UNIVERSIDAD SAN FRANCISCO DE QUITO USFQ

Colegio de Administración y Economía

The Cleansing Effect in Emerging Markets: Evidence from Ecuador.

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Economía

Trabajo de titulación presentado como requisito

para la obtención del título de

Economista

Quito, 19 de mayo de 2021

UNIVERSIDAD SAN FRANCISCO DE QUITO USFQ
COLEGIO DE ADMINISTRACIÓN Y ECONOMÍA

HOJA DE CALIFICACIÓN DE TRABAJO DE FIN DE CARRERA

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Quito, 19 de mayo de 2021

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Código: 00201994

Cédula de Identidad : 1750941559

Lugar y fecha: Quito, 19 de mayo de 2021

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AGRADECIMIENTOS

Agradezco a mis padres por su apoyo incondicional, por fomentar mi curiosidad que es la fuerza motora que me ha llevado tan lejos.

A mi director, Carlos Uribe, por creer en mí, por ser un modelo a seguir, por siempre alimentar mi curiosidad al compartir su conocimiento y sobretodo por su paciencia. Espero algún día llegar a saber tanto como usted.

Finalmente me gustaría agradecer a Otto por acompañarme todas las madrugadas, por todas las tardes que no pudimos ir a jugar.

RESUMEN

Este estudio prueba la existencia de un efecto limpieza en la última recesión ecuatoriana. La estrategia principal es estimar la productividad por la Productividad Total de los Factores (PTF) y verificar econométricamente la relación negativa entre la productividad y la probabilidad de cierre de la empresa. Por lo tanto, este estudio utiliza datos del formulario 101 de la Superintendencia de Compañías del Ecuador (SUPERCIAS). Este estudio demuestra dicho efecto al verificar que las empresas que cierran son menos productivas que las que sobrevivieron a la recesión. Además, demuestra la relación negativa entre la probabilidad de cierre y la productividad. Este efecto no solo apoya la destrucción creativa de Schumpeter, sino que también sirve como puerta de entrada a futuras investigaciones sobre el desempeño macroeconómico ecuatoriano durante las recesiones.

Palabras clave: efecto limpieza, SUPERCÍAS, PTF, destrucción creativa, productividad, desempeño macroeconómico, Ecuador.

ABSTRACT

This study tests the existence of a cleansing effect in the last Ecuadorian recession. The principal strategy is to estimate productivity by the Total Factor Productivity (TFP) and econometrically verify the negative relationship between firms productivity and closure likelihood. Therefore, this study uses data from Form 101 of the Superintendency of Companies of Ecuador (SUPERCIAS). This study demonstrates the cleansing effect by verifying that the closing companies are less productive than those who survived the recession. Furthermore, it proves the negative relationship between the closure probability and productivity. This effect does not only supports Schumpeter's creative destruction but also serves as a gateway to future research on Ecuadorian macroeconomic performance during recessions.

Keywords: Cleansing Effect, SUPERCÍAS, TFP, creative destruction, productivity, macroeconomic performance, Ecuador.

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1. Introduction

During the last Ecuadorian recession (2015 – 2017), the percentage of establishments reporting null sales increased from 10.7% to 15.34%. The Schumpeterian view argues that firms' exit rate raises average productivity by addressing resource reallocation within more productive firms. Therefore, the research question this paper seeks to answer is if the last Ecuadorian recession had a cleansing effect? For this purpose, this study exploits a large dataset that contains financial statements and balance sheets from the Superintendency of Companies (Supercias) for the 2012 to 2019 period, which results in an unbalanced panel with 125,864 observations.

To prove the cleansing effect, there are two empirical strategies. First, to estimate productivity with an Arellano Bond estimator and graphically demonstrate that productivity in closing firms is lower than those who survived the recession. The way to reduce bias in this estimation is to introduce the Windmeijer variance correction. Second, compute the coefficient between productivity and closure probability with a binary response model to confirm a negative relation. The error treatment within this second strategy is to apply a clustering process on level 3 ISIC.

This study finds that there is a cleansing effect in the last Ecuadorian recession. The main findings this study displays are that closing firms are less productive than those who survived the recession. Furthermore, it proves that there is a negative relationship between closure probability and productivity; therefore, proving the cleansing effect.

The findings of this study contribute to the empirical evidence supporting the Schumpeterian hypothesis of creative destruction. These results prove that there was a cleansing effect in Ecuador amidst the 2015 to 2017 period. Since this research mainly trends upon demonstrating this effect, it must serve as a gateway for future research on macroeconomic performance during recessions in Ecuador.

Cleansing effect literature traces back to Joseph Schumpeter (1939 –1942). (Caballero & Hammour, 1991). Schumpeter referred to this creative destruction hypothesis as the ”essential fact about capitalism” that attributes a reallocation process upon inputs from shrinking sectors to growing sectors. (Legrand & Hagemann, 2017). However, the popular view among economists is that ”business cycles do represent waves of creative destruction.” (Lee & Mukoyama, 2008). Regarding empirical studies, principal contributions trace back to the 90s where authors used establishment-level data to represent firms in the tradable goods sector. An example is the American motor industry during the great depression; research demonstrates that the cleansing effect took place by a shakeout of small production plants (Bresnahan & Raff, 1991).

This research was greatly motivated by Caballero Hammour’s study in 1991 despite their investigation trends upon the job creation and destruction volatility. However, modern studies are a great source of inspiration too. One of these studies takes the approach to test if the cleansing effect still happens if the firm faces credit frictions and finding that the cleansing effect still occurs but is weaker (Osotimehin & Pappadà, 2016). The other study trends upon the relation between reallocation processes intensity and the cleansing property of creative destruction; therefore, finding that ”intensity of reallocation fell rather than rose and the reallocation that did occur was less productivity-enhancing than in prior recessions.” (Foster et al., 2014).

Section 2 describes the methodology to calculate the TFP and the closure probability. Section 3 introduces data descriptions and summary statistics. Section 4 delivers the results, and Section 5 concludes and provides a brief discussion on corrections and recommendations to study the cleansing effect in the last Ecuadorian recession.

2. Methodology

The primary goal is to prove the existence of a cleansing effect in the last Ecuadorian recession. For this reason, this section states a two-step methodology: productivity estimation and a binary response model. Each approach aims to prove the cleansing effect. The first provides a general overview of productivity across time, while the second displays the relation between firms' productivity and their closure probability.

2.1. Productivity estimation

A way to measure productivity is through the Total Factor Productivity (TFP). Said measure determines "how efficiently and intensely the inputs are utilized in production." (Comin, 2010). Under the framework of a cleansing effect, the most unproductive firms close. Therefore the expectations are that the productivity of closing firms is lower than those who survived.

The first step to compute the TFP is the production function identification. The reason behind this is that TFP is the residual term in a production function. (Van Beveren, 2007). Therefore, the logarithmic version at value-added is

$$\ln(y_{it}) = \gamma_{it} + \alpha \ln(k_{it}) + \beta \ln(\ell_{it}) + \eta \ln(y_{it-1}) + \boldsymbol{\psi}(\texttt{sales size})_{it} + \delta_t + \omega_{it}, \qquad (1)$$

where k is the capital, ℓ is labor, and y_{it-1} is the lag of the value-added. In addition, sales size is a compilation of dummy variables, equal to 1 according to the firms' sales size. δ_t is the period dummy variable, and ω_{it} represents firm-level productivity (TFP). Finally, a sensitivity check in the appendix section assumes that the firm follows a Transcendental Logarithmic production function and computes its TFP.

Equation 1 can be estimated using OLS. However, this method's limitation is that "since productivity and input choices are likely to be correlated, OLS estimation of firm-level production function introduces a simultaneity or endogeneity problem" (Van Beveren, 2007). The fixed effects method has a long tradition within this literature. One of its most remarkable appearances traces to the 60s with Mundlack's attempt to estimate a production function free of management bias (Van Beveren, 2007). Mundlack proved for this method that "If the assumptions of classical regression hold and if the function is completely specified, then the estimates obtained are unbiased and best" (Mundlak, 1961). Despite the attractive features that the Fixed Effects estimator has, Olley Pakes proved that, in this model, there were apparent signs of bias in the panel coefficients. Thus suggesting the assumptions underlying the model are invalid (Olley & Pakes, 1996).

Since parametric estimations do not solve endogeneity problems, exploiting the data panel structure might come in handy. Therefore, this study uses the Arellano Bond (AB) estimator, which relaxes the time-invariant nature of ω_i, proposed in Fixed Effects by introducing an AR(1) component. Therefore, the dependent variable lag influences the dependent variable by its effect on the current value of the covariates with no correlation to the residual term. Hence, satisfying the exclusion restrictions for instrumental variables (Arellano & Bond, 1991)

Nevertheless, the AB estimator has two options: the one-step and two-step estimator. This work addresses both of them, yet the two-step estimator is favored. The reason to support this decision is that "the one-step system GMM estimator for dynamic AR(1) panel data model, shows that the efficiency loss could be quite severe when the weight matrix $W_{N1} = \left(N^{-1}\sum_{i=1}^{N} Z\prime_i Z_i\right)^{-1}$ is used, especially when T gets large." (Windmeijer, 2000). Therefore, the two-step estimator, robust to heteroskedasticity, applies the Windmeijer finite sample correction (Kripfganz, 2019). This correction reduces the bias in standard errors where there are several periods.

2.2. Binary Response Model

The binary response model construction began by estimating the residuals in equation (1) to observe the productivity for each firm. These results allow the computation of interactions between productivity and sales size. Nevertheless, the firms' closure probability also relies on firm structural factors that contain information of their commercial activity, financial structure, market power, etc.

Because of these limitations, this study uses a binary response model with the dependent variable displaying whether or not the firm has reported null sales. The main arguments, however, are constrained to a year before the recession. The abstract version of this model is:

$$\begin{aligned}\mathbb{P}(C1X_i = 1|\boldsymbol{x}_{it}) = G[&\beta_0 + \beta_1(\texttt{Productivity})_{i,\, t-s} + \beta_2(\texttt{Liquidity})_{i,\, t-s} \\ &+ \beta_3(\texttt{Debt Ratio})_{i,\, t-s} + \beta_4(\texttt{Foreign Trade})_{i,\, t-s} + \beta_5(\texttt{Market Share})_{i,\, t-s} \\ &+ \boldsymbol{\psi}(\texttt{Size})_{i,\, t-s} + \boldsymbol{\delta}(\texttt{Interactions})_{i,\, t-s} + \boldsymbol{\theta}(\texttt{ISIC})_{i,\, t-s} + \boldsymbol{\kappa}(\texttt{Province})_i + \varepsilon_{it}], \quad (2)\end{aligned}$$

where *productivity*, *liquidity*, *debt ratio*, *foreign trade*, and *market share* are the main arguments. In addition, the total effect of productivity has to be size-related. Therefore these interactions take place in the model. For the subindexes, t represents the years into the recession, while s is the years since the recession. Sales size, ISIC, and province are the dummy variables equal to 1 according to the firms' size, ISIC classification, and the province where the firm is working. ε_{it} is the time-variant error. Moreover, as a sensitivity check, the post-recession estimations are in the appendix section. Since the arguments are constrained a year before the recession, the binary response models within a panel regression are not suitable. Therefore, the BRMs are done, following a cross-section methodology.

Estimation of equation (2) could use OLS. This method is known as the linear probability model (LPM). However, the linearity assumption on this model ”will lead the estimates (...) may grossly understate the magnitude of the true effects, systematically yield probability predictions outside the range of 0 to 1" (Aldrich & Nelson, 1984)

The solution to the LPM problems is to specify a nonlinear probability model. These models are favored since they "are specifically designed for binary dependent variables" (Stock & Watson, 2002). Nevertheless, the results obtained from these models are not directly interpretable, so the logistic regression becomes useful since the interpretations are through its odds ratios (which are in the appendix section).

3. Data

This study uses the annual income statements and balance sheets reported in the 101st form of Ecuador's Internal Rents Services from 2012 to 2019. The panel construction and primer homologation come from Grijalva et al. (2019). The financial documents contained in the dataset are transformed to 2007 chained U.S dollars using the gross value-added deflator. Therefore, allowing comparisons within the firms across time.

Within the study period, the analyzed firms must have been open from 2012 to 2014. Hence, an entry barrier sets to avoid attrition bias. Nevertheless, this study does not account for an exit barrier since it aims to work with the firms' exit flow. Furthermore, using the ISIC classification International Standard Industrial Classification at the first level, firms that operate in the following sectors are selected: (A) Agriculture, forestry, and fishing, (C) Manufacturing, (F) Construction, and (G) Wholesale and retail trade with the repair of motor vehicles and motorcycles. The reason behind this decision is that these economic activities represent the tradable goods sector.

For the size classification, it is used the Andean Community (CAN) standards on firms' size.

Table 1: Andean Community Firm Size Classification (U.S. Dollars)

Classification	Micro	Small	Medium	Big
Sales	$\leq$ 100,000	100,001 to 1,000,000	1,000,001 to 5,000,000	$>$ 5,000,000

Source: Decision 702, article 3. (CAN, 2008)

3.1. Descriptive Statistics

Table 2 displays the production factor's averages to highlight the main distinctions across them. Firms concentrate around micro, small, and medium sizes. However, since 2014, the harsh conditions of the recession are perceived. In 2014, the mean value-added registers a loss of almost a quarter-million dollars. A similar effect takes place with the total expense in wages. However, the mean capital does not exhibit this downfall previous to the recession.

Table 2: Descriptive Statistics for Productivity Estimation.

Year	Mean Value-Added	Mean Capital	Mean Labor	Micro %	Small %	Medium %	Big %
2012	933304.792	2232726.731	239981.430	23.651	46.329	20.842	9.178
2013	1034288.946	2361026.233	266110.250	21.172	46.965	22.132	9.731
2014	822051.248	2408658.629	244888.893	22.863	45.916	21.585	9.636
2015	884643.854	2571209.722	275390.426	26.581	43.131	20.748	9.540
2016	870835.825	2603007.743	275294.008	30.184	41.146	19.528	9.142
2017	1025493.206	2881386.730	312745.640	29.620	39.254	20.700	10.426
2018	1123609.972	3204674.181	345954.929	29.582	37.902	21.630	10.887
2019	1050185.624	3112691.422	339812.424	34.166	36.289	19.035	10.510

Table 3 shows the year-average values for the main arguments of the Binary Response Model. It is clear that since the beginning of the recession, the average productivity and debt ratio increase over time. The debt ratio increase means that the average firm adopts a riskier financial structure over time. Moreover, the proportion of firms that partake in foreign trade is constant amidst the study period.

Table 3: Descriptive Statistics for Closure Probability Model

Year	Mean Productivity	Mean Liquidity %	Mean debt ratio %	Foreign Trade %	Mean Market Share %
2013	1.204	13.407	139.513	29.975	0.197
2014	1.248	7.185	159.721	32.702	0.197
2015	1.245	7.167	158.138	31.625	0.198
2016	1.271	35.548	230.140	30.886	0.201
2017	1.305	935.907	294.043	32.191	0.226
2018	1.346	98.259	446.981	33.809	0.249
2019	1.387	332.912	821.509	31.701	0.314

4. Results

The purpose of this section is to exhibit the results from the equations expressed in the methodology section. First of all, the production function identification and the productivity estimation results are displayed. Moreover, in second place, the binary response model results are exhibited.

The main aim for the first subsection is to identify the production function coefficients and to show, graphically, that the closing firms are less productive than the companies that survived that year of recession. This result will demonstrate the cleansing effect. The second subsection aims to, econometrically display, the negative relationship between productivity and the closure probability of the firm during the recession timespan. This result will also demonstrate the existence of a cleansing effect during the last recession.

4.1. Productivity Estimation

The initial assumption that the average firm follows a Cobb Douglas production function bases on the ease of calculating returns to scale. These refer to changes in production that result from a proportional change in all inputs. Formally they require a homogeneity test. However, in a Cobb Douglas production function, to add the coefficients obtained for capital and labor suffices. [1]

As predicted by the econometric theory, OLS estimation grossly underestimates the capital and labor coefficients; however, for every estimation method exhibited in table 4, the production function displays decreasing returns to scale. This result implies, on average, that small firms are more productive than big firms. (Williamson, 2018)

[1] If $\alpha + \beta = 1$: constant returns, > 1 increasing returns, < 1 decreasing returns.

Table 4: Cobb Douglas Estimations

Estimation Method	OLS	Fixed Effects	Arellano Bond One Step	Arellano Bond Two Step
ln(Capital)	0.097***	0.287***	0.273***	0.274***
	(0.004)	(0.010)	(0.013)	(0.013)
ln(Labour)	0.224***	0.372***	0.345***	0.346***
	(0.005)	(0.010)	(0.013)	(0.013)
Lag (Value Added)	0.471***	0.052***	0.118***	0.114***
	(0.006)	(0.007)	(0.013)	(0.013)
Constant	3.228***	4.198***	3.749***	3.774***
	(0.059)	(0.155)	(0.230)	(0.230)
Size Dummy	Yes	Yes	Yes	Yes
Year Dummy	Yes	Yes	Yes	Yes
Observations	79,041	79,041	62,447	62,447
R-squared	0.845	0.324		
Number of ruc		15,365	14,834	14,834

Standard errors in parentheses

*** $p<0.01$, ** $p<0.05$, * $p<0.1$

Figure 1 Indicates the average Total Factor Productivity by the firms' state. For those that have closed, is used the last period TFP estimation. This graph is the cornerstone of this study since it shows that the closing firms are less productive than those that survive that year of recession. Consequently, the existence of a cleansing effect in the last Ecuadorian recession is proven. In the appendix section is a table that displays the average productivity using a Cobb Douglas for closed firms and those who survived, grouping them by year, economic activity, and sales size.

The steady increase in both series is remarkable, with the positive slope showing the redistributive characteristic that the cleansing effect has. This redistributive process can be summarized as unproductive firms' free resources as they close. Then, surviving companies accumulate said resources and become more productive.

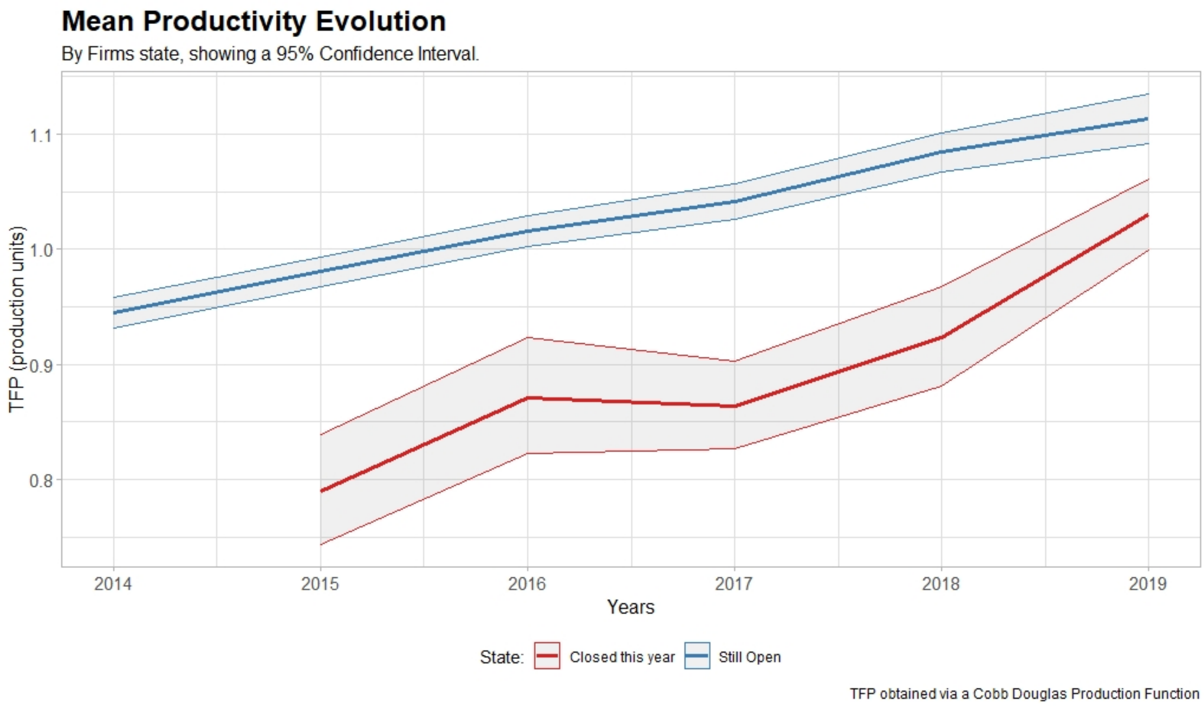

Figure 1: Mean Productivity Evolution for a Cobb Douglas production function

4.2. Binary Response Model Results

The econometrical way of showing the cleansing effect in the latest Ecuadorian recession is through a binary response model. Table 5 displays three different estimation methods for the closure probability. The rows specify the analyzed argument, and the upper section of the columns shows the analyzed year. However, the results shown in this table are slightly different from the second equation since it omits liquidity due to its small size.

Table 5: Binary Response Model Results

Closure year	2015			2016			2017		
Model	OLS	Logit	Probit	OLS	Logit	Probit	OLS	Logit	Probit
Productivity	-0.038***	-0.225***	-0.131***	-0.026**	-0.169**	-0.099**	-0.008	-0.052	-0.029
	(0.009)	(0.047)	(0.028)	(0.011)	(0.068)	(0.039)	(0.012)	(0.068)	(0.039)
Debt Ratio	0.012***	0.092**	0.047***	0.009*	0.047	0.031**	0.009	0.046	0.028
	(0.002)	(0.046)	(0.017)	(0.005)	(0.030)	(0.016)	(0.010)	(0.056)	(0.026)
Foreign Trade	-0.026***	-0.421***	-0.202***	-0.022***	-0.333***	-0.165***	-0.023***	-0.195***	-0.107***
	(0.007)	(0.095)	(0.048)	(0.004)	(0.052)	(0.027)	(0.007)	(0.062)	(0.033)
Market Share	-0.018	-27.432**	-10.060**	-0.028	-7.769	-3.124	0.040	0.249	0.244
	(0.033)	(13.937)	(5.032)	(0.049)	(7.445)	(2.921)	(0.122)	(1.656)	(0.870)
Small	-0.098***	-0.835***	-0.451***	-0.068***	-0.600***	-0.322***	-0.040***	-0.275***	-0.156***
	(0.008)	(0.068)	(0.036)	(0.007)	(0.075)	(0.039)	(0.011)	(0.069)	(0.039)
Medium	-0.126***	-1.349***	-0.694***	-0.097***	-1.067***	-0.547***	-0.056***	-0.414***	-0.230***
	(0.006)	(0.072)	(0.033)	(0.008)	(0.099)	(0.046)	(0.014)	(0.105)	(0.058)
Big	-0.140***	-1.729***	-0.855***	-0.111***	-1.480***	-0.731***	-0.093***	-0.841***	-0.447***
	(0.007)	(0.066)	(0.031)	(0.007)	(0.194)	(0.084)	(0.012)	(0.113)	(0.058)
Productivity · Small	0.025***	0.072	0.050	0.002	-0.080	-0.031	-0.006	-0.052	-0.029
	(0.009)	(0.057)	(0.033)	(0.013)	(0.092)	(0.052)	(0.018)	(0.111)	(0.063)
Productivity · Medium	0.024**	-0.042	0.011	0.012	-0.057	-0.015	-0.021*	-0.186**	-0.098**
	(0.010)	(0.119)	(0.058)	(0.012)	(0.095)	(0.052)	(0.012)	(0.080)	(0.044)
Productivity · Big	0.035***	0.167	0.094	0.005	-0.369**	-0.166**	-0.027	-0.364	-0.191
	(0.008)	(0.150)	(0.066)	(0.007)	(0.148)	(0.073)	(0.024)	(0.232)	(0.126)
Constant	0.460**	0.070	0.002	0.380***	-0.430	-0.280	0.002	-2.330***	-1.329***
	(0.194)	(0.856)	(0.513)	(0.133)	(0.585)	(0.354)	(0.010)	(0.369)	(0.180)
ISIC Dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	-0.041
Province Dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	0.434**
Observations	14,331	14,331	14,331	13,321	13,314	13,314	12,316	12,286	12,286
R-squared	0.060			0.033			0.014		

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

All the regressions exhibited in table 5 have a negative sign for productivity. This result means that a more productive firm is less likely to close, thereby proving the existence of a cleansing effect in the last recession. However, since 2017, this effect is not statistically significant, meaning the cleansing effect is over. Moreover, the productivity coefficient in Table 5 does not solely embrace its total impact on closure likelihood. This result is due to productivity having an interaction with the firms' size, yet this study intends to analyze this effect. Therefore, a quantitative interpretation is needed.

According to the econometrical review on estimation methods, the OLS method grossly underestimates the coefficients, despite its direct interpretation of change in closure probability. Nevertheless, this straightforward interpretation has no place in the non-linear estimations. Therefore, the magnitude interpretation will base on the odds ratio obtained from the logit model.

In the appendix section can be found the calculations for the odds ratios. However, the total effect of productivity registers in Table 6. This table should read as "If there is an increase in productivity and the firm is x size, is z% less probable that it closes regarding the micro size firm." This result is the total effect of productivity on the closure probability.

Table 6: The total effect of productivity on the closure probability

Interaction	2015	2016	2017
Productivity · Small	14.19%	22.04%	9.88%
Productivity · Medium	23.43%	20.23%	21.18%
Productivity · Big	5.64%	41.61%	34.03%

Recall that the existence of a cleansing effect in the last recession proves since the productivity argument, in table 5, has a negative sign. Furthermore, Table 6 sustains that productivity is conditional on the firm's size.

5. Conclusions

This study demonstrates that the cleansing effect took place in the last Ecuadorian recession by showing that closing firms are more unproductive than those who survived and proving that the coefficient between productivity and closure likelihood is negative. For proving this point, this study uses the annual income statements and balance sheets reported in the 101st form of Ecuador's Internal Rents Services from 2012 to 2019, resulting in an unbalanced panel with 125,864 observations.

The empirical strategy relies on two sections: estimating productivity at an establishment level with the two-step Arellano Bond estimator and proving the negative relationship between productivity and the closing likelihood with binary response models. Moreover, to improve the preciseness of this study, it is used variance corrections and clustered standard errors at ISIC 3 level, respectively.

One of the main limitations of this study is that it does not separate the residual term of the production function estimation into TFP and a time-variant error. To have a better performance in the binary response model, it should use other measures for liquidity. The acid test ratio could be a better instrument to measure a firm's capacity to fulfill its obligations. Furthermore, a market concentration index should replace the market share argument. The motivation behind this recommendation is to capture the different market structures and know which market structure is more unstable in a recession.

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7. Appendix

7.1. Apendix A: Transcendental Logarithmic Production Function

Trascendental Logarithmic Production Function

$$\ln(y_{it}) = \varphi_{it} + \overrightarrow{\alpha} \sum_{n=1}^{3} \ln(x_{nit}) + \overrightarrow{\beta} \sum_{n=1}^{3} (\ln(x_{nit}))^2 + \gamma_1 \ln(x_{1it}) \cdot \ln(x_{2it}) + \gamma_2 \ln(x_{it}) \cdot \ln(x_{3it})$$
$$+ \gamma_3 \ln(x_{1it}) \cdot \ln(x_{3it}) + \gamma_4 \ln(x_{1it}) \ln(x_{2it}) \ln(x_{3it})$$
$$+ \eta \ln(y_{it-1}) + \boldsymbol{\psi}(\texttt{sales size})_{it} + \boldsymbol{\delta}_t + \omega_{it}$$

Where the dependent variable is the natural logarithm of the sales,x_1 is the capital measured by the total assets, x_2 is labour measured by wages,x_3 are the inputs (A.K.A sales costs),a first-degree autoregressive process is included, `sales size` is a dummy variable that identifies which size the firm has (according to the Andean Community Decision) and δ_t is a dummy variable that identifies the year within the 2012 and 2019 period. Finally, the TFP term is interpreted via the residual component: ω_{it}.

7.2. Appendix B: Transcendental Logarithmic Estimation

Table 7: Transcendental Logarithmic Estimation

Estimation Method	OLS	Fixed Effect	Arellano Bond One-Step	Arellano Bond Two-Step
Lag (Sales)	0.141***	0.032***	0.000	0.003
	(0.005)	(0.005)	(0.012)	(0.012)
ln(Capital)	0.600***	0.571***	0.728***	0.754***
	(0.036)	(0.080)	(0.106)	(0.105)
ln(Labour)	1.134***	1.034***	1.231***	1.258***
	(0.045)	(0.097)	(0.132)	(0.130)
ln(Inputs)	0.910***	1.042***	1.132***	1.157***
	(0.043)	(0.083)	(0.111)	(0.110)
$\ln(\text{Capital})^2$	-0.010***	0.001	0.002	0.002
	(0.002)	(0.002)	(0.002)	(0.002)
$\ln(\text{Labour})^2$	0.027***	0.036***	0.037***	0.038***
	(0.002)	(0.003)	(0.004)	(0.004)
$\ln(\text{Inputs})^2$	0.047***	0.052***	0.054***	0.054***
	(0.002)	(0.003)	(0.002)	(0.002)
$\ln(\text{Capital}) \cdot \ln(\text{Labour})$	-0.031***	-0.032***	-0.049***	-0.051***
	(0.004)	(0.008)	(0.011)	(0.011)
$\ln(\text{Labour}) \cdot \ln(\text{Inputs})$	-0.151***	-0.152***	-0.164***	-0.167***
	(0.004)	(0.008)	(0.011)	(0.011)
$\ln(\text{Capital}) \cdot \ln(\text{Inputs})$	-0.045***	-0.056***	-0.067***	-0.069***
	(0.004)	(0.007)	(0.009)	(0.009)
$\ln(\text{Capital}) \cdot \ln(\text{Labour}) \cdot \ln(\text{Inputs})$	0.004***	0.004***	0.005***	0.005***
	(0.000)	(0.001)	(0.001)	(0.001)
Constant	-4.157***	-4.313***	-5.846***	-6.198***
	(0.476)	(0.980)	(1.314)	(1.306)
Size Dummy	Yes	Yes	Yes	Yes
Year Dummies	Yes	Yes	Yes	Yes
Observations	75,046	75,046	58,913	58,913
R-squared	0.965	0.786		
Number of ruc		14,788	13,960	13,960

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

7.3. Appendix C: Cleansing Effect using TFP obtained by Trans-Log

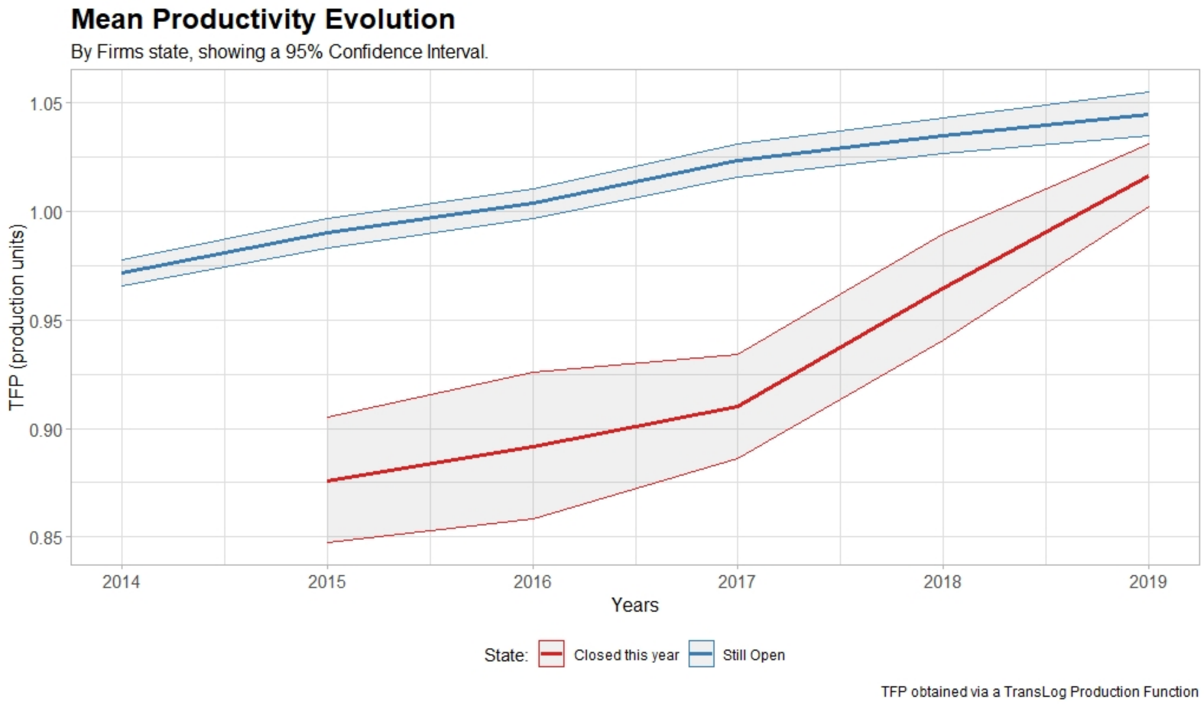

Figure 2: Mean Productivity Evolution using a Transcendental Logarithmic production function

7.4. Appendix D: Mean TFP by heterogeneous classification

TFP Estimation by group

Total Factor Productivity Estimation From Cobb Douglas	State:	2015	2016	2017	2018	2019
		Mean				
Mean	Closed this year	0.78959071	0.87117126	0.86354757	0.92302584	1.02960369
	Still open	0.98032638	1.01577866	1.04087686	1.08407721	1.11295802
		ISIC 1				
A	Closed this year	0.62043208	0.75427838	0.67496217	0.78643016	0.7071588
	Still Open	0.69481095	0.78152696	0.77418689	0.72061791	0.7918807
C	Closed this year	0.79644982	0.92031	0.87662681	0.87608395	0.98174838
	Still Open	0.96166994	0.9863151	1.02517161	1.06880452	1.08792058
F	Closed this year	0.78881781	1.00184054	0.79720948	0.90769547	0.9243248
	Still Open	0.98731577	0.98048707	0.97899331	0.99619078	1.00853174
G	Closed this year	0.81713348	0.83726142	0.93023481	0.98500054	1.17264887
	Still Open	1.07126237	1.10261729	1.13917448	1.22001788	1.23788634
		Size				
Micro	Closed this year	0.74955171	0.84683028	0.79213109	0.84009158	0.9077241
	Still Open	0.99808133	1.00021975	1.01998789	1.09799432	1.08348807
Small	Closed this year	0.87748882	1.31287047	1.23589246	1.25596028	0.98181791
	Still Open	0.95241467	0.99668925	1.0157712	1.05625208	1.07753478
Medium	Closed this year	0.67546175	1.05828915	2.25495843	0.64918927	0.77490672
	Still Open	0.95087939	0.99909281	1.00921988	1.03923074	1.08952904
Big	Closed this year	0.83157248	0.74254645	0.88534592		0.589898
	Still Open	1.15228294	1.17440591	1.24389964	1.25984341	1.32343884

Table 8: TFP estimations by group.

7.5. Appendix E: Binary Response Models Estimation for post-recession years

Table 9: Binary Response Model Estimations for Post-Recession years.

Closure year	2018			2019		
Estimation Method	OLS	Logit	Probit	OLS	Logit	Probit
Productivity	-0.008	-0.045	-0.026	-0.031***	-0.160***	-0.096***
	(0.010)	(0.060)	(0.035)	(0.009)	(0.044)	(0.026)
Debt Ratio	-0.003	-0.023	-0.012	0.008	0.035	0.022
	(0.003)	(0.025)	(0.014)	(0.005)	(0.024)	(0.015)
Foreign Trade	-0.013	-0.112*	-0.061*	0.007	0.038	0.022
	(0.008)	(0.067)	(0.036)	(0.010)	(0.050)	(0.030)
Market Share	-0.076	-0.756	-0.432	0.052	0.263	0.166
	(0.132)	(1.619)	(0.866)	(0.310)	(1.563)	(0.933)
Small	-0.044***	-0.301***	-0.170***	0.020**	0.114**	0.066**
	(0.013)	(0.099)	(0.054)	(0.009)	(0.048)	(0.028)
Medium	-0.072***	-0.553***	-0.304***	0.064***	0.329***	0.194***
	(0.007)	(0.054)	(0.029)	(0.016)	(0.075)	(0.045)
Big	-0.069***	-0.525***	-0.288***	0.035	0.187*	0.109*
	(0.012)	(0.095)	(0.050)	(0.023)	(0.108)	(0.065)
Productivity · Small	-0.011	-0.092	-0.051	0.034**	0.176**	0.105**
	(0.015)	(0.102)	(0.056)	(0.015)	(0.073)	(0.044)
Productivity · Medium	-0.004	-0.060	-0.027	-0.007	-0.014	-0.011
	(0.014)	(0.100)	(0.055)	(0.014)	(0.064)	(0.038)
Productivity · Big	0.009	0.053	0.036	0.009	0.053	0.030
	(0.021)	(0.184)	(0.099)	(0.019)	(0.093)	(0.055)
Constant	0.120	-1.940*	-1.161*	0.113	-1.864**	-1.123***
	(0.148)	(1.070)	(0.596)	(0.101)	(0.737)	(0.411)
ISIC dummy	Yes	Yes	Yes	Yes	Yes	Yes
Province dummy	Yes	Yes	Yes	Yes	Yes	Yes
Observations	10,820	10,805	10,805	9,597	9,597	9,597
R-squared	0.017			0.010		

Robust standard errors in parentheses

*** $p<0.01$, ** $p<0.05$, * $p<0.1$

7.6. Appendix F: Odds-ratios calculations

Table 10: Odds Ratios obtained from the Logistic regression

Closure year	2015	2016	2017
	Main Arguments		
Productivity	0.79851622	0.8445089	0.94932887
Debt Ratio	1.09636482	1.04812201	1.04707441
Foreign Trade	0.6563901	0.71677019	0.82283466
Market Share	1.2202E-12	0.00042264	1.28274203
	Sales Size		
Small	0.43387448	0.54881164	0.75957212
Medium	0.25949963	0.34403909	0.66100095
Big	0.17746178	0.22763769	0.43127903
	Interactions		
Productivity · Small	1.07465534	0.92311635	0.94932887
Productivity · Medium	0.95886978	0.94459407	0.83027359
Productivity · Big	1.18175427	0.69142541	0.69489119
Constant	1.07250818	0.65050909	0.09729575
ISIC Dummies	Yes	Yes	Yes
Province dummies	Yes	Yes	Yes
Observations	14,331	13,314	12,286