Productivity, Reallocation, and Distortions: Evidence from Ecuadorian Firm-Level Data*

Anson T. Y. Ho[†] Kim P. Huynh[‡] David T. Jacho-Chávez[§]

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Abstract

Some view recessions as a cleansing or reallocation mechanism in which inefficient firms exit while only the most efficient firms enter. However, distortions may prevent this efficient adjustment. Ecuador, a developing small open economy, serves as an important case study for reallocation because of its large economic crisis in the late 1990s. We study Ecuadorian firm dynamics to understand the sources of aggregate productivity growth. We find that reallocation of factor inputs and technical efficiency growth are the dominant factors. Net entry as a source of reallocation is only significant during the crisis period (1999-2000). These results illustrate the relative importance of extensive and intensive margins of reallocation.

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†Department of Economics, Kansas State University, 327 Waters Hall, Manhattan, KS 66506-4000, USA. E-mail: atyho@ksu.edu.

‡Bank of Canada, 234 Wellington Ave., Ottawa ON, K1A 0G9, Canada. E-mail: kim@huynh.tv.

§Department of Economics, Emory University, Rich Building 306, 1602 Fishburne Dr., Atlanta, GA 30322-2240, USA. E-mail: djachocha@emory.edu.

1. Introduction

Ecuador's economic crisis in 1999-2000 serves as an important case study of economic reallocation for a developing small open economy. Several financial and labour market reforms were undertaken during this crisis. The rationale for these reforms were to remove impediments for the efficient allocation of economic resources. Using Ecuadorian firm level data from 1998 to 2007, we study the impacts of labour and capital reallocation on both the intensive margin (use of inputs among incumbent firms) and the extensive margin (firm entry and exit). We found that there was substantial job reallocation. Incumbent firms had higher job creation and destruction rates than new entrants and exitors, respectively. Entrants also employed more workers than exitors. For the use of capital, capital reallocation in 1998-2001 was about twice of that in the later years of the sample periods. In 1999-2000 capital destruction was almost 3 times higher than capital creation rate, but the opposite is observed in 2001. Capital level of entrants was higher than that of exitors in most years, except when the crisis hit in 1999.

As market frictions create distortions in input allocation, resource reallocation has important implications on productivity. Nonetheless, the exisiting literature provides mixed empirical evidence. One strand of literature has shown that reallocation improves productivity by reducing market frictions. On the intensive margin, it may enhance the flow of resource from less productive firms to more productive firms. For example, Petrin, Reiter, and White (2011) highlights the positive role of reallocation in the United States. On the extensive margin, Davis and Haltiwanger (1990) and Caballero and Hammour (1994) point out that recessions, although painful, serve as a cleansing effect. Inefficient firms are culled while the efficient ones thrive, resulting in an increase in overall productivity. Another strand of literature arguing that recessions may affect productivity negatively as market frictions intensify. Barlevy (2002) observes that job quality is procylical and in the presence of job search frictions will generate low quality job matches, known as a sullying effect. These low quality matches of firms and workers are inefficient reallocations of labour. Petrin and Sivadasan (2013) study the case of Chile and find that labour market immobility could be a reason for large gaps in marginal product versus marginal cost at any plant. From a capital point of view, Ouyang (2009) shows that recessions may destroy potentially superior firms during their infancy. In terms of cross-country studies, Collard-Wexler, Asker, and Loecker (2011) find that much of the dispersion in productivity is due to capital misallocation caused by the dynamic adjustment costs of capital. These examples of market friction prevent efficient allocation of resources and are reflected as distortions on the economy, which may manifest themselves in either labour and/or capital inputs.

To investigate the impacts of a severe economic crisis and its subsequent resource reallocation, we first measure input (capital/labour) distortions in the economy to illustrate the amount of market frictions. Following the method developed by Restuccia and Rogerson (2008), Guner, Ventura, and Xu (2008), and Hsieh and Klenow (2009), we find that in the late 1990s Ecuadorian firms were under-sized in terms of labour and used too much capital relative to the efficient allocation. Part of the reasoning behind this story is that the Ecuadorian labour market was highly distorted with many regulations on hiring and firing costs. Table 1 contains a description of labour market reforms. The estimated input distortions decreased after the crisis as labour market and financial reforms were carried out.

As reallocation reduced input distortions in Ecuador, we further investigate the importance of it on Aggregate Productivity Growth (APG) using the method proposed by Petrin and Levinsohn (2012). It allows us to decompose aggregate productivity growth into the effects of technical efficiency improvement, reallocation between incumbent firms, and reallocation due to entry and exit. We find that there were positive reallocations of labour and capital, contributing to an increase in aggregate productivity growth. These results highlight the cleansing effect of recessions. However, post-2003 witnessed some reversal of the labour market liberalization. This results in a smaller positive effect on aggregate productivity growth from input reallocation.

Our results suggest that the recession had an overall positive effect on aggregate productivity in Ecuador, which contrast with some of the previous work. For example, Nishimura, Nakajima, and Kiyota (2005) point out that the natural selection mechanism may not lead to efficient reallocation in Japan. Hallward-Driemeier and Rijkers (2013) document that in Indonesia financial market imperfections attenuated relationship between productivity and survival. Oberfield (2013) and Chen and Irarrazabal (2012) also find that misallocation has strong negative effects on productivity in the Chilean manufacturing sector. Our findings suggest that understanding the underlying mechanism of APG, input distortions, and reallocation is important for policymakers as it quantifies on what margin (if any) policies should be directed towards.

This paper is organised in the following fashion: Section 2 offers a background on the economic conditions during this period; Section 3 describes the data used, offers some descriptive statistics, and investigates the reallocation and productivity patterns; Section 4 analyzes the input distortions while Section 5 discusses the APG decompositions; and Section 6 concludes.

2. Background on the Ecuadorian Economic Crisis

This section aims to provide a stylized summary about the economic crisis and the subsequent official dollarisation in Ecuador; a detailed analysis is availbe in Beckerman (2002) and Jácome (2004). The Ecuadorian crisis originated from a series of external shocks. Figure 1 illustrates the difficult macroeconomic conditions faced by Ecuador. While agriculture products and crude oil were the major exports of Ecuador, El Niño floods in late 1997 and 1998 destroyed vast agricultural areas in the coastal region and reduced agricultural production. Oil prices in the world market also sank to a historical low - less than 10 USD per barrel - significantly reducing the total revenue of the debt-ridden government, whose fiscal deficit was 6.2 percent and total debt/GDP ratio was 66.3 percent. Worse still, as the effects of the Asian financial crisis spilled over to Latin America, the foreign loanable funds available to the Ecuadorian government and private banks were further reduced.

The outbreak of the crisis was triggered by the closure of a small bank in April 1998. Market sentiment deteriorated and evolved into widespread bank runs. As the lender of last resort, the Central Bank of Ecuador (CBE, hereafter) provided emergency loans to illiquid banks, reaching about 30 percent of the money base by the end of September 1998. Bank deposits fled from Ecuadorian Sucre, the domestic currency, to US dollars and created pressure on international reserves. In the last quarter of 1998, the CBE's net international reserves shrank by 7.6 percent and cumulative inflation reached 15 percent while real GDP grew only 0.1 percent.

In early December 1998, as a measure to restore stability in the banking sector, the AGD law was passed to establish the Guarantee of Deposit Agency (Agencia de Garantía de depósitos - AGD) for providing deposits guarantee. The government also introduced a 1 percent financial transaction tax aimed at supporting the weak public finance. However, this tax proved critical to the massive withdrawals of deposits from the banking system in order to avoid this transaction tax. It aggravated the insolvency in banks and led to more bank failures, which in turn deepened the monetisation of the banking crisis through the deposit guarantee.

By early 1999, speculations on the depreciation of Sucre further intensified. The CBE could no longer defend its crawling band exchange rate and moved to free floating in February 1999. Between January and February, Sucre had depreciated about 50 percent, causing substantial balance sheet effects on banks and further damaged their solvency. In March, the Ecuadorian government declared a bank holiday and a widespread freeze of bank deposits. Although these measures temporarily halted the fall of the Sucre exchange rate and stabilised inflation, the payment system was severely impaired and led to a 7 percent drop of GDP in 1999. Nonetheless, the deposit withdrawal had not been eased when deposits were gradually 'unfreezed' from mid-1999. In face of the persistently increasing government debts and a reduced level of international reserves, the Ecuadorian government suspended payments on its external debts. As a result, domestic banks holding government securities had their assets further eroded, creating another blow to the already damaged banking system.

As the crisis deepened, two more large banks failed and the deposit guarantee had brought the base money real growth rates to above 50 percent. With an increasing dollarisation of bank liabilities and a plummeting demand of Sucres, the government officially dollarised the economy on January 11, 2000 at a fixed rate of 25,000 Sucres per US dollar. In the Ecuadorian currency crisis, Sucre depreciated 274 percent from 1999 to 2000. Out of the 40 banks that existed in 1998, 16 failed, resulting in a substantial decrease in labour productivity. The real output per worker dropped about 9 percent during the crisis.

3. Stylised Facts

In this section, we describe the data set and document some important stylised facts regarding firm level productivity, turnover, and resources reallocation.

3.1. Data Description

Our study considers Ecuadorian firm level data from 1998 to 2007. The data set is taken from the annual survey of manufacturing and mining (Encuesta Anual de Manufactura y Minería) prepared by the Ecuadorian National Institute of Statistics and Censuses (Instituto Nacional de Estadística y Censos, hereafter INEC). The data set covers a cross section of firms with at least 10 employees in each year. Each firm is identified by a unique registration number. Output is defined as value-added, which is the total value of production minus the total value of intermediate inputs (i.e. raw materials, parts and accessories, and packing). Production is measured at cost value so that the variation in firms' mark-ups does not affect our productivity calculation. Capital is defined as the annual average net capital. Output and capital stock are deflated to 2002-US dollars by the sector specific producer price index[1] and the general producer price index, respectively. Since monetary values in the data set were reported in domestic currency (Ecuadorian sucres) before the official dollarization in year 2000, nominal values in year 1998 and 1999 are converted into US dollars by the official exchange rate at the time of dollarization (25,000 Sucres per US dollar). There was substantial depreciation of the Sucre against the US dollar in 1998 and 1999. We account for exchange rate movement when we use the producer price index to transform the pertinent variables into 2002-US dollars.

All the panels (firms) with negative output or negative capital in one or more years in the survey were dropped. We also dropped firms with top and bottom 1 percent output-labour ratio and/or capital-labour ratio to get rid of the outliers. As a result, we have a sample of 1,699 firms with a total of 9,786 observations. The composition of the data is shown in Table 2.

We also ensure the longitudinal consistency of the data by checking for false entry and exit. There are several possibilities that a firm entered into or exited from the survey. Firms included in the survey for the first time when they start up as new entrants, or by expanding their employment to at least 10 employees. For this reason, some firms entered and exited multiple times during the survey periods. For our entry and exit analysis, we only count the first entry and last exit as legitimate. Firms can also be included in the survey if they switched their product line from other industries. However, firms' entry and exit due to switching from other sector is minimal.

[1] We used the Serie de Índices y Variaciones del IPP, Total (Nacional y Exportación) as readily available at http://www.inec.gov.ec.

3.2. Firm Size and Productivity

In Table 3, we present some descriptive statistics of firms' use of resources, level of output, and their productivity in the sample periods. While the median employment remained at similar levels (about 34 workers) throughout the whole period, median capital dropped by almost 50 percent from 1998 to 2000. It recovered in 2001 but never reached the level of 1998. Median capital-labour ratio also reflects the changes in labour and capital use. It decreased substantially during the crisis and bounced back in 2001. Even though the capital-labour ratio was still lower in the post-crisis periods, median output in the same period exceeded that of 1998 and in general on an increasing trend. This is largely due to the increase in factor productivity. Labour productivity, measured in median output per worker, dropped during the crisis and had been higher since 2001. Median output per capital had been increasing, with the steepest improvements in 1998-2000. As an overall trend, firms were more productive. These results are similar to Wong (2009) study of trade liberalization and Ecuadorian productivity in 1997-2003.

We also illustrate the distribution of employment, capital, and capital-labour ratio by the visualization of conditional density plots (Huynh and Jacho-Chávez, 2007). The first column of Figure 2 shows that the firm size distribution had become more positively skewed but the mode stayed about the same. For capital distribution, it became more negatively skewed from 1998-2000 due to the crisis, and the changes were partially reversed in 2001-2003. The overall distribution became more compact in the post-crisis periods. As for the capital-labour ratio, the distribution became more negatively skewed, with a notable drop in the mode in 2000. In general, the distribution was more dispersed prior to 2003.

3.3. Turnover & Reallocation Patterns

We start by analysing firms turnover since entry/exit rates are indicative of the firm's extensive margin. As expected, the entry rate was lower than the exit rate in 1999, which is the worst year of the economic crisis. After that, the general trend reversed with some exceptions. The entry rate increased steadily until about 2004, then there was some drop in 2005 and 2006. The exit rate was highest in 1999, but it did not vary as much as the entry rate since then.

Given the changes in firms' use of resources and the firm turnover ratio, we further investigate labour and capital reallocation patterns from the macroeconomic point of view. We focus on the rates of creation, destruction, and reallocation for labour and capital. Job (capital) creation is defined as the sum of new jobs (capital) at new entrants and incumbent firms. Job (capital) destruction is defined as the sum of all lost jobs (capital) at exitors and incumbent firms. Job (capital) reallocation refers to the sum of job (capital) created and job (capital) destructed. It is a useful measurement to indicate the extent to which resources are transfered between firms in the economy. All job (capital) creation, destruction, and reallocation rates are expressed as a fraction of total amount of jobs (capital) in the economy.

Job creation was greater than job destruction with the exception of 1999 and 2003. The highest job creation rate occurred in 2001. Over the whole sample period, large fractions of jobs created were due to some incumbents expanding their operations. In contrast to job creation, the highest job destruction rate is observed in 1999. Exitors and incumbents had similar rates of job destruction. Due to high job creation and low job destruction after the crisis, the highest *net* job creation happened in 2000 and 2001. The level of job reallocation (combining both creation and destruction) was on average 27.2 percent in the sample periods. We find that there were more reallocations during the years 1999-2003 when compared to 2004-2007. Both entrants and exitors were small firms, in both cases below the median size of firms. The median firm entrant size was larger than that of the exitors.

For most years, capital destruction was greater than capital creation, and capital creation by incumbents were slightly larger than that of new entrants. A particular exception is 2001, in which the capital creation rate was the highest and more than 3 times of capital destruction. It was driven by strong capital accumulation by incumbents. Capital destruction also decreased by 2/3 in 2001 as that of incumbents significantly reduced. In general, incumbents had higher destruction rates than the exitors, with the most notable differences in 1999-2000. The highest capital destruction rate is observed in 1999, which is not surprising as the economy was deep in crisis. In contrary to *net* job reallocations, *net* capital creation shows more variation, with high levels of net capital destruction in 1999-2000 and strong capital creation in 2001. Variations in net capital creation is also mirrored in capital reallocation, which was about two times higher in 1999-2001 than that in the later years. On average capital reallocation rate was 30.7 percent. Entrants and exitors were smaller firms in terms of median capital level, and entrants were larger than exitors except in 1999 and 2007. However, in terms of median capital-labour ratio, entrants and exitors were close to the median size and that of entrants were similar to exitors, except in 1999 when median exitor were twice bigger than the median entrant.

4. Input Distortions

To understand the resources allocation and the firm turnover documented in the above section, we investigate the source of heterogeneity in firm dynamics. The modeling framework is based on the model of Hopenhayn and Rogerson (1993) in which firms make their decisions on entry/exit and scale of production based on their firm specific TFP. We relax the assumption in Hopenhayn and Rogerson (1993) that these firm specific TFPs are fixed once the firms entered the market and allow them to be time dependent. Changes in the firm specific productivity is attributed to changes in the firm level distortions à la Restuccia and Rogerson (2008). Related work in this line of research includes Guner, Ventura, and Xu (2008) and Hsieh and Klenow (2009). This separation between firm specific TFPs and the distortions faced by firms becomes more relevant in the case of Ecuador, because the economy was hit by a large negative shock. It allows us to study changes in frictions that potentially affected the allocation of resources during the crisis, and afterwards when the economy recovered and economic reforms that took place.

4.1. Total Factor Productivity

We begin by estimating firm level production functions. Using our production function estimation results, we can compute firm specific TFP and input distortions over time. Studying the evolution of the TFP, and input distortion distributions allows us to understand the role of the crisis and market reforms.

To begin with, firms produce output (Y) via a Cobb-Douglas production function in which capital (K) and labour (L) are used as the inputs. Let z_{it} denotes TFP for firm i at time t. The production function can be written as:

$$Y_{it} = z_{it} K_{it}^{\alpha} L_{it}^{\gamma}, \tag{4.1}$$

where α and γ are the capital and labour shares of output. We take logarithms of (4.1) and the production function can be rewritten as

$$\log Y_{it} = \log z_{it} + \alpha \log K_{it} + \gamma \log L_{it}. \tag{4.2}$$

To construct the firm specific TFP conditional on time t, we first estimate the factor shares by using a fixed effects panel data estimator as in Pavcnik (2002). Time and sector dummy variables are also included in the equation. Specifically, we estimate (4.2) by

$$\log Y_{it} = c_i + \alpha \log K_{it} + \gamma \log L_{it} + \{b_l \text{YEAR}_l\}_{l=1999}^{2007} + d_j \text{IND}_j + \epsilon_{it} \tag{4.3}$$

where c_i is the firm's fixed effect, YEAR_l for $l = 1999, ..., 2007$ are time dummy variables, IND_j are the sector dummy variables, and ϵ_{it} is the random component for firm i at time t. Results are reported in Table 7. The estimated factor shares exhibit decreasing return to scale, i.e. $\hat{\alpha} + \hat{\gamma} < 1$, and is consistent with the model assumption in Hopenhayn and Rogerson (1993).[2]

To address the price markups coming from unobserved price and demand shocks, we use the output at cost value reported by firms. The merit of using output at cost value is that we can have a consistent measure in the change in inventory, which is measured in cost and

[2] We also estimate the production function using OLS, and find that combined elasticities are greater than one. The robustness of our analysis does not hinge on these production function estimates. A detailed technical appendix with alternative specifications are available upon request. For example, work by Ackerberg, Caves, and Frazer (2006) has shown that the fixed effects estimates will be the lower bound, and OLS is the upper bound. Popular methods such as Levinsohn and Petrin (2003) lie somewhere in between.

considered as a part of production. There is a literature estimating *revenue* production function in the presence of product differentiation (Klette and Griliches, 1996; Levinsohn and Melitz, 2002; De Loecker, 2011). By using output at cost value, dispersion of productivity only reflects that of technical efficiency and markup by firms is not considered. In terms of econometric specification, our estimating equation (4.3) has the same specification as the revenue production function in Levinsohn and Melitz (2002).

We also construct firm level TFP measures using the estimated factor shares. Specifically,

$$\log z_{it} = \log Y_{it} - \alpha \log K_{it} - \gamma \log L_{it}. \tag{4.4}$$

The estimated log TFP distributions are illustrated on the bottom right panel of Figure 2. Overall, there had been a positive shift of the TFP distributions. From 1998 to 2000, the TFP distributions had lower modes. After that, there was a significant increase in the mode, and the dispersion of TFP distributions decreased due to the trimming of inefficient firms.

4.2. Measuring Firm-Level Distortions

As in Restuccia and Rogerson (2008), we aim at estimating a generic family of idiosyncratic distortions to firm's decisions, and so we assume that the distortions take a form of tax or subsidy. Hsieh and Klenow (2009) have shown that this generic tax can be viewed as distortions that affect both the capital and labour decision of a firm. We assume that firm i maximizes profits π_{it} as

$$\max_{K,L} \pi_{it} = \max_{K,L} \left\{ Y_{it} - \left(1 + \tau_{it}^{K}\right) r_{it} K_{it} - \left(1 + \tau_{it}^{L}\right) w_{it} L_{it} \right\} \tag{4.5}$$

where τ_{it}^{n}, for $n = K, L$, are the input taxes on capital and labour respectively. The capital expenditure is $r_t K_{it}$, and $w_t L_{it}$ is the wage bill. The first order conditions (FOCs) for the firm's profits maximization imply that:

$$\alpha = \left(1 + \tau_{it}^{K}\right) \frac{r_{it} K_{it}}{Y_{it}}, \tag{4.6}$$

and

$$\gamma = \left(1 + \tau_{it}^{L}\right) \frac{w_{it} L_{it}}{Y_{it}}. \tag{4.7}$$

FOCs (4.6) and (4.7) show that if there is no distortions, i.e. $\tau_{it}^{K} = \tau_{it}^{L} = 0$, we get the typical FOCs that the elasticities of factor inputs are equal to the factor shares of output in a Cobb-Douglas production function. If $\{\tau_{it}^{n}\}_{n=K,L}$ is positive, then the firm faces an input tax; and if $\{\tau_{it}^{n}\}_{n=K,L}$ is negative, the firm is receiving an output subsidy. The model implies that the lower bound of input tax is -1 because firms will expand their scales to infinity if the after-distortion-tax factor prices are less than or equal to zero.

To construct the time series of τ_{it}^K and τ_{it}^L from (4.6) and (4.7), we need the elasticities of each factors of production and their output shares. For that we use our estimates $\hat{\alpha}$ and $\hat{\gamma}$ depicted in Table 7. Labour expenditure ($w_{it}L_{it}$) is reported by firms in the survey. Since there is no reported data on the returns on capital, we impute firms' capital expenditures by multiplying their capital by the market interest rate in the corresponding year. The market interest rates are defined as the weighted average lending rate charged by private banks on 92- to 172-days loans. Data is taken from the International Financial Statistics Yearbook 2010 (pg. 248). This simplifying assumption places interest rate dispersions into the distortion term.

4.3. Distortion Results

Distributions of the estimated labour and capital distortions, τ_{it}^L and τ_{it}^K, are displayed in the second column of Figure 2. To reflect the importance of these distortions on firms of different sizes, we also report the Domar (firm level output) weighted firm level distortions in Table 8. Since any distortion taxes deviating from 0 is a distortion, median distortion taxes are reported separately for firms facing positive and negative distortions, along with the fraction of firms that faced a positive distortion (FPos).

4.3.1. Labour Distortions

Figure 2 shows that the distributions of labour distortion tax were skewed to the right with some firms facing high labour distortion taxes. During the economic crisis, the overall labour distortion increased with greater dispersion. After implementing reforms on labour regulations (see Table 1), labour distortions in 2001-2002 were reduced with a more compact distributions. After 2003, however, labour distortions rised again and the right-tail of the distributions increased.

The Domar weighted labour distortions in Table 8 shows that on average 96.1 percent of firms were undersized ($\tau_{it}^L \geq 0$) in terms if employment in the sample periods. Only a small fraction of firms were oversized ($\tau_{it}^L < 0$) and the extent to which had been decreasing over time. For undersized firms, median labour distortion peaked in 2000, decreased in 2001-2002, and increased again since 2003.

4.3.2. Capital Distortions

Compared to labour distortions, Figure 2 shows that capital distortions were much more volatile and more dispersed. The distribution of capital distortion was skewed to the right, significantly shifted from 1998 to 1999, and became more centered around 0. The distribution became more compact from 2000 to 2003, before it expanded again with more frictions in the capital market that kept firms undersized in terms of capital use.

In contrast to the weighted labour distortions, Table 8 also shows that the fraction of firms facing positive capital distortion had been increasing over time. On average 51.0 percent of firms are restricted in capital use. Among the oversized firms ($\tau_{it}^K < 0$), the amount of distortion was the highest in 1998 and it reduces since then. Capital flight during the crisis had strong cleansing effects as exitors were those with high capital-labour ratio. For firms facing positive capital distortions ($\tau_{it}^K \geq 0$), the amount of distortions was the highest in 2001, dropped in 2002-2003, and then increased again since 2004.

4.3.3. A Test of Equality of Distributions

We also proceed to formally test if the distribution of distortions changes over time. These tests are important because distributions could dynamically vary from year to year in ways not fully captured by simply comparing sample means, variances, or eye-balling. In particular, we test the null hypothesis $H_0 : f_t = f_s$ almost surely, for $t \neq s = 1998, \ldots, 2007$. Table 9 shows the p-values based on 399 bootstrap replications of Li, Maasoumi, and Racine's (2009) test statistics for H_0, where f represents the probability density function of the log of capital distortion tax (upper triangular section), and the log of labour distortion tax (lower triangular section). The results show that all yearly distributions differ from each other prior to 2005 for both variables, but one fails to reject the null hypothesis of no distributional changes for both taxes from 2004 till the last year of the samples.

5. Aggregate Productivity Growth Decompositions

Although our estimation of input distortions quantifies the extent of input misallocation and the potential gain from reallocation, the impact of these distortions is unclear in an economy under transition. The existence of distortions may stimulate firms to increase their chances of survival by improving their technical efficiencies, and promote efficient resources reallocation. However, market frictions and distortions may also prevent resources from reallocating to efficient firms, resulting in a sullying effect. It outlines the importance to study how these competing effects are converted into an aggregate adjustment process.

To understand the aggregate adjustment process, a systemic method is required to quantify the relative importance of technological progress and reallocation. We follow the method developed in Petrin and Levinsohn (2012) to measure Aggregate Productivity Growth (APG). Interested readers are referred to the original paper for details. The decomposition has well known advantages, especially for analyzing plant level data in developing economies, taking into account frictions such as plant level heterogeneity, entry and exit of firms, fixed and sunk costs, markups, returns to scale and adjustments costs.

5.1. Methodology

APG is defined as the change in aggregate value-added residual, which is calculated as the change in aggregate output minus the change in aggregate expenditures. APG, as a percentage of aggregate output, can be expressed as:

$$\text{APG} \quad = \quad \left(\sum_i dY_i - \sum_i r_t dK_i - \sum_i w_t dL_i \right) \Big/ \sum_i Y_i. \tag{5.1}$$

For brevity, we reproduce the discrete time APG decomposition from time $t-1$ to t:

$$\begin{aligned} \text{APG}_{t-1,t} \quad &= \underbrace{\sum_{i \in I_t} \bar{D}_{it} \Delta \log z_{it}}_{\text{TE}} + \underbrace{\sum_{i \in I_t} \bar{D}_{it} \left(\gamma_j - \bar{s}^L_{it} \right) \Delta \log L_{it}}_{\text{APG}^L_{RE}} + \underbrace{\sum_{i \in I_t} \bar{D}_{it} \left(\alpha_j - \bar{s}^K_{it} \right) \Delta \log K_{it}}_{\text{APG}^K_{RE}} \\ &+ \underbrace{\sum_{i \in E_t} D_{it} \left(1 - s^K_{it} - s^L_{it} \right)}_{\text{Entry}} - \underbrace{\sum_{i \in X_{t-1}} D_{it-1} \left(1 - s^K_{it-1} - s^L_{it-1} \right)}_{\text{Exit}}, \end{aligned} \tag{5.2}$$

where

$$\bar{D}_{it} \quad = \quad \left(\frac{Y_{it}}{Y_t} + \frac{Y_{it-1}}{Y_{t-1}} \right) \Big/ 2 \tag{5.3}$$

$$\bar{s}^K_{it} \quad = \quad \left(\frac{r_{it} K_{it}}{Y_{it}} + \frac{r_{it-1} K_{it-1}}{Y_{it-1}} \right) \Big/ 2 \tag{5.4}$$

$$\bar{s}^L_{it} \quad = \quad \left(\frac{w_{it} L_{it}}{Y_{it}} + \frac{w_{it-1} L_{it-1}}{Y_{it-1}} \right) \Big/ 2 \tag{5.5}$$

$\bar{D}_{it}$ is the average of plant i's value-added (Y_{it}) Domar weights from period $t-1$ to t, Δ is the first difference operator, $\log z_{it}$ is the value-added residual, α and γ are elasticities of output of each K and L inputs, $\bar{s}^K_{it}$ and $\bar{s}^L_{it}$ are the average over period $t-1$ to t revenue shares for capital and labour respectively.

The first term is *Technical Efficiency* (TE), which is the weighted sum of changes in firm level TFP. It entails how within-firm productivity changes affect the overall APG. The second and third terms are the *Reallocation* terms (APG^L_{RE} and APG^K_{RE}) which detail productivity changes coming from the reallocation of capital and labour. As shown in Section 4.2, if there is no distortions, factors share of output equal to their output elasticities and reallocation of labour and capital between firms does not affect APG. In that sense, the wedges between output elasticities and the factors share of output reflect the amount of firm level distortions estimated as distortion taxes τ^L_{it} and τ^K_{it}. To be precise, the difference between output elasticity and factor share of output is expressed as the distortion tax multiplied by the factor's output share, i.e. $\gamma - \bar{s}^L_{it} = \tau^L_{it} \bar{s}^L_{it}$ and $\alpha - \bar{s}^K_{it} = \tau^K_{it} \bar{s}^K_{it}$.

The reallocation terms are the weighted sum of firm level interactions between input distortions and input levels. For instance, if a firm with positive capital distortion tax increases its use of capital, there will be a decrease in capital distortion and results in a positive contribution to APG. Note that the synthetic distortion taxes are simply measures of distortions, moving resources from firms with low distortion tax to ones with high distortion tax does not create actual inefficiency. In general, positive APG comes from factor inputs being redirected towards firms with positive distortion taxes and away from firms with negative distortion taxes.[3]

The final two term is the combined effects of entry and exit, i.e. *Net Entry* (APG_{NE}) that represents reallocation on the extensive margin. The contribution of *Net Entry* is calculated as *Entry* minus *Exit*. New entrants with positive value-added residuals, i.e. $1 - s_{it}^K - s_{it}^L > 0$, make positive contribution to APG. Similarly, the disappearance of exitors with positive value-added residuals, i.e. $1 - s_{it-1}^K - s_{it-1}^L > 0$, means a loss of value-added residuals and results in a decrease in APG. Positive *Net Entry* can be the results of low TFP exitors replaced by high TFP entrants and/or exitors with more distortions replaced by entrants with less distortions.

5.2. Results

Table 10 displays the APG decompositions for the period 1999-2007. There were large differences between APG and output growth from 1999 to 2001, driven by changes in the use of factor inputs during the economic crisis. Changes in capital stock were notably larger than that in labour use. The use of capital dropped by 21.9 percent in 1999 and by 6.3 percent in 2000. From 2002 onwards, APG and output growth were roughly the same, implying that changes due to factor inputs contributed only a minor amount to changes in output.

Overall, APG was positive in all years, with an average of 8 percent. The largest increase in APG (15.6 percent) is observed 2000. Our APG decomposition shows that APG was mainly contributed by TE and APG_{RE}, with the former one being more volatile. The TE term is the Domar weighted change in TFP in Section 4.1. The contribution from TE were positive in most years, except the substantial negative contribution in 1999. On average, TE alone contributed 4.4 percent to APG, which is 55 percent of the total observed change in APG.

Resources reallocation makes important positive contributions to APG. Total reallocation on average lead to 3 percent APG, which is equal to 37.5 percent of total APG. APG from total reallocation had always been positive, with significantly larger contributions in 1999 and 2000. On average, APG from labour and capital reallocation were equally important, with both contributing 1.5 percent APG, respectively. APG from labour reallocation had been positive

[3] We use APG decompositions rather the standard BHC/FHK decompositions due to Baily, Hulten, and Campbell (1992) and Foster, Haltiwanger, and Krizan (2001), to avoid the issue of a negative between term. For more details on this issue, refer to Petrin, Nishida, and Polanec (2011) who discuss the important difference between APG reallocation and covariance term.

in most years and less volatile than that from capital reallocation. On the contrary, capital reallocation played a more important role in the APG in 1999 and 2000, and a much lesser role afterwards. This observation is consistent with the capital distortion tax estimates, as such distortions decreased substantially after the crisis shown in Table 8.

Compared to TE and resources reallocation, net entry had minor effects on APG over the period considered. On average, net entry alone only caused 0.6 percent APG, which equals to 7.5 percent of total APG. This is because entrants and exitors were smaller in size and carried less weight in the APG decomposition. Also, the difference between entry and exit in terms of contribution to APG is small. On average, entry alone only contributed 1.7 percent APG and exit alone decreased APG by 1.1 percent. The strongest net entry effect happened in 1999 when inefficient firms exited their markets during the economic crisis. Overall, in terms of APG, net entry exhibits both cleansing and sullying effects to a minor extent.

6. Conclusions

We investigate the Ecuadorian crisis as a case study to determine whether there is an efficient reallocation of resources. Using Ecuadorian firm level data from 1998 to 2007, we conduct an empirical analysis and document novel stylised facts about resources reallocation, firm turnover, and productivity patterns during a large crisis in this developing small open economy. As Restuccia and Rogerson (2008) and Hsieh and Klenow (2009) have advocated that distortions or wedges may prevent efficient reallocation of resources, we quantify input distortions at the firm level to illustrate the amount of frictions in this economy. In the years leading up to the crisis (1998 and 1999), the input distortions indicate that firms were under-sized in terms of labour but overused capital relative to the efficient allocation. During the recovery period of 2000-2002, both capital and labour input distortions fell temporarily when substantial labour market and financial reforms took place.

Further, we link input distortions to aggregate productivity growth using the method by Petrin and Levinsohn (2012). This decomposition along with the estimates of input distortions shed light on the input misallocation in Ecuador and the potential gains from reallocation. Our results show that the dominant contribution to aggregate productivity growth is due to input reallocation (intensive margin) and not net entry (extensive margin). For example, in 2000 total input reallocation contributed 5.4 percent, while net entry is about 0.7 percent, aggregate productivity growth (15.6 percent). These estimates of reallocation have an important policy implications and highlights the need for distortions to removed in factor markets via labour and/or capital market reforms. Whereas policies to encourage entry and minimize exit may have little effect on aggregate productivity growth.

Overall, our results point to reallocation as an important margin for re-adjustment. An interesting extension to consider is the role of financial frictions on capital adjustment process. For instance, Buera, Kaboski, and Shin (2011) shows that financial frictions distort capital allocation and negatively affect productivity. On the other hand, Midrigan and Xu (2014) suggests that efficient establishments can quickly accumulate internal funds and financial frictions only produce modest TFP losses. Finally, dollarisation may have an impact on firm's reallocation of inputs via a balance sheet effect. Research by Quispe-Agnoli and Whisler (2006) found that dollarisation improved the Ecuadorian banking sector. Unfortunately, at the present time there is no detailed financial balance-sheet data that can be used to study this phenomena.

References

Ackerberg, D., K. Caves, and G. Frazer (2006): "Structural Identification of Production Functions," MPRA Paper 38349, University Library of Munich, Germany.

Aguiar, V. (2007): *El Mercado Laboral Ecuatoriano: Propuesta de una Reforma*. Edición electrónica gratuita.

Baily, M. N., C. Hulten, and D. Campbell (1992): "Productivity Dynamics in Manufacturing Plants," *Brookings Papers on Economic Activity. Microeconomics*, 1992, pp. 187–267.

Barlevy, G. (2002): "The Sullying Effect of Recessions," *Review of Economic Studies*, 69(1), 65–96.

Beckerman, P. (2002): "Longer-Term Origins of Ecuador's "Predollarization" Crisis," in *Crisis and Dollarization in Ecuador*, ed. by P. Beckerman, and A. Solimano. The World Bank.

Buera, F. J., J. P. Kaboski, and Y. Shin (2011): "Finance and Development: A Tale of Two Sectors," *American Economic Review*, 101(5), 1964–2002.

Caballero, R. J., and M. L. Hammour (1994): "The Cleansing Effect of Recessions," *American Economic Review*, 84(5), 1350–68.

Chen, K., and A. Irarrazabal (2012): "Misallocation and the Recovery of Manufacturing TFP after a Financial Crisis," Unpublished Manuscript.

Collard-Wexler, A., J. Asker, and J. D. Loecker (2011): "Productivity Volatility and the Misallocation of Resources in Developing Economies," NBER Working Papers 17175, National Bureau of Economic Research, Inc.

Davis, S. J., and J. Haltiwanger (1990): "Gross Job Creation and Destruction: Microeconomic Evidence and Macroeconomic Implications," in *NBER Macroeconomics Annual 1990, Volume 5*, NBER Chapters, pp. 123–186. National Bureau of Economic Research, Inc.

De Loecker, J. (2011): "Product Differentiation, Multiproduct Firms, and Estimating the Impact of Trade Liberalization on Productivity," *Econometrica*, 79(5), 1407–1451.

Foster, L., J. C. Haltiwanger, and C. J. Krizan (2001): "Aggregate Productivity Growth: Lessons from Microeconomic Evidence," in *New Developments in Productivity Analysis*, ed. by E. Dean, M. Harper, and C. Hulten, pp. 303–372. University of Chicago Press.

Guner, N., G. Ventura, and Y. Xu (2008): "Macroeconomic Implications of Size-Dependent Policies," *Review of Economic Dynamics*, 11(4), 721–744.

Hallward-Driemeier, M., and B. Rijkers (2013): "Do Crises Catalyze Creative Destruction? Firm-level Evidence from Indonesia," *The Review of Economics and Statistics*, 95(5), 1788–1810.

Hayfield, T., and J. S. Racine (2008): "Nonparametric Econometrics: The np Package," *Journal of Statistical Software*, 27(5), 1–32.

Hopenhayn, H., and R. Rogerson (1993): "Job Turnover and Policy Evaluation: A General Equilibrium Analysis," *Journal of Political Economy*, 101(5), 915–38.

Hsieh, C.-T., and P. J. Klenow (2009): "Misallocation and Manufacturing TFP in China and India," *The Quarterly Journal of Economics*, 124(4), 1403–1448.

Huynh, K. P., and D. T. Jacho-Chávez (2007): "Conditional Density Estimation: An Application to the Ecuadorian Manufacturing Sector," *Economics Bulletin*, 3(62), 1–6.

Hyndman, R. J. (1996): "Computing and Graphing Highest Density Regions," *The American Statistician*, 50, 120–126.

Jácome, L. I. (2004): "The Late 1990s Financial Crisis in Ecuador: Institutional Weakness, Fiscal Rigidities, and Financial Dollarization at Work," *IMF Working Paper WP/04/12*.

Klette, T. J., and Z. Griliches (1996): "The Inconsistency of Common Scale Estimators When Output Prices Are Unobserved and Endogenous," *Journal of Applied Econometrics*, 11(4), 343–61.

Levinsohn, J., and M. Melitz (2002): "Productivity in a differentiated products market equilibrium," *Unpublished manuscript*.

Levinsohn, J., and A. Petrin (2003): "Estimating Production Functions Using Inputs to Control for Unobservables," *Review of Economic Studies*, 70(2), 317–341.

Li, Q., E. Maasoumi, and J. S. Racine (2009): "A Nonparametric Test for Equality of Distributions with Mixed Categorical and Continuous Data," *Journal of Econometrics*, 148(2), 186–200.

Midrigan, V., and D. Y. Xu (2014): "Finance and Misallocation: Evidence from Plant-Level Data," *American Economic Review*, 104(2), 422–58.

Nishimura, K. G., T. Nakajima, and K. Kiyota (2005): "Does the Natural Selection Mechanism Still Work in Severe Recessions?: Examination of the Japanese Economy in the 1990s," *Journal of Economic Behavior & Organization*, 58(1), 53–78.

Oberfield, E. (2013): "Productivity and Misallocation During a Crisis: Evidence from the Chilean Crisis of 1982," *Review of Economic Dynamics*, 16(1), 100–119.

Ouyang, M. (2009): "The Scarring Effect of Recessions," *Journal of Monetary Economics*, 56(2), 184–199.

Pavcnik, N. (2002): "Trade Liberalization, Exit, and Productivity Improvement: Evidence from Chilean Plants," *Review of Economic Studies*, 69(1), 245–76.

Petrin, A., and J. Levinsohn (2012): "Measuring Aggregate Productivity Growth Using Plant-Level Data," *Rand Journal of Economics*, 43(4), 705–725.

Petrin, A., M. Nishida, and S. Polanec (2011): "Explaining Reallocation's Apparent Negative Contribution to Growth," Open access publications from katholieke universiteit leuven, Katholieke Universiteit Leuven.

Petrin, A., J. Reiter, and K. White (2011): "The Impact of Plant-level Resource Reallocations and Technical Progress on U.S. Macroeconomic Growth," *Review of Economic Dynamics*, 14(1), 3–26.

Petrin, A., and J. Sivadasan (2013): "Estimating Lost Output from Allocative Inefficiency, with Application to Chile and Firing Costs," *Review of Economics and Statistics*, 95(1), 286–301.

Quispe-Agnoli, M., and E. Whisler (2006): "Official dollarization and the banking system in Ecuador and El Salvador," *Economic Review*, (Q 3), 55–71.

Restuccia, D., and R. Rogerson (2008): "Policy Distortions and Aggregate Productivity with Heterogeneous Plants," *Review of Economic Dynamics*, 11(4), 707–720.

Wong, S. A. (2009): "Productivity and Trade Openness in Ecuador's Manufacturing Industries," *Journal of Business Research*, 62(9), 868–875.

Table 1: Reforms on Labour Regulations in Ecuador 1998-2006

- **1998: Labour Outsourcing.**
  Allows firms to employ labour services from third party intermediary firms. It applies to activities of any nature, complementary, seasonal and part-time.

- **2000: Economic Transformation of Ecuador (Transformación econmica del Ecuador).**
  Introduces hourly labour contracts, fixing the minimum hourly rate in $0.50 US dollar. Forbids the indexation of wages to a referential sectoral wage rate. Unifies the salaries, eliminating the mandatory payment an annual bonus salary (the 15th and 16th salary). Allows to hire temporary and seasonal workers up to 40% of the workforce in a firm. For temporary workers, it allows to exceed the maximum of 8 hours of the workday and constrains the amount of hourly workers.

- **2000: Promotion of Investment and Citizen Participation (Promoción De La Inversin Y Participación Ciudadana).**
  Repeals section of the Labour Code which permitted the holding of Collective Bargaining Agreement when there is an association of more than 30 workers. Regulates strikes, and facilitates layoffs. Workers who provide services for contractors or intermediaries, are entitled to share in the profits (art. 174).

- **2003: Reform of Art. 113 of the Labour Law (Reformatoria del artculo 113 del Código de Trabajo).**
  Establishes the mandatory payment of a 14th salary to workers (a bonus salary).

- **2004: Labour Disputes (Ley núm. 2004-29 reformatoria de la Ley núm. 2003-13).**
  Establishes oral trials for resolution of individual labour disputes, effective July 1, 2004.

Sources: Aguiar (2007); NATLEX Database, International Labor Organization.

Table 2: Classification of Industries based on two-digit International SIC

ISIC	Industries	Proportion of Observations	Proportion of Firms
15	Food products and beverages	0.33	0.34
16	Tobacco products	0.00	0.00
17	Textiles	0.09	0.09
18	Wearing apparel; dressing and dyeing of fur	0.10	0.10
19	Tanning and leather products	0.04	0.04
23	Coke, refined petroleum products and nuclear fuel	0.00	0.00
24	Chemicals and chemical products	0.09	0.09
25	Rubber and plastics products	0.11	0.11
26	Other non-metallic mineral products	0.08	0.08
27	Manufacture of basic metals	0.01	0.02
28	Fabricated metal products	0.06	0.06
36	Furniture; manufacturing n.e.c.	0.09	0.09

Note: An observation refers to values reported by a unique firm in a particular year. Since our study period is from 1998 to 2007, there can be at most nine observations associated with a particular firm.

Table 3: Descriptive Statistics

Year	N	l	k	k/l	y	y/l	y/k
1998	1043	33	201.846	5.858	132.632	3.774	0.692
1999	952	33	158.570	4.579	114.424	3.237	0.823
2000	950	34	115.899	2.938	128.561	3.227	1.155
2001	952	34.5	164.355	4.179	167.333	4.311	1.049
2002	950	36	172.760	4.398	174.840	4.853	1.106
2003	956	35	176.788	4.694	196.821	5.303	1.145
2004	992	33.5	167.323	4.496	194.254	5.500	1.241
2005	977	33	150.189	4.031	187.577	5.329	1.383
2006	980	35	153.223	3.759	202.343	5.408	1.469
2007	1034	35	152.900	3.820	203.217	5.291	1.431

Note: N is the number of observations, y is median value-added output, l is median number of workers, k is median capital level, y/l is median labour productivity, y/k is median output-capital ratio, k/l is median capital per worker. All monetary values are expressed in thousands of US dollars in year 2000 value.

Table 4: Entry and Exit Rates

Year	1999	2000	2001	2002	2003	2004	2005	2006	2007
E Rate	0.039	0.055	0.080	0.078	0.090	0.131	0.055	0.062	0.119
X Rate	0.130	0.064	0.077	0.074	0.088	0.089	0.072	0.059	0.083

Note: Entry (E) rate and exit (X) rate are expressed as fractions of the average number of firms at time t and $t-1$. There is a small fraction of firms that temporarily exits and later re-enters the sample. For these firms, only the first entry and final exit are included in the calculation of entry and exit rates, respectively.

Table 5: Labour Reallocation Patterns

Year	1999	2000	2001	2002	2003	2004	2005	2006	2007
JC	0.118	0.181	0.194	0.167	0.126	0.140	0.130	0.134	0.141
by E	0.028	0.040	0.047	0.038	0.053	0.062	0.032	0.035	0.052
by I	0.090	0.142	0.147	0.129	0.072	0.078	0.098	0.099	0.089
JD	0.200	0.103	0.101	0.105	0.174	0.094	0.071	0.081	0.115
by X	0.092	0.042	0.045	0.035	0.063	0.034	0.030	0.019	0.065
by I	0.108	0.061	0.056	0.070	0.111	0.060	0.041	0.063	0.050
JR	0.318	0.285	0.295	0.272	0.300	0.234	0.200	0.215	0.256
l of E	25	28.5	21.5	22.5	29	23	17	28.5	22
l of X	21	19	19	22	15	21	16	16	22

Note: Job creation (JC) is defined as the sum of new jobs at new entrants (E) and incumbent firms (I). Job destruction (JD) is defined as the sum of all lost jobs at exitors (X) and incumbent firms (I). Job reallocation (JR) refers to the sum of job created and job destructed. JC, JD, and JR are expressed as fractions of the average employment at time t and $t-1$. Size of l is the median employment (in number of workers).

Table 6: Capital Reallocation Patterns

Year	1999	2000	2001	2002	2003	2004	2005	2006	2007
KC	0.124	0.129	0.365	0.096	0.107	0.091	0.053	0.099	0.150
by E	0.047	0.060	0.072	0.032	0.046	0.052	0.018	0.031	0.052
by I	0.077	0.069	0.293	0.065	0.061	0.039	0.035	0.068	0.098
KD	0.346	0.314	0.105	0.131	0.132	0.138	0.164	0.109	0.114
by X	0.094	0.032	0.092	0.042	0.038	0.039	0.038	0.020	0.066
by I	0.251	0.282	0.013	0.089	0.094	0.099	0.126	0.089	0.047
KR	0.470	0.443	0.470	0.228	0.240	0.229	0.217	0.208	0.264
k of E	99.227	56.040	67.635	104.258	136.010	117.382	80.077	105.506	150.703
k of X	128.206	40.768	55.398	59.330	66.409	85.497	108.255	59.006	81.794
k/l of E	2.961	3.244	3.046	3.291	4.152	4.367	3.422	3.922	4.617
k/l of X	6.198	1.971	3.289	3.224	3.829	4.234	4.433	2.838	3.553

Note: Capital creation (KC) is defined as the sum of additional capital used by new entrants (E) and incumbent firms (I). Capital destruction (KD) is defined as the sum of all decreases in capital at exitors (X) and incumbent firms (I). Capital reallocation (KR) refers to the sum of job created and job destructed. KC, KD, and KR are expressed as fractions of the average capital level at time t and $t-1$. Size of k is median firm capital. All monetary terms are measured in thousands of US dollars.

Table 7: Production Function Estimates

$\widehat{\alpha}$ (capital)	0.1497
	(0.0068)***
$\widehat{\gamma}$ (labour)	0.5708
	(0.0133)***
Constant	1.7763
	(0.1660)***
Firm-level σ_c	0.9033
Random σ_ϵ	0.3580
$\rho(c_i, X_i)$	0.8642

Note: The number of firm and total observations are 1699 and 9786, respectively. Standard errors are in parentheses. *, **, and *** is the statistical significance at the 10%, 5% and 1% levels, respectively. Firm-level variance is σ_c while Random σ_ϵ is the idiosyncratic random error term. $\rho(c_i, X_i)$ is the correlation between the fixed effect and the observables. Coefficients of the industry and time dummies are also estimated but not reported here. They are available upon request.

Table 8: Distortions on Factor Inputs (Domar Weighted)

	τ^L			τ^K		
Year	< 0	≥ 0	FPos	< 0	≥ 0	FPos
1998	-0.212	1.277	0.907	-0.814	0.557	0.036
1999	-0.223	1.717	0.953	-0.544	0.484	0.212
2000	-0.149	2.386	0.978	-0.484	0.783	0.344
2001	-0.133	1.583	0.940	-0.425	0.988	0.267
2002	-0.148	1.301	0.959	-0.437	0.479	0.401
2003	-0.129	1.479	0.964	-0.415	0.586	0.613
2004	-0.125	1.731	0.967	-0.237	1.035	0.762
2005	-0.084	1.738	0.974	-0.289	1.088	0.834
2006	-0.103	1.899	0.988	-0.163	1.179	0.868
2007	-0.102	1.872	0.983	-0.274	1.015	0.765
Average	-0.141	1.699	0.961	-0.408	0.819	0.510
Std. Dev.	0.045	0.324	0.024	0.186	0.272	0.295

Note: If $\tau^n > 0$ for $n = K, L$, then the firm faces a distortionary tax for using input n. On the contrary, if $\tau^n < 0$, the firm is receiving a subsidy for input n. FPos is the fraction of firms that face a positive distortionary tax.

Table 9: Test of Equality of Probability Density Functions: Capital & Labour Distortion Taxes

$t \backslash s$	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
1998	.	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
1999	0.000	.	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2000	0.000	0.000	.	0.401	0.296	0.000	0.000	0.000	0.000	0.000
2001	0.000	0.130	0.000	.	0.238	0.000	0.000	0.000	0.000	0.000
2002	0.000	0.000	0.000	0.050	.	0.000	0.000	0.000	0.000	0.000
2003	0.000	0.000	0.000	0.003	0.707	.	0.000	0.000	0.000	0.000
2004	0.000	0.000	0.000	0.000	0.005	0.125	.	0.078	0.015	0.822
2005	0.000	0.000	0.000	0.000	0.000	0.000	0.278	.	0.825	0.003
2006	0.000	0.000	0.000	0.000	0.000	0.000	0.003	0.163	.	0.000
2007	0.000	0.000	0.000	0.000	0.000	0.000	0.013	0.361	0.759	.

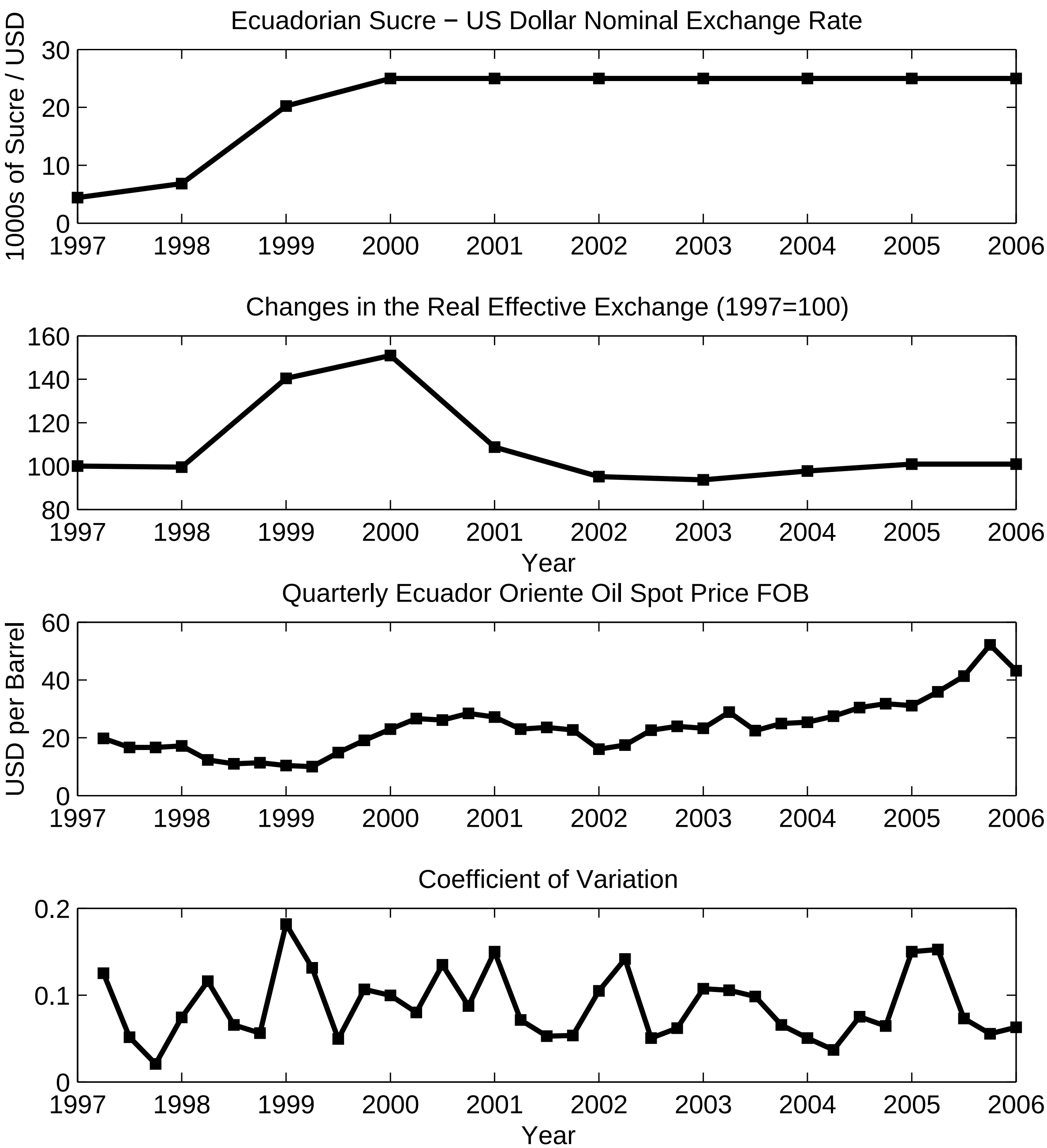
Note: p-values based on 399 bootstrap replications of Li, Maasoumi, and Racine's (2009) test statistics for $H_0 : f_t = f_s$ almost surely, where f represents the probability density function of the log of capital distortion tax (upper triangular section), and the log of labour distortion tax (lower triangular section).

Table 10: Aggregate Productivity Growth (APG) Decomposition

						APG_{RE}			APG_{NE}		
Year	ΔY	ΔL	ΔK	APG	TE	Labour	Capital	Total	Entry	Exit	Net
1999	-0.188	-0.032	-0.219	0.063	-0.073	-0.005	0.104	0.099	0.016	-0.022	0.038
2000	0.111	0.018	-0.063	0.156	0.095	0.025	0.029	0.054	0.013	0.006	0.007
2001	0.213	0.030	0.065	0.119	0.119	0.030	-0.020	0.010	0.010	0.021	-0.010
2002	0.123	0.014	-0.010	0.119	0.087	0.025	0.009	0.034	0.007	0.009	-0.002
2003	0.095	-0.009	-0.008	0.111	0.104	-0.005	0.007	0.002	0.017	0.012	0.005
2004	0.016	0.013	-0.009	0.012	-0.018	0.012	0.005	0.016	0.030	0.017	0.014
2005	0.019	0.011	-0.012	0.019	0.008	0.016	-0.001	0.015	0.013	0.016	-0.004
2006	0.121	0.017	-0.001	0.105	0.081	0.019	-0.003	0.017	0.015	0.008	0.008
2007	0.022	0.006	0.005	0.011	-0.005	0.017	0.004	0.021	0.029	0.034	-0.005
Average	0.059	0.007	-0.028	0.080	0.044	0.015	0.015	0.030	0.017	0.011	0.006
Std. Dev.	0.113	0.018	0.079	0.054	0.067	0.013	0.036	0.030	0.008	0.015	0.014

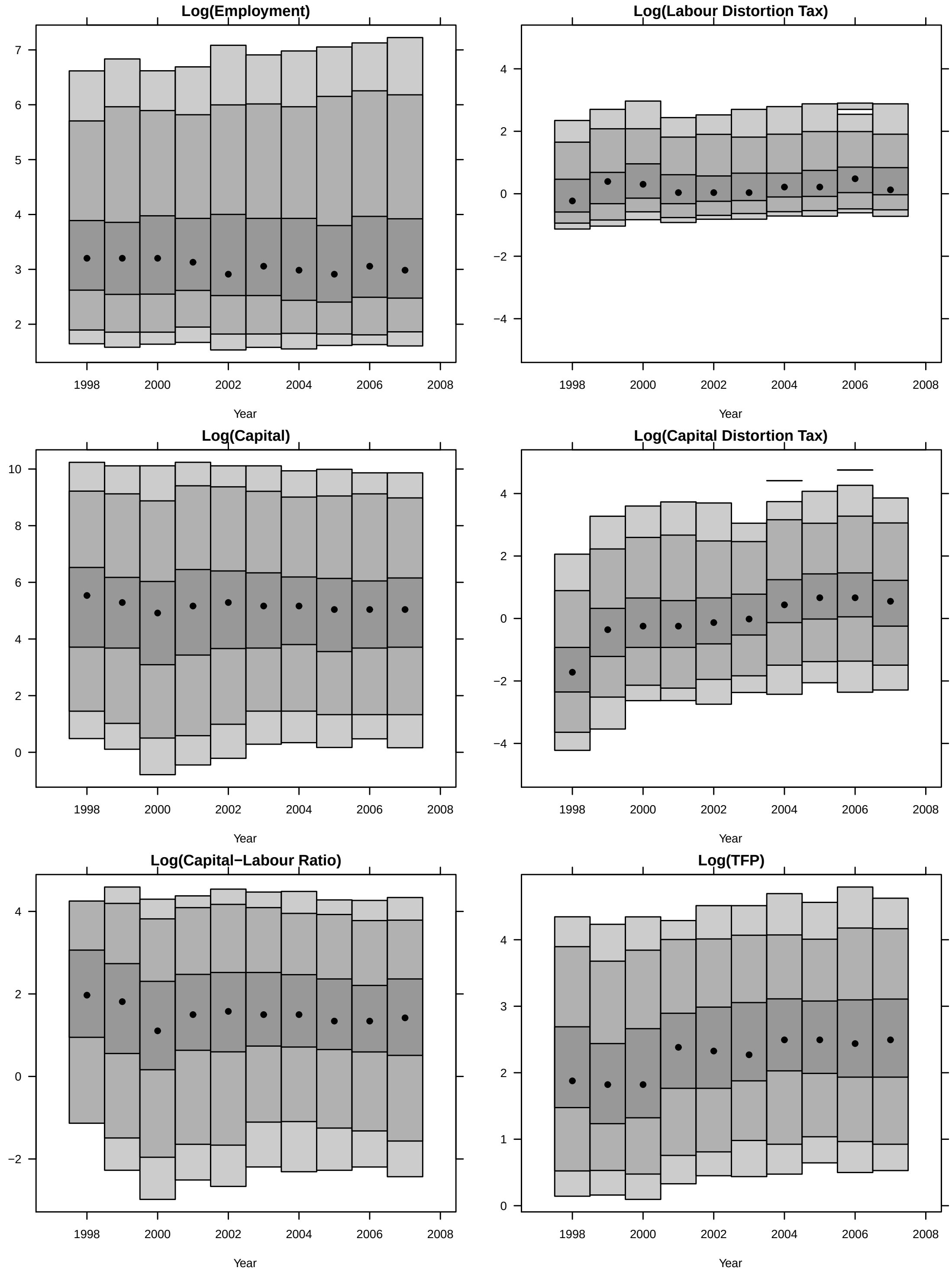
Note: ΔY is output growth while ΔL and ΔK refer to labour's and capital's respective contribution to ΔY. TE refers to technical efficiency, APG_{RE} is the Reallocation term, and APG_{NE} is the effect of Net Entry, which is Entry minus Exit. The TE and APG_{RE} terms are estimated from the production function via a Fixed-Effects (FE) model.

Figure 1: Ecuadorian Sucre-US Dollar Exchange Rate and Oil Prices



Note: Data on Sucre-US dollar exchange rate comes from the World Development Index. Changes in the real effective exchange rate is relative to the real effective exchange rate in 1997. Data on the quarterly oil prices is obtained from the U.S. Energy Information Administration. We calculated the standard deviation of the oil price within the quarter of interest, and then calculated the coefficient of variation.

Figure 2: Distributions of Size, Productivity, and Distortions



Note: Bandwidths chosen by Silverman's rule-of-thumb with a second-order gaussian kernel. The graph displays "highest density regions," i.e. the smallest region of the sample space containing 50% (darkest gray), 95% (medium gray), and 99% (lightest gray) probabilities (Hyndman, 1996). This graph also marks (by •) the empirical modes for each estimated density. Distortion taxes are expressed in gross terms, i.e. $\log(1+\tau^n)$.