico.

Appendix C. Extended evidence of TFP across geographical locations

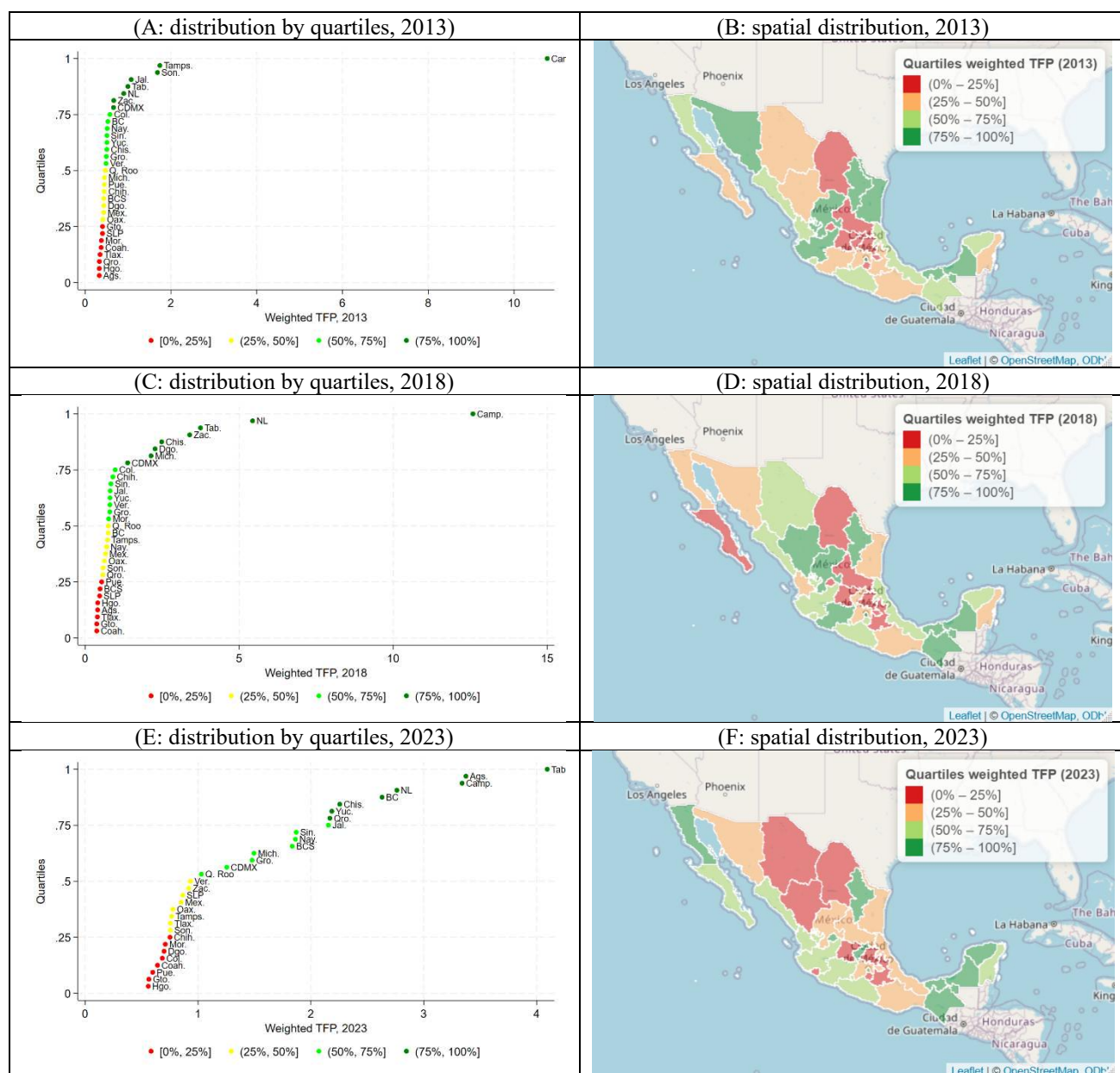
Appendix C extends the spatial analysis of TFP in Mexico. Figures C1, C2, and C3 present weighted TFP at the state and municipal levels, classified into quartiles, for the available years from 1998 to 2023. The results indicate a changing pattern in the distribution of weighted TFP across states and municipalities over time. This shows that TFP varies across geographical locations: some locations are highly productive in one census year, but in the next period their TFP drops to the low quartiles of productivity. Therefore, the spatial distributions of weighted TFP are not consistent over time. The fluctuating pattern of weighted TFP across states can be explained by the fact that regional TFP is subject to the economic cycle (Kydland & Prescott, 1982). Furthermore, aggregated TFP is also sensitive to variation in weights (Equation 4). Consequently, the reallocation of resources within states (i.e., changes in weights) leads to variations in their weighted TFP (Haltiwanger, 1999).

Figure C1. Weighted average TFP at the state level by quartiles (A, C, E) and its spatial distribution (B, D, F), 1998 - 2008



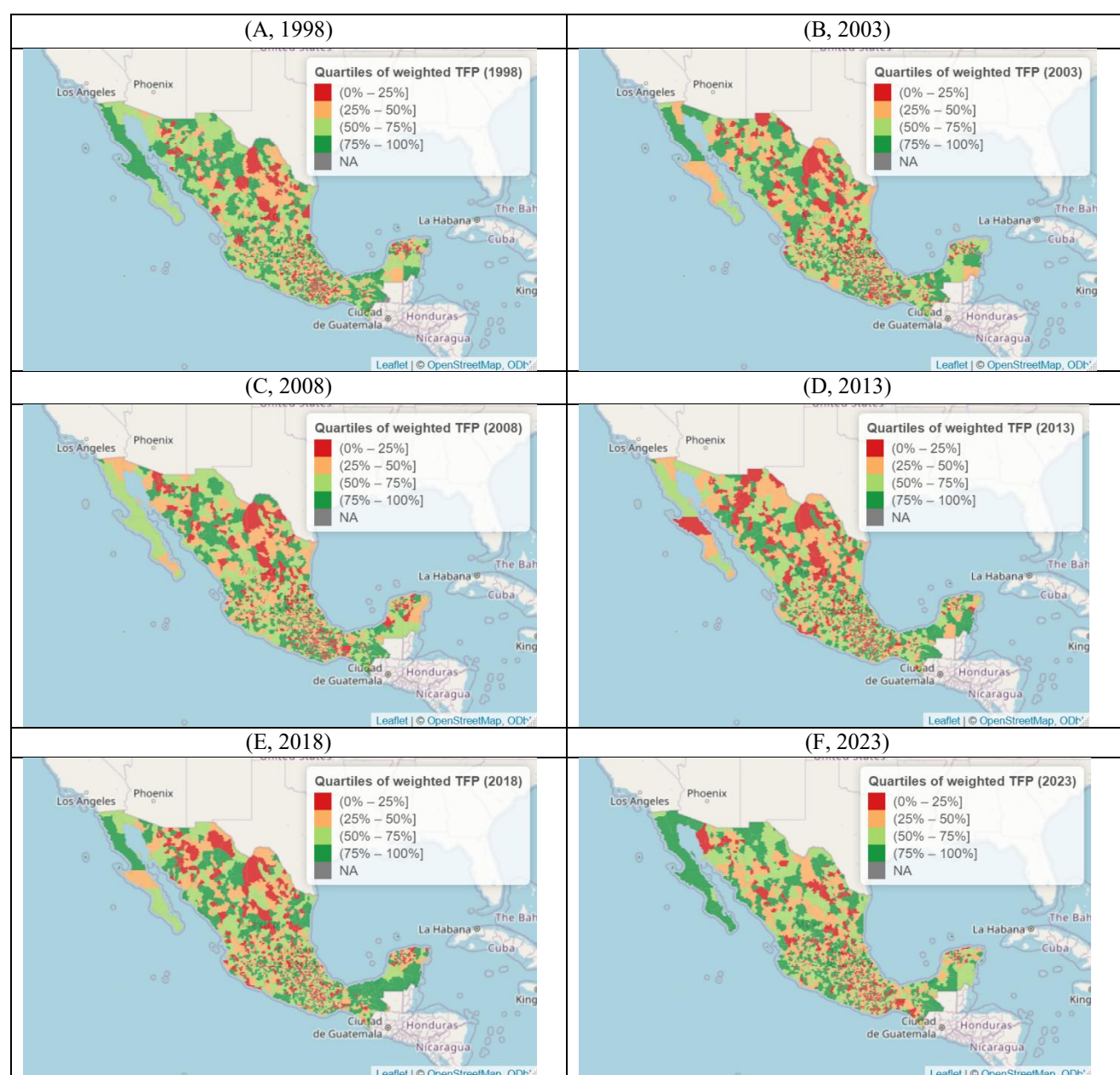
Source: Own estimates using microdata from the Economic Census of Mexico

Figure C2. Weighted average TFP at the state level by quartiles (A, C, E) and its spatial distribution (B, D, F), 2013 - 2023



Source: Own estimates using microdata from the Economic Census of Mexico

Figure C3. The spatial distribution of weighted average TFP at the municipality level by quartiles, 1998- 2023



Source: Own estimates using microdata from the Economic Census of Mexico

Table C1 measures the sectoral contribution to weighted TFP at the state level during 2023 from Figure 2. The objective is to identify the sectors that contribute to a larger extent to weighted TFP within each state in 2023. Overall, the results show that Mining, Quarrying, and Oil and Gas Extraction (NAICS 21), Wholesale (NAICS 43), and Retail Trade (NAICS 46) contribute most to weighted TFP at the state level. In some cases, sectors of manufacturing (NAICS 31-33) and Finance and Insurance (NAICS 52) can also contribute.

Table C1. Sectoral contribution to weighted TFP at the state level, 2023.^{a/ b/ c/ d/}

State	Abv*	Sector at 2-digits of NAICS																				Total
		11	21	23	31	32	33	43	46	48	49	51	52	53	54	56	61	62	71	72	81	
Hidalgo	Hgo.	0.0	0.0	0.0	0.1	0.1	0.0	0.2	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.6
Guanajuato	Gto.	0.0	0.0	0.0	0.0	0.0	0.2	0.2	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.6
Puebla	Pue.	0.0	0.0	0.0	0.0	0.0	0.1	0.2	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.6
Coahuila*	Coah.	0.0	0.0	0.0	0.0	0.0	0.2	0.2	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.6
Colima	Col.	0.0	0.1	0.0	0.0	0.0	0.0	0.1	0.2	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.7
Durango	Dgo.	0.0	0.0	0.0	0.1	0.0	0.0	0.3	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.7
Morelos	Mor.	0.0	0.0	0.0	0.0	0.1	0.0	0.2	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.7
Chihuahua	Chih.	0.0	0.0	0.0	0.0	0.0	0.2	0.2	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.8
Sonora	Son.	0.0	0.1	0.0	0.0	0.0	0.1	0.2	0.1	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.8
Tlaxcala	Tlax.	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.8
Tamaulipas	Tamps.	0.0	0.0	0.0	0.0	0.1	0.2	0.2	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.8
Oaxaca	Oax.	0.0	0.0	0.0	0.0	0.1	0.0	0.4	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.8
Mexico	Mex.	0.0	0.0	0.0	0.0	0.1	0.1	0.3	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.9
San Luis Potosi	SLP	0.0	0.0	0.0	0.0	0.1	0.3	0.2	0.1	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.9
Zacatecas	Zac.	0.0	0.1	0.0	0.0	0.0	0.0	0.4	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.9
Veracruz*	Ver.	0.0	0.3	0.0	0.1	0.1	0.0	0.2	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.9
Quintana Roo	Q. Roo	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	1.0
Mexico City	CDMX	0.0	0.0	0.0	0.0	0.0	0.0	0.6	0.2	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.3
Guerrero	Gro.	0.0	0.1	0.0	0.0	0.0	0.0	0.5	0.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	1.5
Michoacan*	Mich.	0.0	0.0	0.0	0.0	0.0	0.1	1.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.5
Baja California Sur	BCS	0.1	0.0	0.0	0.0	0.0	0.0	0.5	0.5	0.1	0.0	0.0	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	1.8
Nayarit	Nay.	0.0	0.0	0.0	0.0	0.0	0.1	0.2	1.2	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	1.9
Sinaloa	Sin.	0.1	0.0	0.0	0.1	0.0	0.0	0.9	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.9
Jalisco	Jal.	0.0	0.0	0.0	0.1	0.0	0.0	1.6	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.2
Queretaro	Qro.	0.0	0.0	0.0	0.0	0.1	0.1	1.8	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.2
Yucatan	Yuc.	0.0	0.0	0.0	0.1	0.0	0.0	1.7	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.2
Chiapas	Chis.	0.0	1.3	0.0	0.0	0.0	0.0	0.6	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.3
Baja California	BC	0.1	0.0	0.0	0.0	0.0	0.2	0.7	1.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	2.6
Nuevo Leon	NL	0.0	0.0	0.0	0.0	0.0	0.1	2.4	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.8
Campeche	Camp.	0.0	2.4	0.0	0.1	0.0	0.0	0.6	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.3
Aguascalientes	Ags.	0.0	0.0	0.0	0.0	0.0	0.2	3.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.4
Tabasco	Tab.	0.0	3.9	0.0	0.0	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.1

^{a/} The description of the sectors by columns at 2 digits of NAICS are the following: 11 Agriculture, etc. | 21 Mining, Quarrying, and Oil and Gas Extraction | 22 Utilities | 23 Construction | 31 Manufacturing (food, beverage and tobacco, etc.). | 32 Manufacturing (wood, paper, printing and related support activities, etc.) | 33 Manufacturing (primary metals, machinery, computers and electronics, etc.). | 43 Wholesale | 46 Retail trade | 48 Transport | 49 Postal services and warehousing | 51 Information | 52 Finance and Insurance | 53 Real Estate and Rental and Leasing | 54 Professional, Scientific, and Technical Services | 55 Management of Companies and Enterprises | 56 Administrative and Support and Waste Management and Remediation Services | 61 Educational Services | 62 Health Care and Social Assistance | 71 Arts, Entertainment, and Recreation | 72 Accommodation and Food Services | 81 Other Services (except Public Administration)

^{b/} Green cells indicate the sectors with the highest TFP contribution within the state. Blue and purple cells indicate the top 2 and 3 sectors with the highest contribution, respectively.

^{c/} Some sectors show low contributions of 0.0; however, these sectors can be disaggregated to 3 decimal places.

^{d/} The last column shows the sum of sectoral contributions to state-level TFP (i.e., the weighted TFP at the state level). The table is ranked from the lowest to the highest weighted TFP across states. Figure 5 presents the values in the last column.

Source: Own estimates using microdata from the Economic Census of Mexico

Figures C1 and C2 show fluctuations in the spatial distribution using weighted TFP at the state level. However, a few states maintained high productivity from 1998 to 2023, which are identified in Table C2.

Table C2 presents the weighted TFP across states from 1998 to 2023 and classifies it into quartiles (Q) each year. Table C2 also presents the average weighted TFP for the entire period (1998-2023) classified by quartiles in Column 8. The last column of Table C2 is a binary variable indicating whether states had weighted TFP in the top quartiles in each year of the period (Q3 and Q4). The last column identifies states that maintained high TFP throughout the period. The states Campeche, Tabasco, Chiapas, Mexico City, Guerrero, and Sinaloa maintained high weighted TFP during 1998-2023 because they were in the top quartiles of TFP in each census year.

Table C2. Evolution of weighted TFP classified by quartiles and its average across states, 1998-2023.^{a/ b/}

State	1998		2003		2008		2013		2018		2023		1998-2023		TFP w in Q3 and Q4 (1998-2023)
	TFP w	Q	TFP w	Q	TFP w	Q	TFP w	Q	TFP w	Q	TFP w	Q	TFP w	Q	
Hgo.	0.454	2	0.440	1	0.335	1	0.330	1	0.409	1	0.559	1	0.421	1	0
Coah.	0.364	1	0.686	3	0.344	1	0.374	1	0.376	1	0.641	1	0.464	1	0
Gto.	0.503	2	0.528	2	0.533	3	0.405	1	0.376	1	0.564	1	0.485	1	0
SLP	0.442	1	0.466	1	0.320	1	0.405	1	0.471	1	0.865	2	0.495	1	0
Mor.	0.403	1	0.485	1	0.375	2	0.378	1	0.764	3	0.710	1	0.519	1	0
Tlax.	0.358	1	0.444	1	1.185	4	0.348	1	0.397	1	0.756	2	0.581	1	0
Pue.	0.927	3	0.616	2	0.367	1	0.448	2	0.536	1	0.598	1	0.582	1	0
Col.	0.423	1	0.575	2	0.459	3	0.579	3	0.976	3	0.684	1	0.616	1	0
Oax.	0.744	3	0.716	3	0.423	2	0.413	2	0.626	2	0.776	2	0.617	2	0
Ver.	0.495	2	0.574	2	0.585	3	0.488	3	0.805	3	0.933	2	0.646	2	0
Mex.	0.891	3	0.701	3	0.406	2	0.434	2	0.661	2	0.850	2	0.657	2	0
BCS	0.560	2	0.484	1	0.380	2	0.436	2	0.485	1	1.835	3	0.696	2	0
Chih.	1.099	4	0.632	3	0.394	2	0.447	2	0.901	3	0.751	1	0.704	2	0
Nay.	0.494	2	0.565	2	0.346	1	0.515	3	0.693	2	1.863	3	0.746	2	0
Dgo.	0.500	2	0.417	1	0.317	1	0.436	2	2.271	4	0.699	1	0.773	2	0
Q. Roo	1.704	4	0.537	2	0.332	1	0.471	2	0.752	2	1.030	3	0.804	2	0
Ags.	0.405	1	0.349	1	0.297	1	0.330	1	0.406	1	3.373	4	0.860	3	0
Yuc.	0.712	3	0.571	2	0.450	3	0.508	3	0.808	3	2.185	4	0.873	3	0
Sin.	0.774	3	0.775	3	0.654	4	0.508	3	0.837	3	1.870	3	0.903	3	1
Gro.	1.022	3	1.424	4	0.505	3	0.493	3	0.800	3	1.479	3	0.954	3	1
CDMX	1.154	4	0.696	3	0.688	4	0.661	4	1.379	4	1.255	3	0.972	3	1
Jal.	0.704	2	0.653	3	0.437	3	1.075	4	0.813	3	2.155	3	0.973	3	0
Tamps.	0.788	3	1.335	4	0.496	3	1.742	4	0.722	2	0.766	2	0.975	3	0
Son.	1.637	4	1.134	4	0.382	2	1.687	4	0.585	2	0.755	2	1.030	3	0
Zac.	0.421	1	0.464	1	0.383	2	0.667	4	3.393	4	0.919	2	1.041	4	0
Mich.	0.647	2	1.174	4	0.412	2	0.451	2	2.140	4	1.496	3	1.053	4	0
BC	1.221	4	0.638	3	0.851	4	0.530	3	0.749	2	2.631	4	1.103	4	0
NL	1.094	4	0.547	2	0.457	3	0.900	4	5.435	4	2.761	4	1.866	4	0
Chis.	1.625	4	4.756	4	0.659	4	0.505	3	2.484	4	2.256	4	2.047	4	1
Qro.	0.417	1	1.329	4	8.155	4	0.333	1	0.572	2	2.168	4	2.162	4	0
Tab.	3.702	4	9.276	4	0.711	4	0.996	4	3.745	4	4.094	4	3.754	4	1
Camp.	0.962	3	11.192	4	1.219	4	10.774	4	12.589	4	3.339	4	6.679	4	1

^{a/} The full names of the states are the following: Hidalgo (Hgo.), San Luis Potosí (SLP), Coahuila de Zaragoza (Coah.), Guanajuato (Gto.), Morelos (Mor.), Tlaxcala (Tlax.), Puebla (Pue.), Colima (Col.), Oaxaca (Oax.), Veracruz de Ignacio de la Llave (Ver.), México (Mex.), Baja California Sur (BCS), Chihuahua (Chih.), Nayarit (Nay.), Durango (Dgo.), Quintana Roo (Q. Roo), Sinaloa (Sin.), Baja California (BC), Guerrero (Gro.), Aguascalientes (Ags.), Yucatán (Yuc.), Ciudad de México (CDMX), Jalisco (Jal.), Tamaulipas (Tamps.), Sonora (Son.), Zacatecas (Zac.), Michoacán de Ocampo (Mich.), Nuevo León (NL), Chiapas (Chis.), Querétaro (Qro.), Tabasco (Tab.), Campeche (Camp.)

^{b/} The table is sorted using the average weighted TFP 1998-2023 in Column 8.

Source: Own estimates using microdata from the Economic Census of Mexico

Table C3 displays the weighted TFP distribution across two geographic levels: states and municipalities. This table aims to reconcile the discrepancy between the TFP shown in Figures 2 and 3. In Table C3, Column (A) provides state-level information. Column (B) shows the weighted TFP at the state level. Column (C) shows the distribution of weighted TFP across municipalities within each state. The average TFP across municipalities serves as a benchmark for comparison with the state-level weighted TFP. Column (D) highlights cases in which the weighted TFP at the state level exceeds the mean of the TFP distribution across municipalities.

In cases where the TFP at the state level is higher than the distribution mean, this reflects that state-level TFP has been lifted by highly productive municipalities. As a result, when there is a “Yes” in Column (D), high-productivity municipalities raise the state’s productivity upwards. The results indicate that the states with higher weighted TFP tend to be lifted up by their high-productivity municipalities.

Table C3. TFP by state and its distribution across municipalities, 2023.^{a/}

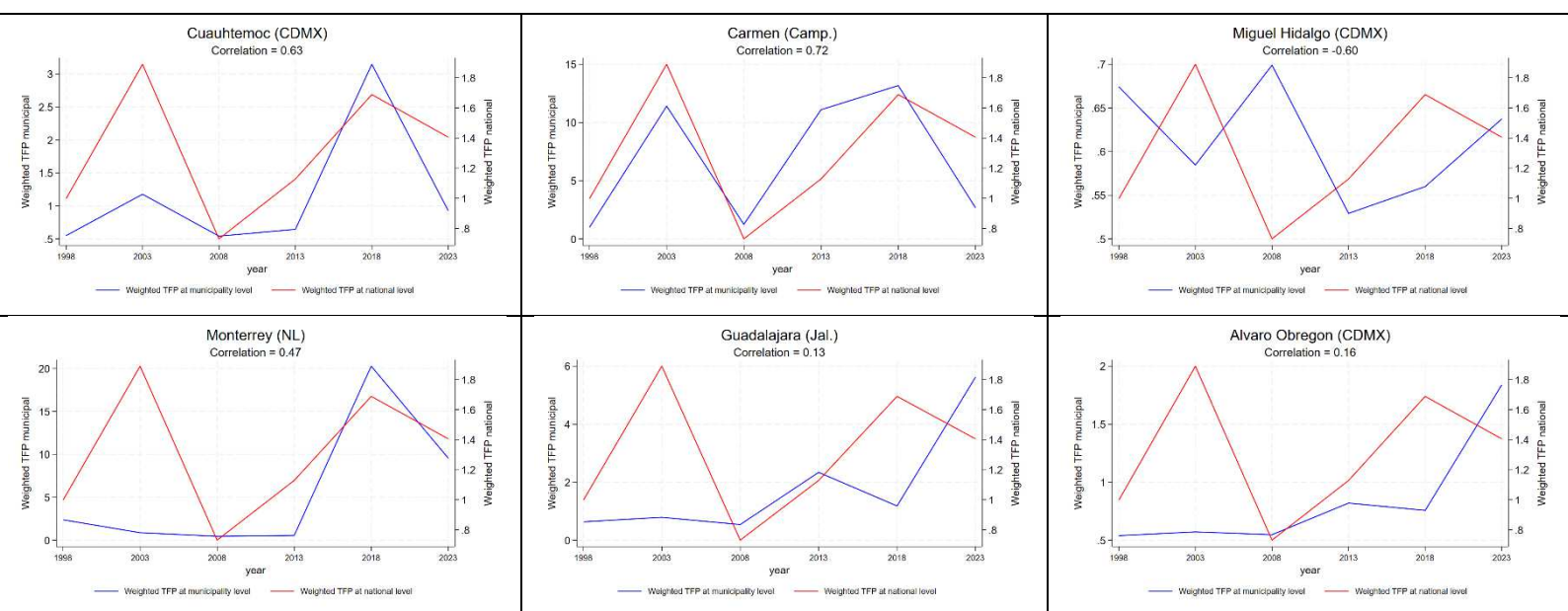
(A) State information		(B) TFP by state	(C) Distribution of weighted mean TFP across municipalities						(D) Comparison of state and municipalities
State’s name and abbreviation		Weighted TFP	Min	25%	Median	Mean	75%	Max	State TFP (B) above the mean across municipalities (C)
Hidalgo	(Hgo.)	0.56	0.12	0.35	0.47	0.78	0.78	6.86	No
Guanajuato	(Gto.)	0.56	0.23	0.43	0.67	0.94	0.96	4.69	No
Puebla	(Pue.)	0.60	0.01	0.30	0.44	0.79	0.60	27.26	No
Coahuila*	(Coah.)	0.64	0.18	0.40	0.61	0.70	0.81	2.75	No
Colima	(Col.)	0.68	0.40	0.54	0.64	0.71	0.72	1.29	No
Durango	(Dgo.)	0.70	0.17	0.44	0.54	1.15	0.94	13.57	No
Morelos	(Mor.)	0.71	0.27	0.38	0.45	0.67	0.76	3.00	Yes
Chihuahua	(Chih.)	0.75	0.13	0.48	0.67	0.84	0.94	3.73	No
Sonora	(Son.)	0.76	0.17	0.41	0.55	0.93	0.87	8.47	No
Tlaxcala	(Tlax.)	0.76	0.21	0.32	0.44	0.70	0.68	3.60	Yes
Tamaulipas	(Tamps.)	0.77	0.13	0.44	0.60	0.84	0.94	3.53	No
Oaxaca	(Oax.)	0.78	0.00	0.23	0.39	0.75	0.65	35.17	Yes
Mexico	(Mex.)	0.85	0.22	0.44	0.67	1.42	1.02	24.14	No
San Luis Potosi	(SLP)	0.86	0.17	0.34	0.52	0.78	0.88	6.81	Yes
Zacatecas	(Zac.)	0.92	0.22	0.47	0.74	0.99	1.32	6.90	No
Veracruz*	(Ver.)	0.93	0.11	0.39	0.52	0.91	0.74	39.16	Yes
Quintana Roo	(Q. Roo)	1.03	0.41	0.44	0.75	0.72	0.88	1.43	Yes
Ciudad De Mexico	(CDMX)	1.25	0.56	0.67	0.86	1.69	1.47	11.97	No
Guerrero	(Gro.)	1.48	0.16	0.44	0.68	0.82	0.98	4.75	Yes
Michoacan*	(Mich.)	1.50	0.29	0.52	0.73	1.25	1.07	14.71	Yes
Baja California Sur	(BCS)	1.83	0.59	0.88	1.00	1.51	1.13	3.97	Yes
Nayarit	(Nay.)	1.86	0.30	0.44	0.94	2.52	1.28	20.36	No
Sinaloa	(Sin.)	1.87	0.41	0.50	0.71	0.83	1.09	1.87	Yes
Jalisco	(Jal.)	2.15	0.22	0.47	0.65	0.89	1.07	5.62	Yes
Queretaro	(Qro.)	2.17	0.32	0.37	0.49	0.91	1.03	4.02	Yes
Yucatan	(Yuc.)	2.19	0.15	0.30	0.47	0.70	0.68	14.56	Yes
Chiapas	(Chis.)	2.26	0.00	0.46	0.77	1.45	1.26	47.21	Yes
Baja California	(BC)	2.63	0.57	0.63	1.17	1.11	1.50	2.04	Yes
Nuevo Leon	(NL)	2.76	0.18	0.34	0.46	0.87	0.78	9.54	Yes
Campeche	(Camp.)	3.34	0.38	0.49	0.72	0.93	1.19	2.67	Yes
Aguascalientes	(Ags.)	3.37	0.23	0.28	0.34	0.76	0.47	4.39	Yes
Tabasco	(Tab.)	4.09	0.27	0.53	0.69	1.22	0.84	7.43	Yes

^{a/}The table is sorted using the weighted TFP during 2023 in Column B.

Source: Own estimates using microdata from the Economic Census of Mexico

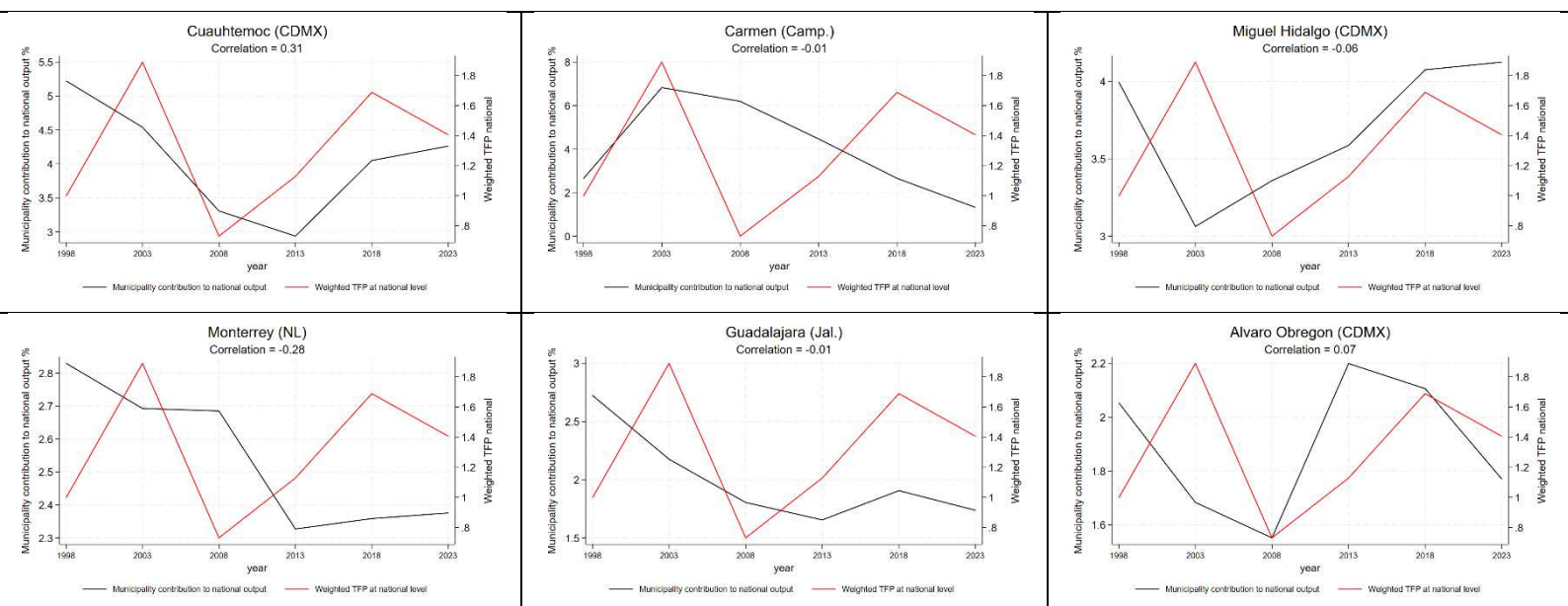
Figure C4 replicates Figure 4, using weighted TFP for municipalities with the highest production (i.e. output) levels, and correlates it with the national-level weighted TFP (Figure 1). Campeche (Camp) has the highest correlation (0.72), followed by Cuauhtemoc (CDMX) (0.63) and Miguel Hidalgo (CDMX) (0.60). One might expect municipalities with a stronger correlation between municipal and national weighted TFP also have municipality-to-national weights that are more strongly correlated with municipal TFP. However, Figure C5 does not support this expectation. Cuauhtemoc (CDMX) shows a positive correlation between the municipal-to-national weights and the weighted TFP (0.31). The remaining municipalities show low or negative correlations between these two variables (Figure C5). For that reason, patterns in municipal-to-national weights do not explain the correlation between municipal and national weighted TFP.

Figure C4. Time series of weighted TFP in selected municipalities in relation to weighted TFP at the national level, 1998-2023.



Source: Own estimates using microdata from the Economic Census of Mexico

Figure C5. Time series of the evolution of municipality-to-national weights in selected municipalities in relation to the weighted TFP at the national level, 1998-2023.



Source: Own estimates using microdata from the Economic Census of Mexico

Appendix D. Extended evidence of TFP across sectors

Table D1 presents the weighted TFP by sector from 1998 to 2023. The weighted TFP is classified by quartiles in each year. Column 8 also presents the average weighted TFP over the period and its quartiles. The last column of Table D1 is a binary variable indicating whether sectors are in the top quartiles for weighted TFP in each census year (Q3 and Q4). Identifying consistently high-productivity sectors is relevant because TFP can fluctuate significantly across sectors.

The Mining, Quarrying, and Oil and Gas Extraction (NAICS 21), Wholesale Trade (NAICS 43), and Retail Trade (NAICS 46) sectors have maintained high productivity throughout the period. The weighted TFP of the manufacturing sectors (NAICS 31-33) has also been in the lowest quartiles from 1998 to 2023.

Table D1. Evolution of weighted TFP classified by quartiles and its average across sectors, 1998-2023.^{a/ b/}

Sector (NAICS code)	1998		2003		2008		2013		2018		2023		1998-2023		TFP w in Q3 and Q4 (1998- 2023)
	TFP w	Q	TFP w	Q	TFP w	Q	TFP w	Q	TFP w	Q	TFP w	Q	TFP aw	Q	
72	0.230	1	0.221	1	0.245	1	0.193	1	0.234	1	0.284	1	0.234	1	0
23	0.229	1	0.243	1	0.549	3	0.227	1	0.236	1	0.223	1	0.284	1	0
33	0.284	1	0.294	1	0.294	1	0.287	1	0.276	2	0.328	2	0.294	1	0
51	0.344	2	0.314	1	0.214	1	0.333	2	0.264	1	0.298	1	0.295	1	0
32	0.290	1	0.344	2	0.331	1	0.294	1	0.302	2	0.280	1	0.307	1	0
31	0.284	1	0.329	1	0.331	1	0.361	2	0.279	2	0.303	1	0.315	2	0
71	1.007	3	0.417	2	0.407	2	0.299	1	0.333	3	0.609	3	0.512	2	0
61	0.648	2	0.703	3	0.542	2	0.374	3	0.450	3	0.557	3	0.546	2	0
48	0.403	2	0.810	3	1.200	4	0.372	2	0.296	2	0.526	2	0.601	2	0
81	1.046	3	0.753	3	0.702	3	0.682	3	0.323	3	0.413	2	0.653	2	0
49	1.243	3	0.807	3	0.496	2	0.334	2	0.262	1	3.037	4	1.030	3	0
62	0.847	2	4.188	4	0.420	2	0.327	2	0.267	1	0.413	2	1.077	3	0
52	0.534	2	1.311	3	0.751	4	0.637	3	2.308	4	0.964	3	1.084	3	0
54	3.815	4	0.557	2	1.061	4	0.396	3	0.476	3	0.553	3	1.143	3	0
53	4.354	4	3.164	4	0.575	3	0.411	3	0.579	3	0.543	2	1.605	3	0
56	1.518	3	0.611	2	0.653	3	5.821	4	1.002	4	0.547	3	1.692	4	0
46	2.339	4	1.871	4	0.713	3	1.841	4	8.550	4	1.870	4	2.864	4	1
43	4.062	4	1.583	4	5.088	4	1.511	4	3.556	4	9.862	4	4.277	4	1
21	0.994	3	10.551	4	1.030	4	6.006	4	6.466	4	3.484	4	4.755	4	1
11	27.148	4	0.522	2	0.351	2	7.033	4	0.319	2	1.003	4	6.063	4	0

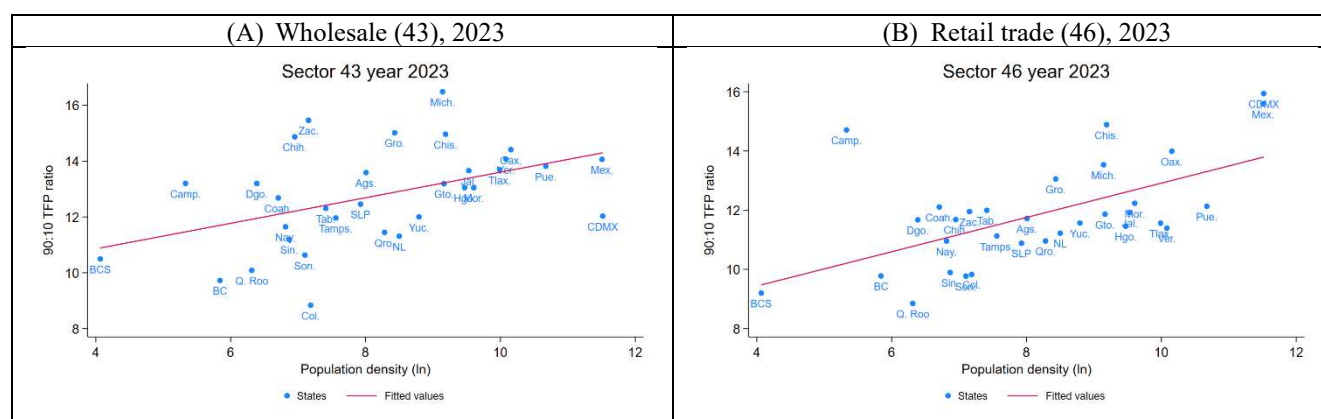
^{a/} Sectors are sorted according to the average weighted TFP 1998-2023 in column 8.

^{b/} 72 Accommodation and Food Services, 23 Construction, 33 Manufacturing (primary metals, machinery, computers and electronics, electrical equipment, transportation equipment), 51 Information, 32 Manufacturing (wood, paper, printing and related supporting activities, petroleum and coal products, chemicals, plastics and rubber products, non-metal mineral products), 31 Manufacturing (food, beverage and tobacco, textiles, apparel, leather and allied), 71 Arts, Entertainment, and Recreation, 61 Educational Services, 48 Transport, 81 Other Services (except Public Administration), 49 Postal Service and Warehousing, 62 Health Care and Social Assistance, 52 Finance and Insurance, 54 Professional, Scientific, and Technical Services, 53 Real Estate and Rental and Leasing, 56 Administrative and Support and Waste Management and Remediation Services, 46 Retail Trade, 43 Wholesale Trade, 21 Mining, Quarrying, and Oil and Gas Extraction, 11 Agriculture, Forestry, Fishing and Hunting.

Source: Own estimates using microdata from the Economic Census of Mexico

Figure D1 shows population density (ln) and the 90:10 TFP ratio (ln) across Mexican states in two sectors: Wholesale (43) and Retail trade (46). These variables are positively correlated: states with higher population density also show greater sectoral productivity disparity in 2023. Table D2 extends this correlation to the remaining years, 1998-2023, and shows that the correlation persists each year in that period.

Figure D1. Population density (ln) and 90:10 TFP ratio across Mexican states for the sectors Wholesale (43) and Retail trade (46), 2023



Source: Own estimates using microdata from the Economic Census of Mexico

Table D2. Correlations between population density (ln) and 90:10 TFP ratio for the sectors Wholesale (43) and Retail trade (46), 1998-2023

Year	Sector wholesale (43)	Sector retail trade (46)
1998	0.15	0.63
2003	0.46	0.63
2008	0.35	0.58
2013	0.60	0.71
2018	0.58	0.70
2023	0.46	0.59

Source: Own estimates using microdata from the Economic Census of Mexico

Appendix E. Contribution to TFP growth by states and sectors

Haltiwanger (1997) decomposition measuring the contribution from states and sectors

This section applies the Haltiwanger (1997) decomposition to measure the contributions of different subgroups to national Total Factor Productivity (TFP) growth in Mexico. Its purpose is to identify which states and sectors are driving increases or decreases in national TFP growth. The contribution of each state (or sector) j to national TFP growth uses the same specification as equation 10. The difference is that the establishments have to be aggregated across the groups of surviving establishments in a state or sector j (S_j), entering establishments (E_j) and exiting establishments (X_j).

Equation E1 presents the formal specification for calculating the contributions of these subgroups to national TFP growth.

$$\begin{aligned} \Delta \ln(\overline{TFP}_{jt}^H) = & \sum_{i \in S_j}^{N_t^j} \theta_{i,t-k} [\ln(\overline{TFP}_{it}) - \ln(\overline{TFP}_{i,t-k})] + \sum_{i \in S_j}^{N_t^j} [\ln(\overline{TFP}_{i,t-k}) - \ln(\overline{TFP}_{t-k})] [\theta_{it} - \theta_{i,t-k}] + \\ & \sum_{i \in S_j}^{N_t^j} [\ln(\overline{TFP}_{it}) - \ln(\overline{TFP}_{i,t-k})] [\theta_{it} - \theta_{i,t-k}] + \sum_{i \in E_j}^{N_t^j} \theta_{it} [\ln(\overline{TFP}_{it}) - \ln(\overline{TFP}_{t-k})] - \\ & \sum_{i \in X_j}^{N_t^j} \theta_{i,t-k} [\ln(\overline{TFP}_{i,t-k}) - \ln(\overline{TFP}_{t-k})] \end{aligned} \quad (E1)$$

The variable $\Delta \ln(\overline{TFP}_{jt}^H)$ measures the TFP growth contribution of the subgroup j (state or sector) to TFP growth at the national level using the Haltiwanger (1997) approach. Calculating the Haltiwanger (1997) decomposition by state or sector is straightforward. The only difference between equation 10 and E1 is that the latter equation aggregates the total establishments in j and t , which is represented by N_t^j .

The results present the Haltiwanger (1997) approach, using average TFP growth contributions by state and sector. The measurement of the contributions to average TFP growth in the period 1998-2023 is expressed as $\Delta \ln(\overline{TFP}_{jt}^H)/(T - t)$. In addition, the results present the contributions of survivors (the first three terms in equation E1) and net entrants (the fourth term minus the fifth term in equation E1). Tables E1 and E2 present the decomposition of the contribution of states and sectors to TFP growth using the Haltiwanger (1997) approach, respectively. The last row of Tables E1 and E2 is equivalent to the last row of Table 4.

Table E1 shows that 26 of 32 states contributed positively to TFP growth. Mexico City, Tabasco, and Veracruz contributed more to TFP growth, while Quintana Roo, San Luis, and Guanajuato contributed less. Table E2 shows that 10 of the 20 sectors contributed positively to TFP growth. Mining, Quarrying, and Oil and Gas Extraction (NAICS 21), Finance and Insurance (NAICS 52), and Manufacturing of food, beverage and tobacco etc. (NAICS 31) contributed to a larger extent to TFP growth.

Table E1: Haltiwanger (1997) decomposition of average TFP growth by states in Mexico, 1998 – 2023.^{a/}

State	Acronym	(1)=(2)+(3) TFP growth (%) p.a. (1998-2023)	(2) Survivors	(3) Net entrants
Aguascalientes	Ags.	0.011	0.010	0.001
Baja California	BC	0.003	-0.005	0.008
Baja California Sur	BCS	0.006	0.005	0.000
Campeche	Camp.	0.010	-0.563	0.573
Coahuila	Coah.	0.029	0.035	-0.006
Colima	Col.	0.004	0.004	0.001
Chiapas	Chis.	0.008	-0.039	0.047
Chihuahua	Chih.	0.002	0.001	0.001
Mexico City	CDMX	0.214	0.176	0.038
Durango	Dgo.	0.006	0.008	-0.001
Guanajuato	Gto.	-0.021	0.002	-0.024
Guerrero	Gro.	0.004	0.002	0.002
Hidalgo	Hgo.	0.008	0.009	-0.002
Jalisco	Jal.	-0.006	0.020	-0.025
State of Mexico	Mex.	0.044	0.044	0.000
Michoacan	Mich.	-0.000	0.006	-0.006
Morelos	Mor.	0.004	0.003	0.001
Nayarit	Nay.	0.006	0.007	-0.000
Nuevo Leon	NL	0.017	0.014	0.003
Oaxaca	Oax.	0.009	0.006	0.003
Puebla	Pue.	0.014	0.014	0.000
Queretaro	Qro.	-0.002	0.003	-0.005
Quintana Roo	Q. Roo	-0.006	0.004	-0.010
San Luis Potosi	SLP	-0.018	-0.006	-0.012
Sinaloa	Sin.	0.006	0.005	0.001
Sonora	Son.	0.010	0.006	0.004
Tabasco	Tab.	0.100	-0.031	0.131
Tamaulipas	Tamps.	0.008	0.007	0.002
Tlaxcala	Tlax.	0.005	0.006	-0.001
Veracruz	Ver.	0.055	0.064	-0.010
Yucatan	Yuc.	0.006	0.003	0.003
Zacatecas	Zac.	0.009	0.002	0.007
Total 1998-2023		0.546	-0.178	0.724

^{a/} This table is sorted by alphabetical order of the states' names. Numbers in red reflect negative rates.

Source: Own calculation using microdata from the Economic Census of Mexico.

Table E2: Haltiwanger (1997) decomposition of average TFP growth by sectors in Mexico (2 digits of NAICS), 1998-2023.^{a/}

NAICS ID	Sector	(1)=(2)+(3) TFP growth (%) p.a. (1998-2023)	(2) Surviving	(3) Net entering
11	Agriculture, Forestry, Fishing and Hunting	-0.001	-0.001	-0.000
21	Mining, Quarrying, and Oil and Gas Extraction	0.157	-0.611	0.768
23	Construction	0.004	0.004	0.000
31	Manufacturing (food, beverage and tobacco etc.).	0.088	0.074	0.014
32	Manufacturing (wood, paper, printing and related supporting activities etc.)	0.045	0.072	-0.028
33	Manufacturing (primary metals, machinery, computers and electronics, etc.).	0.003	0.064	-0.061
43	Wholesale	0.071	0.037	0.035
46	Retail trade	0.086	0.036	0.050
48	Transportation	0.057	0.035	0.022
49	Postal services and warehouse	-0.003	0.000	-0.003
51	Information	-0.016	-0.013	-0.003
52	Finance and Insurance	0.157	0.155	0.002
53	Real estate, rental and leasing	-0.016	-0.014	-0.002
54	Professional, scientific, and technical services	-0.035	-0.022	-0.013
56	Administrative and support of waste management and remediation services	-0.014	-0.017	0.002
61	Educational services	-0.007	-0.007	-0.000
62	Health care and social assistance	-0.010	-0.007	-0.004
71	Arts, entertainment, and recreation	-0.001	0.001	-0.001
72	Accommodation and food services	-0.020	0.024	-0.044
81	Other services (except public administration)	0.003	0.012	-0.008
Total 1998-2023		0.546	-0.178	0.724

^{a/} This table is sorted by NAICS ID. Numbers in red reflect negative rates.

Source: Own calculation using microdata from the Economic Census of Mexico.

Melitz & Polanec (2015) decomposition measuring the contribution from states and sectors

The Melitz & Polanec (2015) approach can be applied to measure the contribution to national TFP by subgroups (i.e. states and sectors), which is specified as the variable $\Delta \ln(TFP_{jt}^{MP})$. It is possible to transform the TFP growth decomposition with the Melitz & Polanec (2015) approach at the national level, as in equation 12, into TFP growth contributions by states or sectors. For that transformation, it is necessary to aggregate the contribution of surviving, entering and exiting establishments across states/sectors j expressed as S_j , E_j and X_j , respectively.

The use of weights at the national (i.e., aggregated) level is necessary to preserve the identity of the state/sector contribution to national TFP growth by subgroups. This condition can be expressed with the notation of Melitz & Polanec (2015) where ϕ_2^j is the state/sector contribution to national weighted TFP in period t and ϕ_1^j is the state contribution to national weighted TFP in period $t - k$. The weights at the national level $s_{S2} + s_{E2} = 1$ and $s_{S1} + s_{X1} = 1$ will fulfil the following conditions necessary for the decomposition $\phi_2^j = s_{S2}\phi_{S2}^j + s_{E2}\phi_{E2}^j = \phi_{S2}^j + s_{E2}(\phi_{E2}^j - \phi_{S2}^j)$ and $\phi_1^j = s_{S1}\phi_{S1}^j + s_{X1}\phi_{X1}^j = \phi_{S1}^j + s_{X1}(\phi_{X1}^j - \phi_{S1}^j)$.

Equation E2 measures the TFP growth contribution $\Delta \ln(TFP_{jt}^{MP})$ by state (or sector) j using the Melitz & Polanec (2015) approach.

$$\begin{aligned} \Delta \ln(TFP_{jt}^{MP}) = & \frac{1}{N_t^S} \sum_{i \in S_j} \ln(\widehat{TFP}_{it}) - \frac{1}{N_{t-k}^S} \sum_{i \in S_j} \ln(\widehat{TFP}_{i,t-k}) + \\ & \sum_{i \in S_j} \text{cov}(\theta_{it}^S, \ln(\widehat{TFP}_{it})) - \sum_{i \in S_j} \text{cov}(\theta_{i,t-k}^S, \ln(\widehat{TFP}_{i,t-k})) + \sum_{i \in E_j} \theta_{it} \left\{ \sum_{i \in E_j} \theta_{it}^E \ln(\widehat{TFP}_{it}) - \right. \\ & \left. \sum_{i \in S_j} \theta_{it}^S \ln(\widehat{TFP}_{it}) \right\} - \sum_{i \in X_j} \theta_{i,t-k} \left\{ \sum_{i \in X_j} \theta_{i,t-k}^X \ln(\widehat{TFP}_{i,t-k}) - \sum_{i \in S_j} \theta_{i,t-k}^S \ln(\widehat{TFP}_{i,t-k}) \right\} \quad (E2) \end{aligned}$$

The first four terms in equation E2 are equivalent to the TFP growth contribution of surviving establishments $i \in S_j$ in the state (or sector) j . In addition, the fifth and sixth terms of equation E2 measure the contribution of the entering $i \in E_j$ and exiting establishments $i \in X_j$ in the state (or sector) j to TFP growth at the national level. Note that equation E2 presents the first four terms disaggregated, while equation 12 presents the first two terms in first differences. These terms are equivalent. In addition, the specification of the weights does not change in relation to equation 12.

The geographical and sectoral contribution to TFP growth, applying the Melitz & Polanec (2015) approach, uses the average TFP growth contribution in each state/sector j , which is measured as $\Delta \ln(TFP_{jt}^{MP})/(T - t)$. The period $(T - t)$ covers 1998-2023 by states (or sectors) j . The results of the Melitz & Polanec (2015) decomposition present the contributions of survivors (the first four terms in E2) and net entrants (the fifth term minus the sixth term in E2). The Melitz & Polanec (2015) decomposition measuring the contribution of states and sectors to TFP growth are presented in Table E3 and E4, respectively. The last row of Tables E3 and E4 are equivalent to the last row of Table 5.

Table E3 indicates that 23 of 32 states contributed positively to TFP growth. Mexico City, Tabasco and Veracruz were the states that contributed to a larger extent to TFP growth while San Luis, Queretaro and Campeche contributed in lesser extent. Table E4 shows that 8 sectors of 20 contributed positively to TFP growth. Finance and Insurance (NAICS 52), Manufacturing of food, beverage and tobacco etc. (NAICS 31), and Manufacturing of wood, paper, printing etc. (NAICS 32) contributed to a larger extent to TFP growth.

Table E3: Melitz & Polanec (2015) decomposition of average TFP growth by states in Mexico, 1998 – 2023.^{a/}

State	Acronym	(1)=(2)+(3) TFP growth (%) p.a. (1998-2023)	(2) Survivors	(3) Net entrants
Aguascalientes	Ags.	0.005	0.010	-0.006
Baja California	BC	0.010	0.002	0.008
Baja California Sur	BCS	-0.002	0.005	-0.007
Campeche	Camp.	-0.259	-0.660	0.401
Coahuila	Coah.	0.064	0.059	0.006
Colima	Col.	0.001	0.004	-0.004
Chiapas	Chis.	0.004	-0.047	0.051
Chihuahua	Chih.	0.034	0.023	0.011
Mexico City	CDMX	0.381	0.199	0.181
Durango	Dgo.	0.005	0.006	-0.001
Guanajuato	Gto.	0.005	0.029	-0.023
Guerrero	Gro.	-0.011	-0.010	-0.001
Hidalgo	Hgo.	0.000	0.006	-0.005
Jalisco	Jal.	-0.005	0.022	-0.027
State of Mexico	Mex.	0.005	-0.029	0.034
Michoacan	Mich.	0.019	0.018	0.002
Morelos	Mor.	0.005	-0.007	0.011
Nayarit	Nay.	0.006	0.011	-0.005
Nuevo Leon	NL	0.063	0.032	0.031
Oaxaca	Oax.	0.019	0.004	0.014
Puebla	Pue.	0.003	0.005	-0.002
Queretaro	Qro.	-0.034	-0.004	-0.030
Quintana Roo	Q. Roo	-0.017	0.005	-0.022
San Luis Potosi	SLP	-0.029	-0.003	-0.026
Sinaloa	Sin.	0.003	0.008	-0.005
Sonora	Son.	0.006	0.010	-0.004
Tabasco	Tab.	0.114	0.006	0.108
Tamaulipas	Tamps.	0.018	0.017	0.001
Tlaxcala	Tlax.	-0.002	-0.001	-0.001
Veracruz	Ver.	0.099	0.073	0.027
Yucatan	Yuc.	0.038	0.016	0.022
Zacatecas	Zac.	-0.003	0.003	-0.005
Total 1998-2023		0.546	-0.188	0.734

^{a/} This table is sorted by alphabetical order of the states' names. Numbers in red reflect negative rates.

Source: Own calculation using microdata from the Economic Census of Mexico.

Table E4: Melitz & Polanec (2015) decomposition of average TFP growth by sectors in Mexico (2 digits of NAICS), 1998-2023.^{a/}

NAICS ID	Sector	(1)=(2)+(3) TFP growth (%) p.a. (1998-2023)	(2) Surviving	(3) Net entering
11	Agriculture, Forestry, Fishing and Hunting	-0.019	-0.021	0.002
21	Mining, Quarrying, and Oil and Gas Extraction	-0.132	-0.671	0.539
23	Construction	-0.009	-0.012	0.004
31	Manufacturing (food, beverage and tobacco etc.).	0.215	0.086	0.129
32	Manufacturing (wood, paper, printing and related supporting activities etc.)	0.213	0.066	0.147
33	Manufacturing (primary metals, machinery, computers and electronics, etc.).	0.092	0.077	0.015
43	Wholesale	0.114	0.095	0.019
46	Retail trade	-0.148	-0.051	-0.097
48	Transportation	0.080	0.026	0.054
49	Postal services and warehouse	0.001	-0.000	0.002
51	Information	0.073	-0.004	0.076
52	Finance and Insurance	0.299	0.309	-0.010
53	Real estate, rental and leasing	-0.033	-0.021	-0.012
54	Professional, scientific, and technical services	-0.056	-0.057	0.001
56	Administrative and support of waste management and remediation services	-0.013	-0.001	-0.012
61	Educational services	-0.004	-0.006	0.002
62	Health care and social assistance	-0.016	-0.005	-0.012
71	Arts, entertainment, and recreation	-0.005	0.003	-0.008
72	Accommodation and food services	-0.033	0.062	-0.095
81	Other services (except public administration)	-0.073	-0.064	-0.009
Total 1998-2023		0.546	-0.188	0.734

^{a/} This table is sorted by NAICS ID. Numbers in red reflect negative rates.

Source: Own calculation using microdata from the Economic Census of Mexico.

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