What is the Impact of Increased Business Competition? *

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Abstract

This paper studies the impact of a structural reform that reduces entry costs for firms. We provide novel empirical evidence on the response of firms' entry, employment, and exit behavior. To do so, we use as a natural experiment a reform in Portugal that significantly reduced entry time and costs. We find that the reform had an expansionary impact: firm entry and employment increased by 25% and 4% per year, respectively. Moreover, around 60% of the increase in employment came from incumbent firms expanding their size, with most of the rise occurring among the firms that were the most productive before the reform. Standard models of entry, exit, and firm dynamics, which assume a constant elasticity of substitution, are inconsistent with our findings about the heterogeneous response of incumbents to the reform. We show that a model with heterogeneous firms and variable markups accounts for our evidence. In this framework, the most productive firms face a lower demand elasticity and increase their employment in response to the entry of new firms.

1   Introduction

Business competition is a fundamental driver of productivity and output growth. This view underlies a host of recent structural reforms aimed at increasing competition in the business sector. Such policies may include the removal of artificial restrictions on firm entry or on output-capacity constraints, as well as the reduction in bureaucratic costs associated with creating or expanding businesses.

Increased business competition, however, may entail some costs. The downsizing or exit of less efficient firms may lead to significant job destruction. To the extent that the costs of disruptive forces manifest earlier than the benefits from increased entry, the reform may exacerbate or induce a short-run recession. Because of potential large short-run costs, implementing structural reforms may not be politically feasible.

There is limited empirical evidence regarding the effects of structural reforms that aim at fostering competition. This is because empirical work on these issues faces important identification challenges. First, firms' entry, hiring, and investment decisions are endogenous in nature and depend on the state of the economy (Lee and Mukoyama 2008; Bilbiie et al. 2012). Second, reforms may be implemented in response to poor economic performance. So it is hard to distinguish between the dynamics triggered by a structural reform and other macroeconomic forces affecting the economy.

This paper makes both an empirical and a theoretical contribution to this question. We study the effects of a structural reform that was implemented in Portugal starting in 2005. This reform reduced the bureaucratic and monetary costs required to start a business, drastically decreasing entry costs for firms. To identify the causal response to the reform, we exploit its staggered implementation across municipalities over time. We ask three specific questions: (i) Did the reform lead to a significant change in firm entry and exit? (ii) What was the effect of the reform on aggregate employment at the municipality level? (iii) What are the micro mechanisms underlying the observed response of aggregate employment?

Our main empirical results can be summarized as follows. We study the first three years after the approval of the reform and find that it had an expansionary effect: entry and employment in reformed municipalities increased by 25% and 4% per year, respectively. Moreover, around 60% of the increase in employment came from incumbent firms expanding their size, with most of the rise occurring among the firms that were the most productive before the reform.

In the second part of the paper, we present a theoretical framework to compare our empirical findings with the predictions of models featuring heterogeneous firms and monopolistic competition. We find that standard models, which assume a constant elasticity of substitution, are inconsistent with the observed response of incumbents to the reform. We then show that a model with heterogeneous firms and variable markups is consistent with

our evidence. Key features of the model are that the elasticity of substitution between goods increases with the number of available firms, and that the demand elasticity of each firm decreases with its level of productivity. In such environment, the most productive incumbents increase their employment following a rise in firm entry.

Our empirical analysis uses the Portuguese reform as a natural experiment. The reform was called Empresa na Hora, which means "Business On the Spot". Before the reform, Portugal was ranked 113th out of 155 countries in the "Doing Business Index" of the World Bank. It would take between 54 to 78 days to complete the required bureaucracy to start a new business (Leitão Marques, 2007). After the reform, registering a new business took less than an hour and could be accomplished at one specific office, called One-Stop Shop. Total monetary costs to register a new business fell as well, from 2,000 to 360 euro. Because of the reform, Portugal moved to the 33rd position in the ranking of the World Bank (see Branstetter et al., 2014).

A key feature of the reform is that it was implemented gradually across the country. That is, One-Stop Shops opened over different years in the various municipalities. This was due to constraints on the availability of office space and trained public servants. The staggered implementation of the reform allows us to adopt a generalized difference-in-differences strategy to identify its effects. In particular, we compare the evolution of firm entry, exit, and employment across municipalities with and without the One-Stop Shop in the years preceding and following the opening of the office.

One concern in such empirical setting is that municipalities with the One-Stop Shop were chosen based on past or expected economic performance. If that is the case, it would not be possible to identify the effect of the reform. Our identification assumption, instead, is that the Portuguese municipalities did not follow different trends before the reform (i.e., parallel-trend assumption). We assess the plausibility of this assumption by studying the dynamics of entry, exit, and employment in the years preceding the approval of the reform, which happened in 2005. Our results show no evidence of divergent trends in the pre-reform period.

Our empirical analysis uses administrative firm-level data from Portugal on the population of limited-liability employer firms, i.e., firms with at least one employee. This dataset contains detailed information on the year of incorporation, sector of activity up to 5 digits, location at the municipality level, annual turnover, and employment. We complement these data with publicly-available information on the dates when the One-Stop Shops were opened in the different municipalities. Our dataset covers the years 2000-2008.

The first part of our empirical analysis studies the impact of the reform on firm entry. We show that the reform significantly increased entry and that the effect does not fade away within the first three years of the implementation of the reform. In municipalities with the

One-Stop Shop, we find that the reform increased firm entry by 25% per year. Moreover, we show that there was no systematic difference in the evolution of entry over time across reformed and non-reformed municipalities before the opening of the One-Stop Shop. The entry rate of limited-liability firms in Portugal averages around 8.5%, so the reform increased annual entry rate by approximately 2 percentage points.

We then study the behavior of aggregate employment at the municipality-level. We find that, due to the reform, local employment increased on average by 4% per year. That is, the short-run impact of the reform was expansionary.

In the last part of the empirical analysis, we explore the mechanisms underlying the observed increase in employment. We study how much of the increase is due to incumbents, and whether the response was heterogeneous across them. To study the average response of entrants and incumbents, we divide the sample into different age groups of firms (0-5, 6-15, and older than 15). We find that total employment increased across all age groups. More importantly, we measure that 60% of the increase is coming from older incumbents, i.e., those older than 5 years. In addition, we find that the increase in employment by older incumbents came from the *intensive margin*. That is, an expansion in their average size rather than a substantial reduction in their exit rates. On the other hand, we find that the increase in employment by entrants and younger firms was entirely driven by the *extensive margin*. That is, by the higher number of firms in this group. In fact, we do not see a significant change in the average size of entrants and young firms, or in their exit probability.

To study the heterogeneous response of incumbents, we divide the sample according to firms' sales per employee prior to the reform (a proxy for labor productivity). Specifically, we classify firms based on their productivity in 2004, the year preceding the implementation of the reform. We then compare the evolution of employment for firms that were in the top and bottom tercile of the productivity distribution in 2004. We find that only high productivity firms (i.e., firms belonging to the top tercile in 2004) expanded their workforce. We also find that exit decreased for the most productive firms, while it remained unchanged for those in the bottom tercile.

Having established our empirical results, we turn to a theoretical analysis of the reform. We first present a general framework of heterogeneous firms and monopolistic competition in general equilibrium. Our framework nests a variety of models used in the literature on firm dynamics. In particular, we compare the predictions of the model under the assumption of constant elasticity of substitution across goods and under variable elasticity. The former is the standard CES model, which features constant markups. For the latter, we consider the symmetric translog demand model proposed by Feenstra (2003). In this model, a rise in the number of operating firms leads to an increase in the elasticity of substitution across goods, and so a decrease in markups.

We show that, under standard calibration of the CES model, an increase in the mass of operating firms drives down employment at all firms. Moreover, the fall in employment is of the same magnitude for all firms, regardless of productivity. This is because, following a decrease in the aggregate price level, the relative price of each firm increases by the same amount. As a consequence, they all face a homogeneous fall in demand. These facts are inconsistent with our empirical evidence.

We then study the model with translog demand. The interaction of variable elasticity with heterogeneous firms delivers new predictions on the aggregate impact of the reform and on the underlying channels. The model shows that the impact of the reform on firms' labor demand depends on their productivity. In particular, more productive firms expand their employment. The intuition for why this happens is as follows. A rise in the measure of firms is similar to a homogeneous increase in the relative price of all firms. However, because more productive firms face a lower demand elasticity, their demand goes down by less. As the economy is expanding at the same time due to increased entry, the most productive firms end up hiring more workers. This heterogeneous response of firms is consistent with our empirical evidence.

The translog model also implies that firm heterogeneity matters for the aggregate response of the economy to the reform. The model predicts that higher productivity dispersion amplifies the expansionary impact of the reform. Due to markup dispersion in the translog model, the economy suffers from production misallocation. The reform leads to reallocation of production resources towards the more productive firms, resulting in higher output. The higher the initial dispersion of productivity in the economy is, the stronger this reallocation channel will be.

Related Literature. This paper is related to two strands of literature in macroeconomics on structural reforms and firm dynamics. In addition, the empirical part connects to an applied literature on entrepreneurship.

The seminal paper in the structural reform literature is Blanchard and Giavazzi (2003), which presents a theoretical framework to study the macroeconomic impact of a reduction in entry costs. Building on those insights, a more recent literature has characterized the effects of a reduction in entry costs in the context of quantitative general equilibrium macro models, given the identification challenges faced by empirical work on this topic.[1] While differing in the specification of the model and in the proposed channels, the majority of papers in this

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[1]Empirical contributions on this topic are based on macroeconometric models that mostly exploit cross-country variation in the aggregate index of product-market deregulation provided by the OECD. Other work uses national/sectorial reform shocks identified via narrative analysis, (see for instance Bouis et al. 2016; Duval and Furceri 2018). These analyses find that benefits from the product market reform materialize slowly and have no relevant short-run effects.

literature argued that a fall in entry costs leads to a decrease in the size of all incumbent firms and contractionary short-run aggregate dynamics.

Specifically, a strand of research has investigated structural reforms in a New Keynesian economy with a representative firm and binding Zero Lower Bound constraint on monetary policy (Eggertsson 2012; Eggertsson et al. 2014). In this framework, structural reforms are recessionary, because they lead to lower prices and higher real interest rates. This rise induces households to postpone consumption (via the so-called *substitution effect*), which leads to a contraction in aggregate output. We share with these models a setting with exogenous and fixed interest rate. However, our analysis highlights expansionary forces associated with the reform that are not supportive of the "substitution effect" and that are not captured by a representative firm framework.

A second strand of literature is based on models with endogenous producer entry, a representative firm and translog demand function for goods, building on the framework developed by Bilbiie et al. (2012). Cacciatore and Fiori (2016) extended the latter by including capital adjustment costs and search frictions in the labor market.[2] Adjustment costs imply that it takes time for entrants to grow, while they induce incumbent firms to immediately start contracting their scale. In their model the reform leads to a short-run recession. However, a homogeneous contraction in output is inconsistent with the results of our empirical analysis.

Our evidence on the heterogeneity of the responses of incumbent firms based on their idiosyncratic productivity is in line with the predictions in Aghion et al. 2005, 2009; Gutiérrez and Philippon 2017. The authors, however, focused on innovation or capital investment, while our focus is on labor demand. Moreover, their explanation for heterogeneity relied on monopolistic market structure and strategic behavior, while we consider markets with a mass of atomistic firms.

By including firm heterogeneity, we connect to a vast literature on firm dynamics. This literature builds on the work by Hopenhayn (1992) and Melitz (2003), and focuses on role of entrants and incumbents in shaping aggregate dynamics (see for instance Lee and Mukoyama 2008; Clementi and Palazzo 2016). Relative to these papers, we show empirically and theoretically that firm heterogeneity and CES demand are not sufficient to deliver responses in line with our empirical evidence.

Another strand of the literature investigated the impact of the decline in firm formation in the aftermath of the financial crisis (see for instance Sedlácek 2014; Gourio et al. 2016). A key takeaway from these works is that the role of entrants is minimal in the short-run, while it increases over time as new firms grow. We complement this work by providing causal

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[2]Related papers, which add New Keynesian features, are Cacciatore et al. (2016) and Cacciatore et al. (2017).

evidence on the fact that entry matters also in the short-run, mostly because of its impact on incumbents.

Finally, our empirical analysis connects to a broad literature in applied microeconomics in the field of barriers to entry and entrepreneurship (see for instance Betrand and Kramarz 2002; Viviano 2008; Hombert et al. 2014). Papers by Kaplan et al. (2011) and Branstetter et al. (2014) are the closest to our empirical work, as they exploit the staggered implementation of an entry deregulation reform to study its impact on firm creation. Branstetter et al. (2014), in particular, studied Empresa na Hora as well. While we share with this paper the idea of exploiting the staggered opening of One-Stop Shops across the Portuguese municipalities, we depart from this work both in terms of research questions and empirical methodology. Their research aims at characterizing entrants and testing models of occupational choice, while our focus is on characterizing the response of firms and macro aggregates to the structural reform.

Outline. The remainder of the paper is organized as follows. Section 2 describes Empresa na Hora and the Portuguese data. Section 3 discusses the empirical analysis, focusing both on the empirical methodology and the results. Section 4 presents the theoretical analysis. Section 5 concludes.

2   Institutional Setting and Data

In this section we provide an overview of the background on which we build our empirical analysis. We start by describing Empresa na Hora, in its institutional details and in the context of the Portuguese economy. We then describe our dataset and provide some statistics concerning the business sector in Portugal.

2.1   Portugal and the Empresa na Hora Reform

After joining the European Monetary Union in 1999, Portugal entered a prolonged slump, with anemic productivity and economic growth (Blanchard, 2007). When a country with relevant structural weaknesses like Portugal loses control of its monetary policy and exchange rate, the call for structural reforms becomes even more compelling. In 2005, it took 56-78 days to start a business, making it slower than the Democratic Republic of Congo, as documented by Leitão Marques (2007). An entrepreneur needed to fill in around 20 forms, provided by different public agencies, and complete 11 procedures, for a total cost of €2, 000.

From February 2005 to May 2005 a cross-departmental task force, called *Unidade de Coordenação da Modernazição Administrativa* (UCMA), designed and managed a broad plan of modernization and simplification of public services for both citizens and businesses. The

plan was called SIMPLEX and covered areas such as digitalization of income tax declaration, simplification of immigration admission procedures, and approval of licenses and permits for different industrial and retail activities.

The reform that we are studying, which was called Empresa na Hora, was a relevant part of this broader plan and was aimed at significantly reducing both time and monetary costs of starting a business. The program made it possible to start a business "on the spot", by means of a single personal visit to an official Registry. UCMA designed standardized pre-approved documents created on pre-defined firm names.[3] Within an hour, on average, an entrepreneur receives an official legal person identification card, a Social Security number and a registration of the enterprise in the Business Registry. Monetary costs shrunk to €360, making this procedure among the cheapest in Europe. The law was approved on July 6th, 2005 (*Decreto Lei 111/2005*). The SIMPLEX package, and Empresa na Hora in particular, were intensively advertised by the government. International institutions strongly supported the initiative. Accordingly, Branstetter et al. (2014) report that the European Commission selected Portugal for the European Enterprise Award in 2006. The country also moved from the 113th position (out of 155 countries) in the Doing Business Index of the World Bank to the 33rd.

There are several features of the program that require a deeper discussion, since they will be key for the identification strategy. First, the program was implemented in a staggered fashion across the different municipalities. This was mostly due to budget constraints and the need to assess the program and train public servants. As soon as the *Decreto Lei* was approved in July 2005, six One-Stop Shops were opened in four different cities: Coimbra, Aveiro, Moita and Barreiro. Over the following years the program gradually expanded across the country. Table 2 is taken from Branstetter et al. (2014) and describes the timing of the opening of the One-Stop Shops across Portugal. Out of the 308 municipalities, 164 had a One-Stop Shop by the end of 2009. Figure 3 shows the pattern of the opening of One-Stop Shops in a map of the country.

A second feature of the program is that a firm was allowed to register in any One-Stop Shop, regardless of the location of the company. In our empirical exercise, however, we assume that firms registered in the same municipality in which they were operating. Conversations with public officials reassured us that the relevant coverage of each One-Stop Shops was local, so that the number of new firms registered in a One-Stop Shop in a given municipality and year provides a good approximation of the number of new firms in the same municipality and year. Nevertheless, as we will argue in details in our discussion on identification (see Section 3.1), this aspect would, if anything, bias our estimates on the

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[3]Note, however, that it is possible for an entrepreneur to request a personalized name for the business and have all documents ready withing two business days.

expansionary effect of the reform downwards.

2.1.1   Implementation of Empresa na Hora

Our identification strategy exploits the timing of the opening of the One-Stop Shops in each municipality. While we postpone the detailed description of our identification strategy to Section 3.1, it is key to understand whether the municipalities were chosen according to some criteria.

As we described in the previous section, the reform was implemented gradually because of constraints in the availability of both trained public officials to run the program and physical venues. This is why One-Stop-Shops generally took advantage of pre-existing Trade Registry Offices and Business Formality Centers (Branstetter et al., 2014).

However, conversations with public officials revealed that the most populated municipalities were chosen earlier to maximize the aggregate impact of the reform. Otherwise, municipalities were chosen according to physical availability. In particular, municipalities were not chosen due to past or expected future economic activity. We explore this in greater detail in Section 3.1.

In Table 3 we provide the summary statistics of the Portuguese municipalities organized in four partitions. In columns (1) and (2) we summarize the information on *Treated* relative to *Never-Treated* municipalities. We consider as *Treated* those municipalities in which a One-Stop Shop opened by the end of 2008. Columns (3) and (4) refer to the *Early-Treated* and *Late-Treated* municipalities. We define the former as all those municipalities in which a One-Stop Shop opened in 2005-2006. The Table characterizes the different municipality groups according to measures of firm demographics, aggregate macroeconomic characteristics and the sector composition of economic activity. It provides the mean and standard deviation of each variable, as well as the 25th and 75th percentiles. We notice that the different municipality groups did not significantly differ from each other in the pre-reform period. The standard deviations are indeed very high. This is due to the fact that there is strong heterogeneity across the municipalities within each group. While municipalities in different groups had similar 25th and 75th percentile, the gaps between the two are wide.

Looking at the means, we see that the different groups have, on average, entry rates between 7.9-9.4%, exit rates around 8.5% and between 8.3 and 12 active firms per 1,000 residents. However, *Treated* and *Early-Treated* municipalities have higher average employment rates, sales per capita, and average number of residents. The latter is particularly noticeable, given that *Never-Treated* municipalities have, on average, a third of the resident population of the *Treated* ones. Relative to the sectoral composition of activity, *Treated* municipalities are characterized by a more service-oriented economy.

2.2 Data and Summary Statistics

Our analysis mainly relies on one dataset with detailed administrative records on the universe of limited-liability firms with at least one employee in Portugal. We cover the years 2000-2008. The dataset is called Quadros de Pessoal and is built from a census submitted each year in October. The dataset is managed by the Portuguese Ministry of Employment and Social Security and provides information at the firm, establishment, and worker level. In this project we use annual information on firms' entry, exit, sector of activity (provided at the 5-digit level), location at the municipality level, annual nominal sales, and employment. This choice is justified by the fact that Empresa na Hora concerned the creation of new firms rather than the opening of establishments. Moreover, while it is true that the opening of an establishment may change local competition and affect our estimates, over 93% of firms in Portugal have only one establishment.

While the reform was approved in 2005, the time coverage of our dataset allows us to include pre-period observations and inspect the presence of pre-period trends that may harm the validity of our analysis. Our sample ends in 2008 as there was a drop in the coverage of the Quadros in the following years. As a consequence, we can measure the impact of the reform during the first three years of implementation. However, since the reform was implemented gradually, we are not able to track all reformed municipalities for the same number of years after the opening of the One-Stop Shop.

We exploit the panel structure of the dataset to construct a measure of firm exit. In particular, we define as exit the case in which a firm stops appearing in our dataset for at least two consecutive years.[4] As mergers and acquisitions play a very marginal role in Portugal, we are confident about our measure.

Our final dataset has, on average, 125,000 non-financial private corporations per year, spanning all sectors of the economy, except for Mining, Electricity, Gas and Water, and Insurance. Table 4 in the Appendix provides the relevant summary statistics for the non-financial employer firms in our dataset. In the sampling period, the average entry rate is 7.5% and exit rate is 9.5%. Information on the size distribution across firms reveals that the Portuguese business sector is mostly characterized by very small enterprises: 50% of firms have less than 4 employees and 50% of entrants have less than 2.

We complement the Quadros de Pessoal with other publicly available datasets. The first is provided by the Instituto dos Registos e Notariado, equivalent to the Portuguese Business Registry, and contains the exact opening date of each One-Stop Shop across the Portuguese municipalities. The second is provided by the Instituto Nacional de Estatística and includes municipality-level data on total residents and more detailed local demographic information.

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[4]This method is equivalent to define exit as the last time a firm appeared in the dataset for more than 97% of the cases.

3 Empirical Analysis

In this section, we describe the methodology and the results of the reduced-form analysis. The goal of our empirical exercise is twofold. First, we study the effect of the reform on the entry behavior of firms and aggregate employment. Second, we uncover the micro channels underlying our results on aggregate employment.

We start by explaining the identification strategy (Section 3.1). We then present the regression equations used to measure the impact of the reform on firm creation and we show the results (Section 3.2). We use the same model to study the dynamics of local employment (Section 3.3). Next, we move to the analysis of the underlying channels. In particular, we study the contribution of younger firms and older incumbents to the observed aggregate response of employment (Section 3.4.1, 3.4.2 and 3.4.3). We then explore the role of incumbents heterogeneity (Section 3.4.4). Last, we present more disaggregated evidence at the level of the sector of economic activity (Section 3.5).

3.1 Empirical Specification and Identification

To study the impact of the reform, we exploit Empresa na Hora as a natural experiment. We use a dynamic difference-in-differences specification that uses the staggered opening of the One-Stop Shops over the Portuguese municipalities. In most of our specifications, our unit of analysis is a municipality in a given year. More specifically, we study the following regression:

$$y_{m,t} = \alpha_m + \delta_t + \sum_\tau \beta_\tau \mathbb{1}(t - \tau_{0,m} = \tau) + \gamma X_{m,t} + \epsilon_{m,t}. \tag{1}$$

In this regression, α_m and δ_t are the municipality and year fixed effects; $X_{m,t}$ is a vector of controls, which we will discuss in more detail in Section 3.2, $\epsilon_{m,t}$ is an error term with the usual statistical properties. Importantly, $\mathbb{1}(t - \tau_{0,m} = \tau)$ is a municipality-specific dummy that equals 1 whenever municipality m is τ years following the reform. A negative value for τ corresponds to the years preceding the reform. Because of the staggered implementation of the reform, the year of the opening of the local One-Stop Shop varies by municipality, i.e., $\tau_{0,m}$ varies with m. Thus, β_τ measures the average treatment effect for each time lag and lead relative to the year of the reform. In particular, β_τ captures the following variation:

$$\beta_\tau = \underbrace{E\left[y_{(\tau)}^{\text{treated}} - y_{(-1)}^{treated}\right]}_{\text{treated municipalities}} - \underbrace{E\left[y_{(\tau)}^{\text{control}} - y_{(-1)}^{control}\right]}_{\text{control municipalities}}$$

where (-1) denotes the year before the opening of the One-Stop Shop in each *Treated* municipality.

The key identification assumption is that the variation in the variable of interest at the municipality level for each year after the opening of the One-Stop Shop is only due to the reform. This is the *"parallel-trend assumption"*. In other words, the identification assumption is that all the unobserved determinants of the outcome, as reflected in the residual, evolve in parallel over time for the different municipalities. Identification assumptions are inherently not testable, as they refer to unobserved scenarios. However, since our dataset includes the 5-year period before the approval of the reform, our regression model can explicitly account for each time lag relative to the reform. This allows us to test for the presence of differential trends among the observables of the *Treated* and *Control* municipalities. Ideally, we expect non-statistically significant coefficients for the years preceding the reform and statistically significant coefficients afterwards. As we show in the next sections, there is no trend in the periods leading to the reform. This reassures us that municipalities do not have differential trends over the observables across the treated and control groups.

3.2 Analysis of Entry

We now show how Empresa na Hora affected firm creation. To do so, we construct our dependent variable, $y_{m,t}$ by aggregating the number of entrants in each municipality and year and scaling it per 1,000 residents. This provides a more homogeneous measure of entry across the different municipalities. Following the description of our identification strategy, our main regression equation is

$$y_{m,t} = \alpha_m + \delta_t + \sum_{\tau=-7}^{\tau=3} \beta_\tau \mathbb{1}(t - \tau_{0,m} = \tau) + \gamma_m \mathbb{1}(\text{Municipality}_m = 1)t + \epsilon_{m,t}. \qquad (2)$$

In this regression, α_m and δ_t are municipality and year fixed effects respectively. The indicator $\mathbb{1}(t - \tau_{0,m} = \tau)$ refers to the time lag or lead of the reform for each municipality. In our benchmark regression, we allow for municipality-specific trends, that is, we let our vector of controls in equation (1) - $X_{m,t}$ - be defined as $X_{m,t} \equiv \mathbb{1}(\text{Municipality}_m = 1)t$. Since the municipalities within the treatment and control groups are highly heterogeneous, allowing for municipality-specific trends provides cleaner estimates of the impact of the reform over time. We cluster standard errors at the municipality level.

Figure 4 shows the results for entry in our benchmark regression. Since the timing of the increase in entry coincides with the opening of the One-Stop Shops in the different municipalities, we are reassured that our results capture the impact of the reform. We see that the opening of the One-Stop Shops significantly increased annual firm entry at the municipality level. The coefficients in Figure 4 refer to the absolute change in the annual number of entrants per 1,000 residents at the municipality level. This increase corresponds to an annual rise in the number of entrants per 1,000 residents between 12% and 40%, that

is, local annual entry increased on average by 25% following the reform. Since the pre-reform entry rate in the Treated municipalities averaged around 8.5%, the reform led to an approximate increase in the entry rate of two percentage points.

As described in Section 2.1, a firm did not have to register in the same municipality where it was operating. As a consequence, entrepreneurs living in a municipality belonging to the control group could have driven to the closest One-Stop Shop. However, we assume that firms registered in the same municipality in which they were operating. While we mentioned that One-Stop Shops operated predominantly on a local scale, the possibility of driving from a *Control* municipality to the closest One-Stop Shop would, if anything, bias our estimates downwards. So, to the extent that we see a positive and statistically significant effect of the reform, we do not view this feature of the reform as a concern.

Our entry results are robust to a number of different specifications. In particular, we relax municipality-specific trends and allow trends to differ across groups of municipalities defined over some pre-reform characteristics. For instance, since *Treated* municipalities were on average more populated and had a more service-oriented economy, we rank municipalities based on these two characteristics and allow for specific trends by the different deciles. This is shown in Figure 11 in the Appendix. In results not shown, we also allow for separate trends for the municipalities belonging to the different deciles of total population only. Our results are noisier but robust to this empirical specification.

3.3   Analysis of Local Employment

We now move to the analysis of employment. We use equation (2) and define the dependent variable $y_{m,t}$ as the log of aggregate employment at the municipality-year level normalized per 1,000 residents.

Differently from the entry regression, we choose to normalize the coefficients of the reform lags and leads to $t-3$, rather than $t-1$. This choice deserves further discussion. Since the reform became perfectly anticipated by the incumbents once it started to be implemented in 2005, the response of aggregate employment captures not only the direct impact of higher entry and incumbents' reaction to actual entry, but also incumbents' reaction to *expected* entry. This means that each β_τ in the employment regression model captures the impact of both an actual and an expected change in entry. To the extent that firms face convex adjustment costs in labor, we should expect incumbents to start adjusting their workforce even before the actual opening of the One-Stop Shop in their municipality.

Figure 5 shows the resulting regression coefficients for each reform lag and lead. We see that employment increased significantly in *Treated* municipalities relative to the *Control* ones. While the coefficients are statistically significant only for the year of the reform and onwards, it is worth highlighting that employment started rising from $t-2$. To the extent

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that the lags from $t - 7$ to $t - 3$ are flat and not statistically different from zero, the slight increase in employment in $t - 2$ and $t - 1$ likely captures the adjustment of employment by incumbents anticipating a change in their competitive environment and not differential pre-trends across municipalities.

We interpret the coefficients as the cumulative percentage increase in municipality-level employment relative to $t - 3$. Accordingly, we see that employment increased by 5% in the year of the reform, and then continued growing at an average annual rate of 4%. Results on aggregate employment dynamics are robust to different trend specifications. Figure 11 in the Appendix shows the results of a specification that allows for trends by municipalities grouped by deciles of total residents and per-capita value of activity in services during the pre-reform period.

3.4   Analysis of the Underlying Channels

In this section, we explore the micro-level forces underlying our results on aggregate employment. We start by decomposing the increase in employment between the contributions of entrants and young firms (i.e., firms younger than 5 years old) and of older incumbents (Section 3.4.1). We then study the extent to which the aggregate responses of these two groups are driven by an intensive or extensive margin of adjustment. Accordingly, we investigate the evolution of the average size of the firms in each group (Section 3.4.2), and the changes in the exit probability for the average firm in each group (Section 3.4.3). We then study whether the analysis of the employment and exit decisions of incumbent firms masks some relevant firm heterogeneity (Section 3.4.4).

3.4.1   The Response of Employment by Age Groups

We start by analyzing the role of young firms and older incumbents in explaining the observed response of local employment. We classify firms according to three age classes: age $0 - 5$, $6 - 15$, and older than 15 (15+ henceforth). That is, we keep the analysis of incumbents of age $6 - 15$ and 15+ distinct.

We aggregate the employment of firms in each municipality and year by the three age groups, and run model (2) separately for each age group. We classify firms based on their current age. This means that the sample of underlying firms is not constant over time. This method identifies the contribution of the different age groups under the identification assumption that firms belonging to any age group in the *Treated* municipalities would have behaved as the corresponding ones in the *Control* municipalities absent the reform.

The reason why we chose to use an aggregate measure at the municipality level deserves further discussion. An alternative strategy could have been using data on employment at

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the firm level. In that case, the β_s on each time lag and lead would measure the impact of the reform on the size of the average firm by age group, given the sample of surviving firms in each period. While firm-level regressions allow us to rely on a much larger sample and on more controls, the resulting coefficients are subject to an upward bias. In particular, since exiting firms are on average smaller than surviving ones, results from firm-level regressions artificially lead to an increase in the size of the average firm. Aggregate employment by the different age groups, instead, solves this selection-into-exit problem.

Figure 6 shows the results of these regressions. With the caveat for firms older than 15 years showing a noisier and essentially flat response, we see that both young firms and older incumbents contribute positively to the rise in local employment. Moreover, we do some back of the envelope calculations to understand the relative contribution of each age group to the overall increase in local employment. To do so, we use the coefficients from the age-group regressions and combine them with information on the average employment share of each age group in the pre-reform period. This exercise reveals that around 60% of the overall increase in local employment is due to the response of incumbents older than 5 years old, while entrants and young firms account for the remaining 40%.

While evidence on the positive contribution of incumbents to local employment growth is new and of interest by itself, the estimates in Figure 6 are silent on the mechanisms underlying these responses. As a next step, we investigate the extent to which the results are driven by an *intensive* or an *extensive* margin of adjustment. The former is related to changes in employment accounted by operating firms, the latter captures the role of entry and exit.

3.4.2 Analysis of the Intensive Margin of Adjustment by Age Groups

To capture the intensive margin of adjustment, we study the evolution of the average size of firms in the different age groups. We construct this measure using the following ratio

$$y_{m,a,t} = \frac{\sum_{i \in (m,a,t)} \text{employment}_i}{\sum_{i \in (m,a,t)} \text{active firms}_i},$$

that is, we sum the employment of each firm i belonging to municipality m, age group a and year t, and divide it by the corresponding value for the number of operating firms. We then use this measure as the dependent variable in the regression equation (2).

Figure 7 shows the estimated coefficients. We notice that the average size of incumbents increased, while that of entrants and young firms remained unchanged. This means that entrants and young firms contributed to the aggregate rise in employment exclusively by the fact that the number of entrants increased after the reform, that is, by the extensive margin. Incumbents, instead, contributed via the intensive margin. This result is robust to relaxing

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municipality-specific trends and allowing for trends specific to municipalities belonging to the different deciles of total residents and per-capita value of activity in services in the pre-reform period (see Figure 11 in the Appendix).

Evidence on the expansion of the average size of incumbents in response to an increase in entry is novel and inconsistent with the predictions from current workhorse models of firm dynamics, as explained in Section 4. What this evidence does not say, however, is whether the increase in the average size of incumbents holds along the whole distribution of firms or whether it is driven by a smaller subset of them. We explore this possibility of underlying heterogeneity of the incumbents in Section 3.4.4.

3.4.3 Analysis of the Extensive Margin of Adjustment by Age Groups

To get a better understanding of the role of the extensive margin in shaping local aggregate dynamics, we turn to the analysis of exit. In particular, we study whether and how the reform affected the exit probability of firms in the different age groups.

Our analysis of exit is based on firm-level data. This means that we study the evolution of the exit probability for the *average firm*. In contrast to the analysis of employment, the behavior of exit at the firm level is not subject to problems of selection.

Our baseline firm-level regression is specified as follows:

$$Pr(exit_{it} = 1) = \alpha_m + \delta_t + \sum_{\tau=-7}^{\tau=3} \beta_\tau \mathbb{1}(t - \tau_{0,m} = \tau) + \sum_m \gamma_m \mathbb{1}(\text{Municipality}_m = 1)t + \epsilon_{i,t}, \quad (3)$$

where α_m and δ_t are the municipality and year fixed effects, respectively. $exit_{it}$ is an indicator variable equal to 1 if firm i exits operations in year t. By allowing for the municipality-effect only, we are controlling just for within-municipality variation, while we allow for variation across sectors of economic activity. We do this to remain consistent with the previous municipality-level regressions.

We estimate model (3) keeping one age group at a time. Figure 8 Panel (a) shows the resulting estimated coefficients. In particular, it shows that the exit probability for the average firm remained mostly unaffected by the reform across all age groups. This result is robust to replacing the municipality fixed effect with a fixed effect for the municipality interacted with the 3-digit sector of activity, as shown in Figure 8 Panel (b). It is also robust to replacing municipality-specific trends with trends by deciles of total residents and per-capital value of activity in services in the pre-reform period, as shown in Figure 11 in the Appendix.

Along the lines of the analysis of the average size presented in Section 3.4.2, the results on the exit probability refer to an average firm. We now explore whether these results mask

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evidence of an heterogeneous impact of the reform at different points of the productivity distribution of incumbents.

3.4.4 Analysis of the Heterogeneous Response of Incumbents

In this section, we explore whether we can detect any relevant heterogeneity in the responses of employment and exit by incumbents. Ideally, we want to compare the evolution over time of a measure of employment and exit for "high-productivity" and "low-productivity" incumbents.

Exploring the role of heterogeneity based on *current* measures of productivity leads to biased estimates. The productivity of the firm is indeed an endogenous variable. As a consequence, we need to classify firms based on a proxy for their idiosyncratic productivity measured in the period before the implementation of the reform. This is why we can only study the heterogeneity of the responses by incumbent firms. Additionally, given the available data, we proxy for labor productivity using the ratio of nominal sales over employment for each firm, that is, revenue labor productivity.

To be able to study the heterogeneous impact of the reform on the largest sample of young firms, we choose the year 2004 - being the year preceding the announcement and implementation of the reform - as the initial year of our analysis. We rank operating firms in 2004 according to our proxy for labor productivity. Our specification ranks firms based on their revenue labor productivity within each age group (i.e., age 0-5, 5-15, 15+), 3-digit sector of activity, and municipality. We then aggregate total employment and total exit at the municipality-year level for the first and third terciles, and compare their evolution over the different reform lags and leads as in the regression equation (2). We use as dependent variable the implied municipality-level aggregate of employment and exit for each tercile.

Figure 9 shows the results of this exercise for both total employment and exit (Panels (a) and (b), respectively). The estimates unveil substantial heterogeneity in firms' response, according to their productivity level. We see that the increase in aggregate employment is driven by the most productive firms, while the behavior of the bottom tercile remained unchanged after the reform. A similar story emerges from the analysis of exit. In particular, the number of exiting firms in the top tercile dropped significantly after the reform, while the exit behavior of the bottom tercile remained unaffected. As a robustness exercise, we alternatively rank firms based on their productivity within 3-digit sector of economic activity and municipality (that is, pooling the age groups together). Our results are weaker but still robust to this specification, as shown in Figure 12 in the Appendix. Additionally, we find that our results are robust to decile-specific trends by residents and per-capita value of activity in services, as shown in Figure 13.

3.5 Analysis of the Reform by Sector

We conclude the empirical analysis by providing evidence on the impact of the reform disaggregated by sector of economic activity. In particular, we consider sectors classified at the 1-digit level. This is because any finer classification leads to very noisy results. We focus on manufacturing and services only, which are larger and more homogeneously distributed across the municipalities. We redo the exercises presented in the previous sections, but we allow for a distinct municipality aggregation for firms in the two macro sectors.

Figure 10 compares entry, exit, employment and the behavior of incumbents for firms operating in the manufacturing and service sectors. We start from the analysis of entry. This Figure reveals that entry grew significantly after the reform for the service sector, while it remained flat for manufacturing. This result is not surprising. Indeed firms in the manufacturing sectors are highly intensive in capital, so they face high fixed capital investment. As a consequence, entry decision may not be substantially influenced by the change in time and monetary entry costs induced by the reform. Another interpretation of this result is to consider services and manufacturing as non-tradable and tradable goods, respectively. The firms in the former sector are influenced by variations in local demand, and so are more responsive to the change in the local economy induced by the opening of the One-Stop Shop.

We then look at aggregate employment and find that it increases for the service sector, while it did not significantly change for manufacturing. Next, we investigate the impact of the reform on the average size of firms in different age groups. We see that the average size of entrants and young firms in the service sector decreased. This is consistent with the fact that the smallest firms should be more responsive to a reduction in entry costs. Consistent with no evidence of a change in entry behavior, the average size of entrants and small firms in manufacturing is unchanged. On the other hand, incumbents expanded their average size in services, and mildly in manufacturing. Indeed, the increase in the total number of operating firms and in aggregate employment had an overall expansionary effect on the aggregate economy. Interestingly, this turned out to be beneficial for incumbents in all sectors, and suggests that the economy-wide increase in firm entry triggered an increase in aggregate demand.

4 Theoretical Analysis

In this section, we verify to what extent the empirical findings of Section 3 are consistent with the predictions of a model with heterogeneous firms and monopolistic competition. We start by describing a general framework that nests a variety of models of monopolistic competition (see Section 4.1). We then study two specific models that are nested in the

general framework. The first is the standard CES model with a continuum of firms (see Section 4.2). The second is a model with a symmetric translog demand specification (see Section 4.3). The latter allows the demand elasticity to differ across firms, based on their productivity, and to vary with the mass of operating firms. We compare the properties of the model under CES demand and under the symmetric translog demand specification. We do so both theoretically and in a numerical example, that is presented in Section 4.4. Our main conclusion is that the translog demand model delivers predictions in line with the empirical analysis. In particular, incumbents' response depends on their productivity, and the most productive incumbents expand in response to the reform.

4.1 Framework

We now provide a description of a model of heterogeneous firms and monopolistic competition in general terms.

4.1.1 Consumers

The economy has a representative consumer. The consumer gets his income from supplying labor at wage w and from the profits of the firms. Given the schedule of prices $\{p_i\}_{i \in \mathcal{M}}$, we can express the demand for the differentiated goods in general terms as

$$q_i = \mathcal{D}\left(\frac{p_i}{P}, M, \frac{E}{P}\right), \tag{4}$$

where P is the aggregate price index, p_i/P is the relative price of firm i, M is the mass of operating firms and E is total expenditure in the economy. $\mathcal{D}$ is a continuously differentiable function that is decreasing in the relative price $\frac{p_i}{P}$ and in the mass of firms M, and increasing and in total expenditures E, that is, $\mathcal{D}_1, \mathcal{D}_2 \leq 0$ and $\mathcal{D}_3 \geq 0$. The variables P, E, and M are endogenous. The aggregate price index, P, is a function of the schedule of prices,

$$P = \mathcal{P}(\{p_i\}_{i \in M}), \tag{5}$$

with $\frac{\partial \mathcal{P}}{\partial p_i} > 0$, for all i.

4.1.2 Firms

The economy has a continuum of heterogeneous firms that are indexed by $i \in [0, M]$. M is comprised of an exogenous mass of incumbents, M_I, and an endogenous mass of entrants, denoted by M_E. Firms are heterogeneous in their productivity, a_i. Production is linear in labor, such that $y_i = a_i l_i$. To enter the market, a firm needs to pay f_e units of labor. After paying the entry cost, a firm draws its idiosyncratic productivity from the distribution $F(a)$.

We assume that this distribution is the same as the productivity distribution of incumbents. The endogenous measure of entrants, M_E, is determined in equilibrium by an expected zero-profit condition. That is, in equilibrium the expected profit of an entrant is equal to the entry cost. This condition is given by:

$$\int V\left(a_i; \frac{p_i}{P}, M, \frac{E}{P}\right) dF(a_i) = f_e w, \tag{6}$$

where $V(.)$ is the profits function of firm i, gross of entry costs. Upon entry, the problem of an entrant is the same as that of any incumbent. In particular, each firm in the market solves:

$$V\left(a_i; \frac{p_i}{P}, M, \frac{E}{P}\right) = \max_{p_i, q_i, l_i} \frac{p_i}{P} q_i - \frac{w}{P} l_i \quad \text{s.t.} \quad q_i = a_i l_i$$

$$q_i = \mathcal{D}\left(\frac{p_i}{P}, M, \frac{E}{P}\right).$$

For ease of notation, we define the marginal cost of firm i as $mc_i \equiv \frac{w}{a_i}$ and its markup as $\mu_i \equiv p_i / mc_i$. Solving the firm's problem, we get that in equilibrium, the markup takes the following form:

$$\mu_i = \frac{\varepsilon\left(\frac{p_i}{P}, M, E\right)}{\varepsilon\left(\frac{p_i}{P}, M, E\right) - 1}, \tag{7}$$

where $\varepsilon(.)$ is the elasticity of substitution of demand of good i, defined as $\varepsilon\left(\frac{p_i}{P}, M, E\right) = -\frac{\mathcal{D}_1}{\mathcal{D}} \frac{p_i}{P}$. Given the firm's price, the labor demand of firm i, which we denote by l_i, can be written as:

$$l_i = \frac{1}{a_i} \mathcal{D}\left(\frac{p_i}{P}, M, \frac{E}{P}\right). \tag{8}$$

4.1.3 Aggregate Variables

We take the aggregate labor supply function as given. We assume it depends only on the real wage in the economy. One preference specification that gives rise to such labor supply function is the one introduced by Greenwood, Hercowitz and Huffman (1988). In particular, we define aggregate labor supply L^S as follows:

$$L^S = \left(\frac{w}{P}\right)^\nu, \tag{9}$$

where $\nu > 0$ is the labor supply elasticity.

While entrants make zero profits on average, incumbents make positive profits. We assume that profits of incumbents are distributed lump-sum to households. So that,

$$\frac{E}{P} = \frac{w}{P} L + M_I \int V(a_i) dF(a_i) + f_e w M_E, \tag{10}$$

where the second term represents the aggregate profits of incumbent firms, since their measure is M_I.

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4.1.4 Equilibrium

Without loss of generality, we normalize the wage level to one. An equilibrium in this economy consists of aggregate variables $\{M, M_E, P, L, E\}$, the schedule of prices set by firms, $\{p_i\}_{i\in[0,M]}$, the demand schedule for labor, $\{l_i\}_{i\in[0,M]}$, and firm-level goods produced $\{q_i\}_{i\in[0,M]}$, such that:

(i) An expected zero-profit condition (6) holds if the measure of entrants in equilibrium is positive, $M_E > 0$.

(ii) Given aggregate variables, the allocations solve the firm's problem. That is, the markup set by each firm satisfies equation (7), labor demand l_i satisfies (8), and the level of production q_i is equal to (4) $\forall\ i$.

(iii) The labor market clears. In particular, $L^S = \int_0^M l_i di$, with L^S determined by (9).

(iv) The goods market clears. That is:

$$\frac{E}{P} = \int_0^M \frac{p_i}{P} q_i di,$$

where $\frac{E}{P}$ is given by equation (10).

Having described the theoretical framework in general terms, we now study the impact of the reform under CES and symmetric translog demand. In particular, we are going to study, in a static setting, how the reform affects the demand for labor at the firm level l_i, as well as its effect on aggregate employment L. We consider the reform as a reduction in entry costs, f_e. This leads to an increase in the mass of operating firms M.

4.2 The CES Case

We start by considering the CES case, which is characterized by the following expression for the demand function of each firm i:

$$q_i = \left(\frac{p_i}{P}\right)^{-\sigma} \frac{E}{P}. \tag{11}$$

Here, $\sigma > 1$ is the elasticity of substitution of the good produced by firm i. Notice that such elasticity is constant and equal across the different firms. Moreover, the aggregate price index is given by

$$P = \left(\int_0^M p_i^{1-\sigma} di\right)^{\frac{1}{1-\sigma}}.$$

Since the elasticity of substitution is constant, so is the markup charged by each firm. Accordingly, the latter is equal to $\mu_i = \frac{\sigma}{\sigma-1}$ for all i.

The presence of constant demand elasticity and markup is key to determine the response of aggregate and firm-level variables to the reform, and the underlying economic forces. We show it by studying the impact of the reform on the labor demand of each firm l_i and the aggregate employment level L.

We summarize the response of the labor demand of each firm to the reform in the following Proposition.

Proposition 1. *Under CES, the response of labor demand is homogeneous across firms. Moreover,*

$$\frac{\partial \ln l_i}{\partial \ln M} = -\frac{\sigma - 1 - \nu}{\sigma - 1}. \tag{12}$$

Proof. The proof of this Proposition and all the proofs of this section can be found in Appendix A.2. □

The Proposition above implies that the employment level of each firm falls if $\sigma - 1 > \nu$, i.e., if the demand elasticity for each good i is higher than the elasticity of labor supply. Otherwise, the labor demand of each firm increases. This means that the impact of the reform on labor demand is theoretically ambiguous. However, it is worth pointing out that the usual calibration in the literature is $\sigma \in [3, 7]$ and $\nu \in [0.5, 2]$. Therefore, under standard calibration values, the reform leads to a decline in the size of all operating firms.

The intuition for this result is as follows. The increase in the number of operating firms M leads to a reduction in the aggregate price level P.[5] This induces incumbents to downsize. Moreover, since incumbents face the same demand elasticity, they will all be subject to the same decline in demand. On the other hand, the increase in labor supply L^S, increases total expenditure E. This force instead pushes all incumbents to expand by the same amount. Under standard calibration of ν, the labor supply elasticity, this expansionary channel from E is not strong enough to counteract the contraction induced by the change in P.

Regardless of the contraction in the size of each incumbent, aggregate labor demand increases. This is stated in the next Proposition.

Proposition 2. *Under CES, aggregate labor L increases in response to an increase in the the mass of operating firms M. That is,*

$$\frac{\partial \ln L}{\partial \ln M} > 0.$$

An immediate implication of Propositions 1 and 2 is that under traditional parameter calibration, the increase in total labor L is entirely driven by the *extensive margin*, i.e., by the increase in the mass of operating firms M. So the CES specification is not only inconsistent

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[5]In CES, the decrease in the aggregate price level P is due to the "love-of-variety" effect.

with heterogeneous response by incumbents, but also stands in contrast with our finding that the majority of the rise in aggregate labor is due to an increase in incumbents' labor demand.

4.3 An Economy with Variable Markups

Consider again the same framework, but suppose that the demand is derived from a symmetric translog expenditure function. This specification was proposed by Feenstra (2003) and leads to a homothetic utility function, with no closed-form solution, and with a non-constant price elasticity of the corresponding demand functions.

Under the symmetric translog specification, the demand for good i is defined as

$$q_i = \left[\frac{1}{M} + \gamma \left(\ln P - \ln p_i \right) \right] \frac{E}{p_i}, \tag{13}$$

where the aggregate price index is given by

$$P = \exp \left(\frac{1}{M} \int_0^M \ln p_i di \right). \tag{14}$$

The solution to the firm's problem delivers

$$p_i = \underbrace{\left(1 + \frac{s_i}{\gamma} \right)}_{\mu_i} \underbrace{\frac{1}{a_i}}_{mc_i}, \tag{15}$$

where s_i is the expenditure share of good i, given by

$$s_i = \frac{1}{M} + \gamma \left[\ln P - \ln p_i \right]. \tag{16}$$

Having introduced s_i, we express the demand elasticity in the translog framework as follows:

$$\varepsilon_i = 1 + \frac{\gamma}{s_i}. \tag{17}$$

There are two important properties concerning the demand elasticity - and so markups - in the translog framework. First, the elasticity of each firm i is increasing in the mass of operating firms M. This implies that the markup is decreasing in M. We prove this result in the following proposition:

Proposition 3. *Under translog, the demand elasticity of each firm i is increasing in the mass of operating firms M, that is:*

$$\frac{\partial \ln(\varepsilon_i)}{\partial \ln M} > 0, \quad \forall i.$$

Second, the elasticity of each firm i is decreasing in the idiosyncratic productivity a_i. This means that the demand faced by more productive firms is less elastic, so it responds less to changes in the relative price of the firm. This can be seen from (17), after replacing the expression for p_i given by (15) into (16). An implication for this fact is that more productive firms charge higher markups.

The dependence of the elasticity ε_i on M and a_i puts the translog case in stark contrast with the CES case and delivers richer predictions on the impact of the reform on the labor demand of each firm and on the aggregate employment level. Accordingly, we provide a key result on the response of the labor demand of each firm i in the following Proposition:

Proposition 4. *In the translog framework, the reform has a heterogeneous impact on labor demand l_i. In particular, the response of labor demand is increasing in the productivity of the firm. That is,*

$$\frac{\partial^2 \ln l_i}{\partial \ln M \partial \ln a_i} > 0.$$

The heterogeneous response of labor demand is consistent with evidence from our empirical analysis. In particular, the proof of Proposition 4 reveals that not only is the response heterogeneous, but it is also the case that the most productive firms in the economy expand and the least productive reduce their employment. This is true regardless of the parameter specification. As a consequence, the predictions of the translog model on the heterogeneous response by incumbents are in line with our empirical evidence, differently from the CES case.

The key variable which is responsible for this heterogeneous response of labor demand is the demand elasticity ε_i. The increase in the measure of firms M is similar to a decline in the aggregate price level P.[6] Accordingly, holding firms' prices fixed, it is as if the relative price of all firms goes up by the same amount. However, because more productive firms face a lower demand elasticity, their demand goes down by less. At the same time, the increase in labor supply L^S stimulates the economy through the aggregate expenditure E. As the economy is expanding, the most productive firms end up hiring more workers. This means that, in response to an increase in M, the most productive firms expand their size, while accounting for a smaller share of the entire economy.

Finally, we study the impact of the reform on aggregate labor L. We prove that aggregate labor L increases in the following Proposition.

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[6]While the decline in P in CES was driven by the "love-of-variety" effect, in the translog case the decline in P is driven by the reduction in the markups μ_i at all firms.

Proposition 5. *Under translog, aggregate labor L increases in response to an increase in the the mass of operating firms M. That is*

$$\frac{\partial \ln L}{\partial \ln M} > 0.$$

All in all, given our empirical findings, the translog demand case seems a more promising framework to study the response of the economy to a structural reform in the business sector. First, it yields heterogeneous responses by the different firms. Second, a large portion of the expansion of aggregate labor demand can come from incumbents.

4.4 CES versus Translog: A Numerical Example

Having described the theoretical channels and effects of the reform in the CES and translog frameworks, we now compare their predictions for firms' labor demand l_i and aggregate employment L using a numerical example. Since we are working with a simple static model, the goal of this exercise is to provide additional intuition on the theoretical channels presented before, and not to achieve realistic quantitative results.

We calibrate the economy as follows. We set the parameter γ, which is specific to the translog framework, to 0.359, consistent with Bilbiie et al. (2012). The other parameters are chosen to match standard values used in the literature. We set the labor supply elasticity $\nu = 2$ as in Clementi and Palazzo (2016) and the demand elasticity σ in CES to 5. We choose $\sigma_a = 0.25$, and calibrate the measure of incumbents to 1.7. We set M_E to match the annual entry rate of limited-liability employer firms in Portugal, which corresponds to 9%. We then set the entry cost f_e in the CES framework to get an entry condition consistent with M_E. We simulate the impact of the reform by decreasing f_e, such that we get an implied increase in M_E of 25%, consistent with the evidence from Empresa na Hora.

To begin, we compare the response of the labor demand of each firm as a function of its idiosyncratic productivity under the CES and translog specifications. This is shown in Figure 1. There are two main takeaways from this Figure. First, the response of labor demand in CES is the same across firms, regardless of productivity, as we already explored theoretically. Second, consistently we the theoretical results shown above, the response of labor demand under translog depends on the productivity of the firm, with the more productive firms expanding their size following the reform.

We then explore how the differential impact of the reform on firm-level labor demand translates into the response of aggregate employment. In particular, we compare the relative contribution of entrants and incumbents to the response of aggregate employment. This is summarized in Table 1. We notice that the contribution of incumbents to the response of aggregate employment is negative in CES and positive in translog. The translog specification

Figure 1: Impact of an Increase in M on Incumbents' Labor Demand
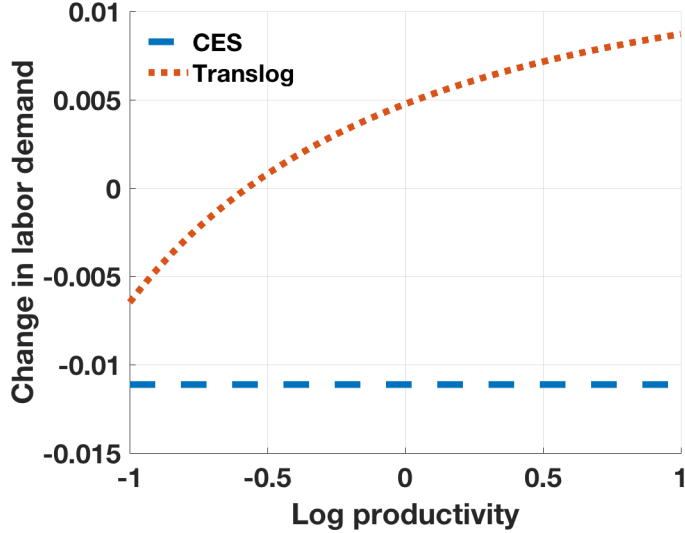
The figure plots the change in the labor demand of each firm as a function of its idiosyncratic productivity following a decrease in entry costs f_e. The dashed line shows that under CES all firms reduced their size by the same amount, regardless of their productivity. The dotted line instead shows that the response in labor demand depends on firm's productivity. More productive firms decrease their labor demand by less, and even expand it for sufficiently high levels of productivity.

is in line with our empirical evidence. However, differently from our empirical evidence, in this calibration exercise incumbents account only for a small share of the overall increase in aggregate employment.

Table 1: Response of Aggregate Employment and Contribution of Entrants and Incumbents

Δ L	Entrants	Incumbents	Total
CES Demand	2.22%	-1.10%	1.12%
Translog Demand	2.26%	0.46%	2.73%

While the first two exercises showed that, under translog, the reform had a heterogeneous effect on the different firms, we now show how firm heterogeneity matters for the aggregate effect of the reform. Figure 2 displays the impact of the reform on aggregate labor as a function of the productivity dispersion σ_a, given the translog specification. We see that a higher initial productivity dispersion increases the aggregate effect of the reform. The intuition is as follows. Since the markup is not constant across firms, the economy suffers from

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misallocation. In particular, the high productivity firms are under producing.[7] As Figure 1 shows, the relative share of employment in high-productivity firms increases following the reform. So the reform leads to an efficient reallocation of production in the economy. Since the level of initial misallocation is increasing the level of productivity dispersion (σ_a), this reallocation channel is stronger if dispersion is higher.

The overall increase in L as a function of σ_a, however, is not large. On the one hand, as written above, higher initial productivity dispersion implies that the reallocation channel is stronger, strengthening the aggregate effect of the reform. On the other hand, the reallocation of production inputs leads to an increase in the share of production of firms with relatively higher markups. This slightly attenuates the overall increase in aggregate employment.

Figure 2: Impact of an Increase in M on Total Labor Demand
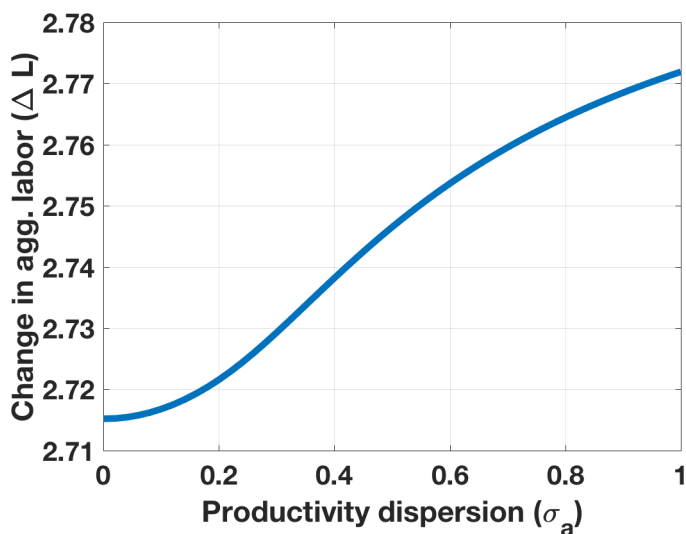
The figure plots the change in the aggregate labor following a decrease in entry costs f_e, as a function of the initial dispersion in firms' productivity. It shows that the response of aggregate labor L is increasing in the intial dispersion in firm-level productivity.

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[7]To see why markup dispersion leads to misallocation in equilibrium see Baqaee and Farhi (2017) and Edmond et al. (2018).

5 Conclusion

In this paper we provide novel evidence on the macroeconomic impact of a structural reform that reduced entry costs for firms. We do so by using an economy-wide entry deregulation reform in Portugal as a natural experiment. The reform led to an increase in firm entry and aggregate employment. We then uncover the mechanisms underlying the response of employment. We find that the bulk of employment expansion is coming from older incumbents increasing their size. Moreover, the response of incumbents is heterogeneous. In particular, the expansion is driven by incumbents who were the most productive before the reform.

We show that models with heterogeneous firms and CES demand deliver predictions that are inconsistent with our evidence on the response by incumbents. Accordingly, these models predict that all incumbents reduce their employment by the same amount, regardless of their idiosyncratic productivity. We then present a model with heterogeneous firms and variable markups that delivers predictions that are consistent with the empirical evidence. The model assumes symmetric translog demand as in Feenstra (2003), such that the elasticity of substitution increases with a higher mass of available goods, and the demand elasticity of each firm decreases with its level of productivity.

A key result from our model is that the response of labor demand for each firm depends on the firm's idiosyncratic productivity. In particular, the most productive incumbents expand their size in response to an increase in the mass of firms. This is because they face a lower demand elasticity, which, for a given size of the economy, allows them to lose a smaller market share following entry of new firms. In addition, since the rise in entry expanded the economy, the most productive incumbents end up increasing their level of output and employment.

The Portuguese experiment allows us to identify the short-run effect of the reform. On the other hand, a concern can be raised about the external validity of our results. Evidence of no change in the exit probability or no downward adjustment in the size of the least productive incumbents may be related to structural rigidities specific to the Portuguese economy. Another possibility is that this evidence requires a longer time coverage of the post-reform period.

However, the key takeaways from this paper are robust beyond the Portuguese setting. Specifically, we believe that quantitative models used to inform policy-making on structural reforms in the business sector should be modified to allow for firm heterogeneity and variable markups.

In this paper, we have abstracted from worker heterogeneity and assumed that all workers face a similar wage. In future work, we plan to explore the distributional impact of the reform on the different workers.

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Figures and Tables

Table 2: One-Stop Shop Program Implementation

	2005	2006	2007	2008	2009	Total
Number of shops	20	28	31	36	49	164
Number of counties implementing	13	24	28	34	46	145
Number of counties > 1 shop	6	3	1	2	0	12

Source: Branstetter et al. (2014) based on publicly available calendar data provided by the Instituto dos Registos e Notariado.

Figure 3: Timing of the Opening of One-Stop Shops across the Country
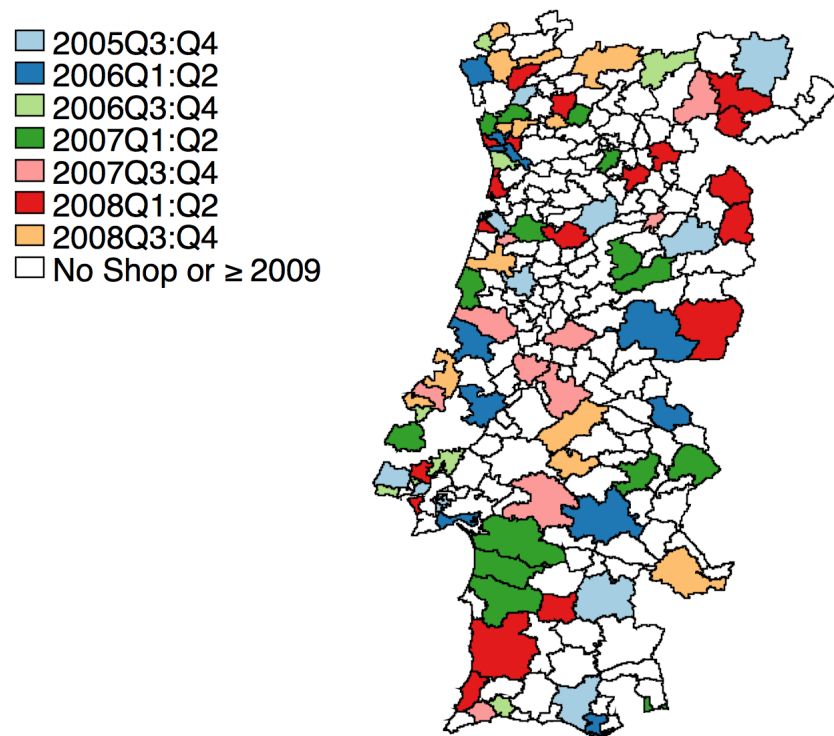
Source: Instituto dos Registos e Notariado.

The figure shows the pattern of opening of the One-Stop Shops across the Portuguese municipalities.

Table 3: Descriptive Statistics on Municipality Groups in the Pre-Reform Period

	Treated Municipalities	Never-Treated	Early-Treated	Late-Treated
Firm Demographics				
Entry rate	8.5% (4.6%)	9.4% (6.9%)	7.9% (4%)	8.8% (5%)
	[5.7%, 10.2%]	[5.4%, 11.9%]	[5.8%, 8.7%]	[5.6%, 10.8%]
Entrants x 1,000 inhab	0.83 (0.4)	0.71(0.45)	0.88 (0.34)	0.81 (0.42)
	[0.56, 1.02]	[0.4, 0.97]	[0.64, 1.03]	[0.54, 1.01]
Exit rate	8.4%(2.8%)	7.7%(4.1%)	8.5%(2.3%)	8.3%(3%)
	[6.8%, 10%]	[5.3%, 10%]	[7%, 9.7%]	[6.6%, 9.9%]
Exit x 1,000 inhab	0.93 (0.38)	0.68 (0.4)	1.1 (0.39)	0.84 (0.35)
	[0.67, 1.1]	[0.38, 0.94]	[0.8, 1.3]	[0.6, 1.1]
Active firms x 1,000 inhab	10.67 (3.8)	8.32 (3.4)	12.21 (3.8)	9.8 (3.5)
	[8.1, 12.9]	[5.7, 10.4]	[9.4, 15.1]	[7.4, 11.7]
Macroeconomic Characteristics				
Employment rate (Census)	47.2% (24%)	34.1% (21%)	53.7%(27%)	43.4% (18%)
	[34.4%, 59.2%]	[25.8%, 44.3%]	[39.8%, 65.7%]	[30.6%, 54.9%]
Residents (mean)	66,896.1 (128,244)	18,540,7 (41,762.5)	114,213.3 (149,881.3)	39,421.6 (56,260.2)
	[17,852, 74,965]	[6,396, 21,135]	[44,162, 142,728]	[14,241, 52,604]
Share of pop aged 65 or more	19.07%(6.5%)	22.05%(8.2%)	16.31% (3.99%)	20.7% (7.21%)
	[14.3%, 22.3%]	[17.3%, 26.3%]	[12.9%, 19.9%]	[16.2%, 24.7%]
Macro-Sector of Activity				
Agriculture - Sales	2.82%(6%)	3.9%(6%)	1.37%(4%)	3.67%(6%)
	[0.1%, 2.8%]	[0.4%, 5.2%]	[0.1%, 1.3%]	[0.2%, 3.8%]
Manufacturing - Sales	28.3% (19%)	27.2% (20%)	28.2% (20%)	28.3% (20%)
	[11.1%, 40.5%]	[11.7%, 40.4%]	[14.3%, 45.4%]	[10.9%, 40.5%]
Construction - Sales	12.1% (9%)	16.9% (13%)	10.4% (7%)	13.1% (10%)
	[5.3%, 14.6%]	[7.2%, 22%]	[6.2%, 12.7%]	[4.8% 16.6%]
Services - Sales	46.66% (19%)	41.13% (15%)	53.76% (17%)	41.92% (16%)
	[42.5%, 70.1%]	[39.6%, 65.3%]	[43.9%, 73.5%]	[42%, 66.2%]

Source: *Quadros de Pessoal and Portugal National Statistics Institute.*

The Table displays the mean of each variable. Standard deviations are in round parenthesis. The 25th and 75th percentiles are in square parenthesis. The statistics refer to the period 2000-2004.

Table 4: Descriptive Statistics on Non-Financial Corporations

	yearly average
Relevant Statistics	
Entry Rate	7.5%
Exit Rate	9.3%
Operating Firms	125,015
Employment Sector Shares	
Agriculture	1.63%
Manufacturing	32.6%
Construction	15.13%
Services	50.64%
Sales Sector Shares	
Agriculture	1.52%
Manufacturing	26.6%
Construction	10.14%
Services	61.74%

	$p1$	$p25$	$p50$	$mean$	$p75$	$p99$
Relevant Distributions						
Size Distribution	1	2	4	7.13	8	55
Age Distribution	0	2	6	10.87	15	59
Size of Entrants	1	1	2	3.75	4	27
Size of Young Firms ($\leq$ 5 yrs)	1	2	3	4.95	5	36
Size of Old Firms	1	3	5	8.96	10	64

	Entrants	Age 0-2	3-5	6-15	15 +	Young Firms	Old Firms
Average Statistics by Age Groups							
Municipality Sales Share	2.5%	13.7%	16.2%	37.7%	34%	29.7%	70.3%
Municipality Employment Share	5%	14.4%	17.8%	35.6%	28.7%	36.9%	63.1%
Municipality Exit Share	12.5%	43.2%	23.7%	23.3%	10.3%	66.7%	33.3%
Municipality Count Firm Share							
Size	3.75	4.42	5.7	7.71	10.5	4.9	9
Exit Rate	16.6%	15.7%	11.4%	7.45%	5.4%	13.9%	6.5%
2-yr Survival Rate Entrants	69.7%						
4-yr Survival Rate Entrant	46.6%						

Source: *Quadros de Pessoal*

The statistics refer to the period 2000-2008.

Figure 4: Impact of Empresa Na Hora on Aggregate Local Firm Creation
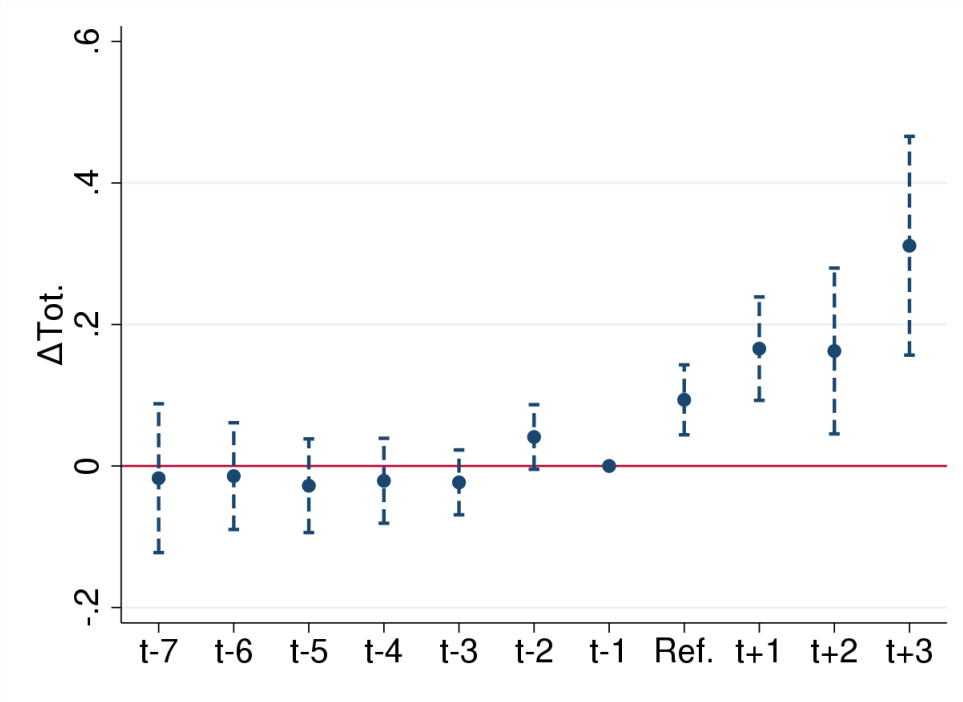
The figure shows the estimates of β_τ from the following regression at the municipality level:

$$y_{m,t} = \alpha_m + \delta_t + \sum_{\tau=-7}^{\tau=3} \beta_\tau \mathbb{1}(t - \tau_{0,m} = \tau) + \sum_m \gamma_m \mathbb{1}(\text{Municipality}_m = 1)t + \epsilon_{m,t},$$

where $y_{m,t}$ = total entrants per 1,000 residents, $\tau_{0,m}$ corresponds to the year in which the One-Stop Shop opened in municipality m and γ is a vector of coefficients for municipality-specific trends. Standard errors are clustered at the municipality level. 90% confidence intervals.

Figure 5: Impact of Empresa na Hora on Aggregate Local Employment
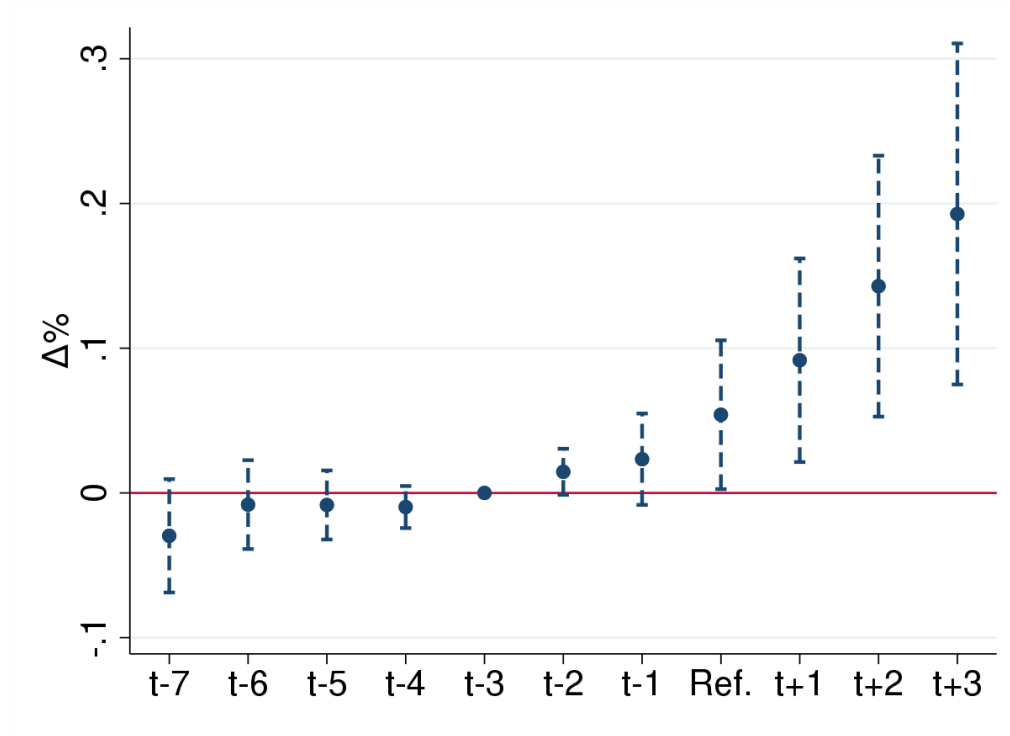
The figure shows estimates of β_τ from the following regression with municipality-level aggregates:

$$y_{m,t} = \alpha_m + \delta_t + \sum_{\tau=-7}^{\tau=3} \beta_\tau \mathbb{1}(t - \tau_{0,m} = \tau) + \sum_m \gamma_m \mathbb{1}(\text{Municipality}_m = 1)t + \epsilon_{m,t},$$

where $y_{m,t} = \log(\text{total employment per 1,000 residents})$, $\tau_{0,m}$ corresponds to the year in which the One-Stop Shop opened in municipality m and γ is a vector of coefficients for municipality-specific trends. Standard errors are clustered at the municipality level. 90% confidence intervals.

Figure 6: Impact of Empresa na Hora on Employment by Age Groups
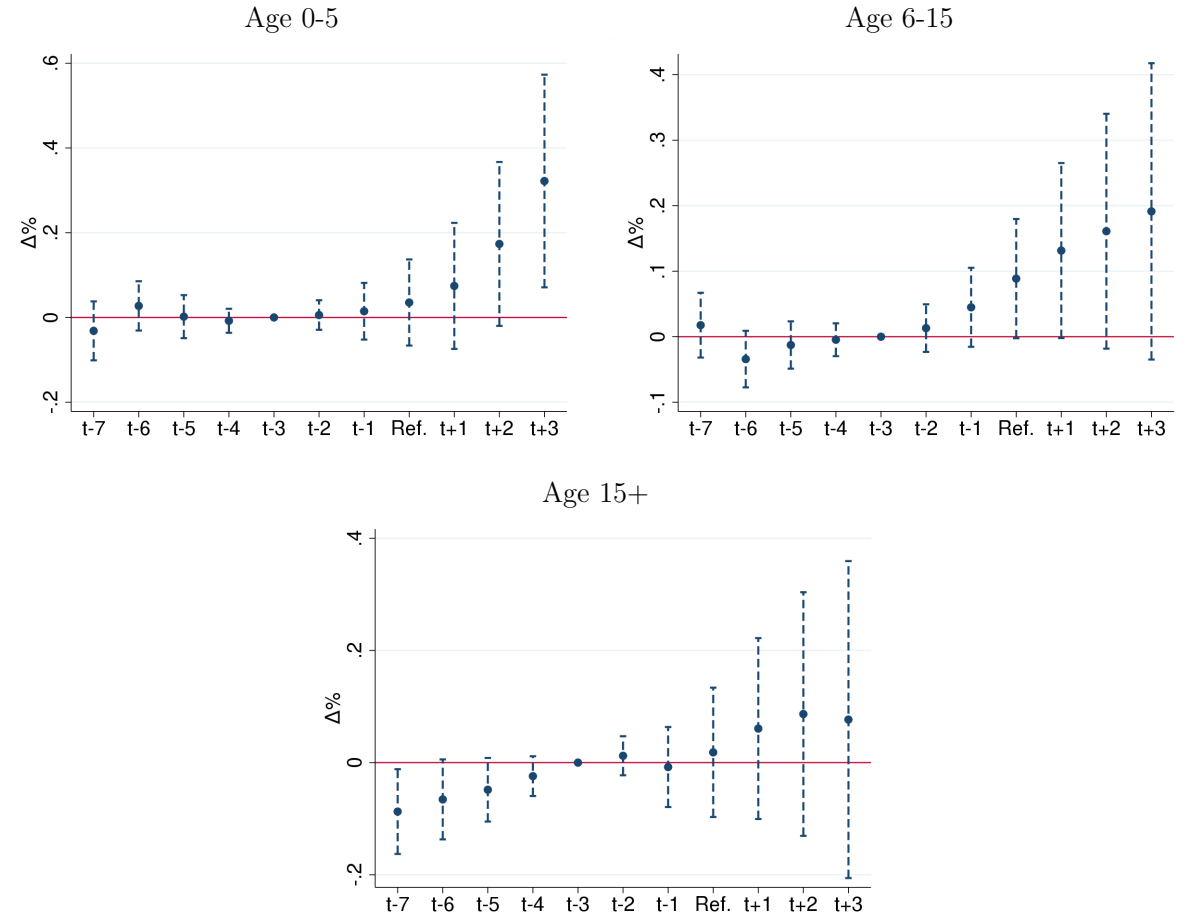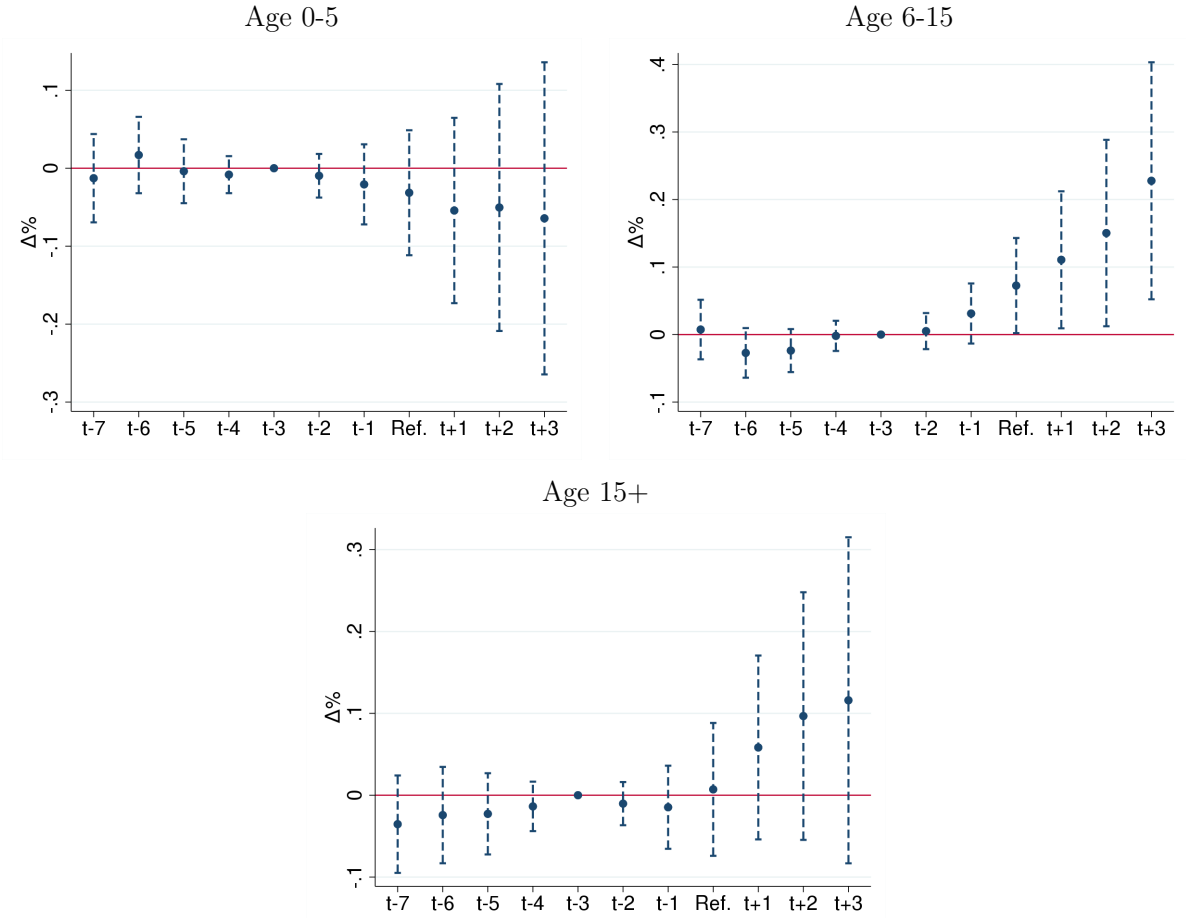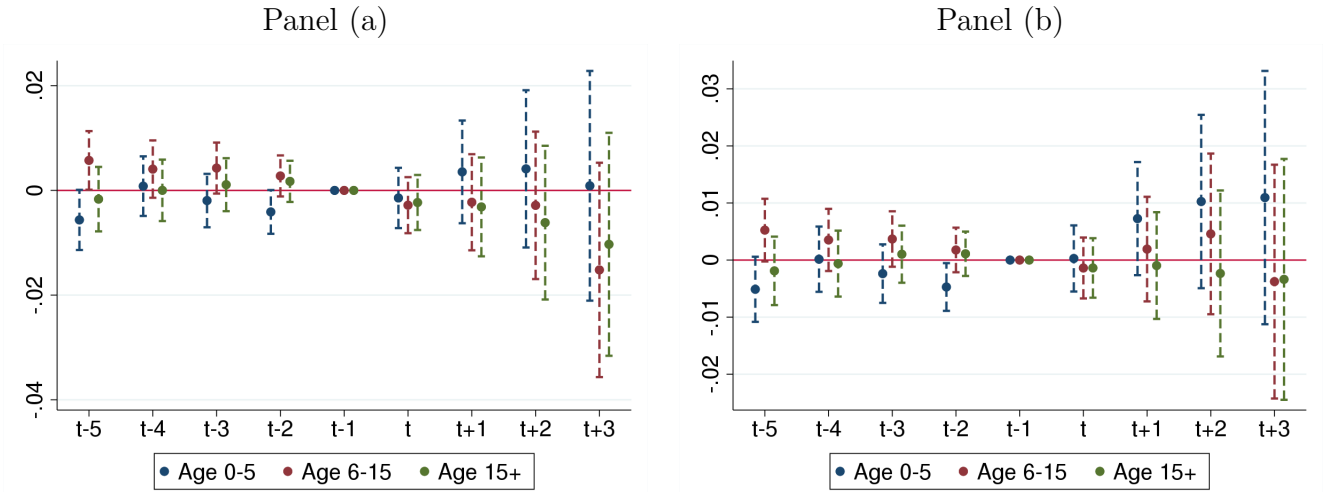
The figures show the estimates of β_τ from the following regression with municipality-level aggregates:

$$y_{m,t} = \alpha_m + \delta_t + \sum_{\tau=-7}^{\tau=3} \beta_\tau \mathbb{1}(t - \tau_{0,m} = \tau) + \sum_m \gamma_m \mathbb{1}(\text{Municipality}_m = 1)t + \epsilon_{m,t},$$

where $y_{m,t}$ = total employment per 1,000 residents by the different age groups, $\tau_{0,m}$ corresponds to the year in which the One-Stop Shop opened in municipality m and γ is a vector of coefficients for municipality-specific trends. Standard errors are clustered at the municipality level. 90% confidence intervals.

Figure 7: Impact of Empresa na Hora on Average Size by Age Groups

The figures show the estimates of β_τ from the following regression with municipality-level aggregates:

$$y_{m,t} = \alpha_m + \delta_t + \sum_{\tau=-7}^{\tau=3} \beta_\tau \mathbb{1}(t - \tau_{0,m} = \tau) + \sum_m \gamma_m \mathbb{1}(\text{Municipality}_m = 1)t + \epsilon_{m,t},$$

where $y_{m,t} = \text{average size} = \frac{\text{Tot. Employment}}{\text{Tot. Firms}}$ for the different age groups, $\tau_{0,m}$ corresponds to the year in which the One-Stop Shop opened in municipality m and γ is a vector of coefficients for municipality-specific trends. Standard errors are clustered at the municipality level. 90% confidence intervals.

Figure 8: Impact on Exit Probability by Age Groups

Panel (a)

Panel (b)

The figures show estimates of β_τ from the following regression at the firm level that we run for each age group (age 0-5, 6-15, 15+):

$$Pr(exit_{it}) = \alpha_m + \delta_t + \sum_{\tau=-7}^{\tau=3} \beta_\tau \mathbb{1}(t - \tau_{0,m} = \tau) + \sum_m \gamma_m \mathbb{1}(\text{Municipality}_m = 1)t + \epsilon_{i,t},$$

where α_m and δ_t are municipality and year fixed effects, respectively. $\tau_{0,m}$ corresponds to the year in which the One-Stop Shop opened in municipality m and γ is a vector of coefficients for municipality-specific trends. Standard errors are clustered at the municipality level. 90%. confidence intervals. In Panel (b) we also allow for a 3-digit sector of activity fixed effect interacted with the municipality fixed effect.

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Figure 9: Heterogeneous Responses in Employment and Exit by Incumbents

Employment

Exit
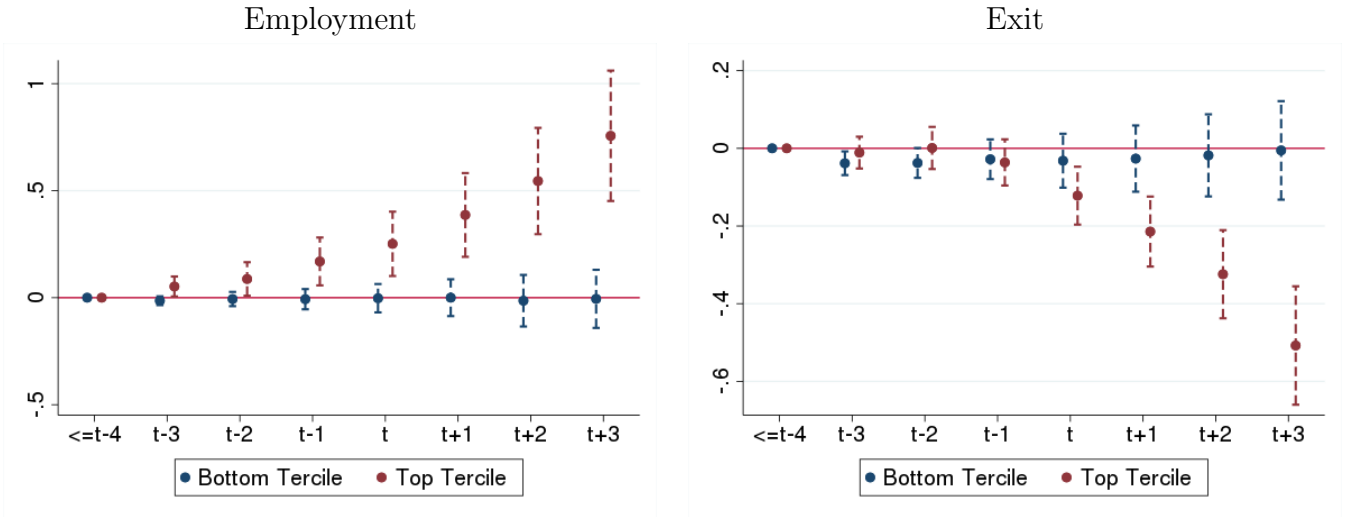
The figures show the estimates of β_τ from the regression of municipality-level aggregates for firms in the top and bottom terciles of the productivity distribution measured in 2004. We proxy productivity with the value of sales per employee at the firm level. We rank firms based on sales per employees within 3-digit sector of activity, municipality and age group (age 0-5, 6-15, 15+). Our regression model is specified as follows:

$$y_{m,t} = \alpha_m + \delta_t + \sum_{\tau=-7}^{\tau=3} \beta_\tau \mathbb{1}(t - \tau_{0,m} = \tau) + \sum_m \gamma_m \mathbb{1}(\text{Municipality}_m = 1)t + \epsilon_{m,t},$$

where $y_{m,t} = $ {total employment per 1,000 residents; total exit per 1,000 residents}. $\tau_{0,m}$ corresponds to the year in which the One-Stop Shop opened in municipality m and γ is a vector of coefficients for municipality-specific trends. Standard errors are clustered at the municipality level. 90%. confidence intervals.

Figure 10: The Impact of Empresa na Hora for Different Sectors of Economic Activity
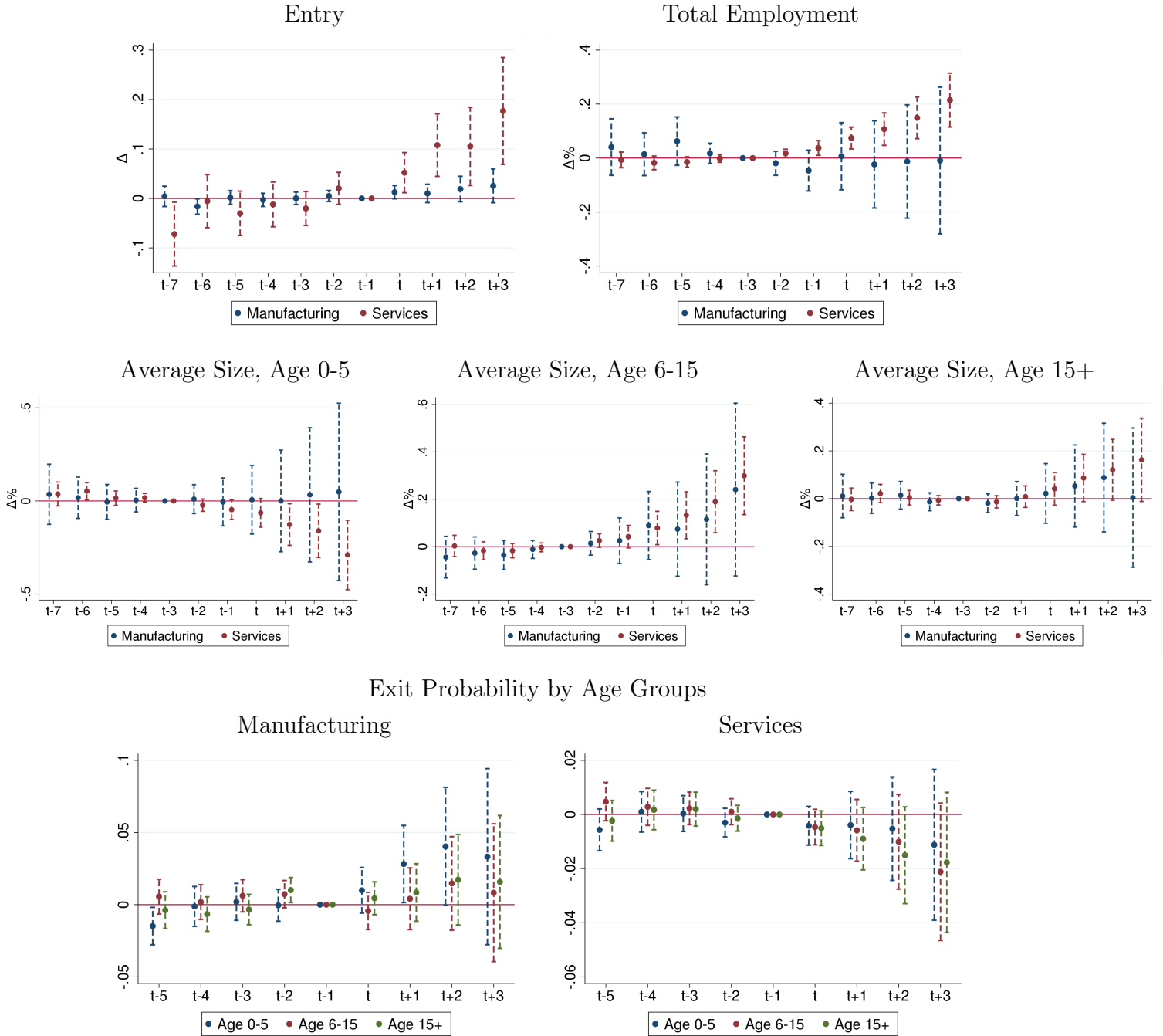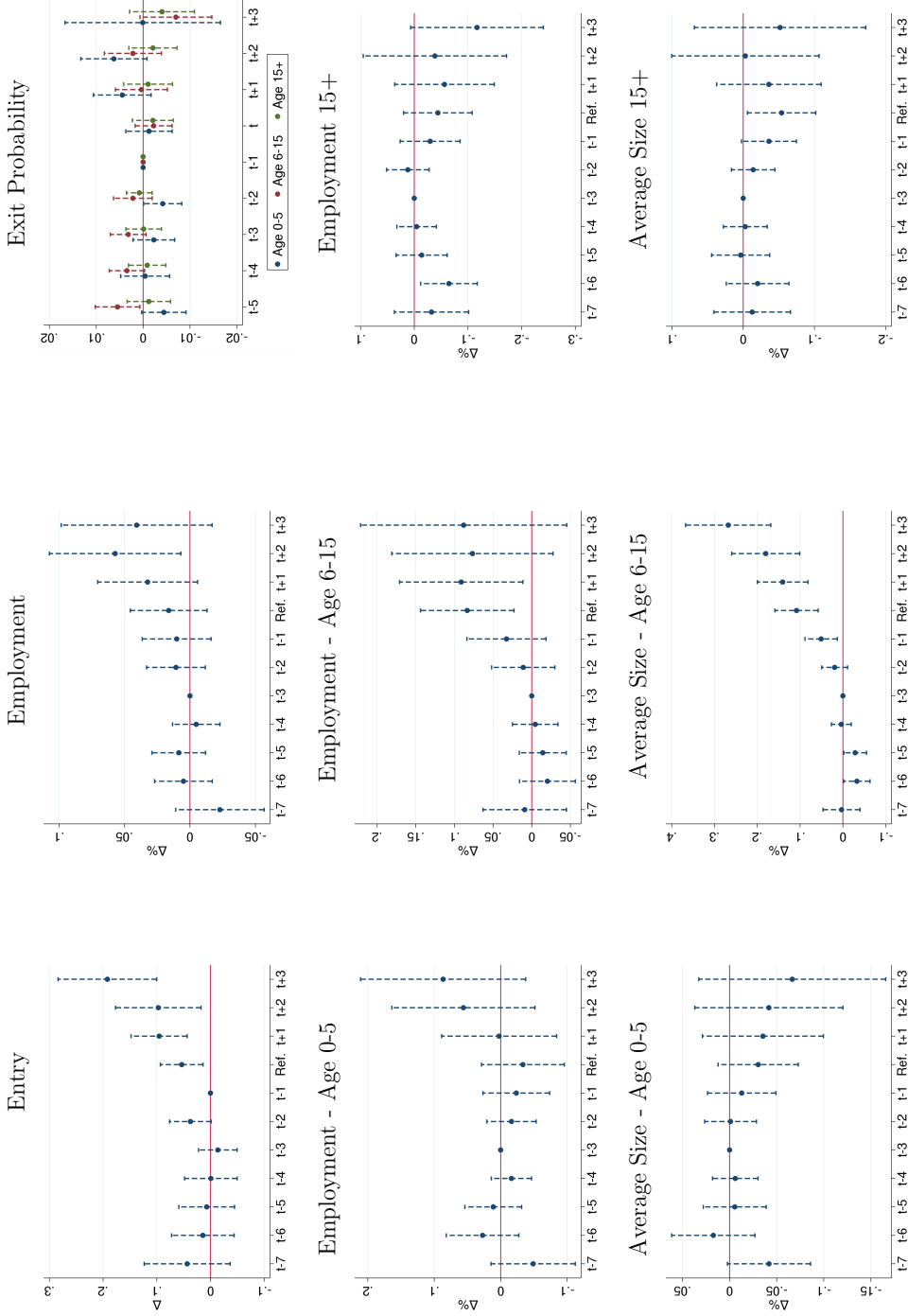

The figures show the estimates of the β_τ from the regressions of municipality-level aggregates separately for manufacturing and services. The regressions allow for municipality-specific trends. Standard errors are clustered at the municipality level. 90% confidence intervals.

A Appendix

A.1 Tables and Figures

Figure 11: Impact of Empresa Na Hora - Decile-Specific Trends

The figures show the estimates of β_τ from the following regression at the municipality level:

$$y_{m,t} = \alpha_m + \delta_t + \sum_{\tau=-7}^{\tau=3} \beta_\tau \mathbb{1}(t - \tau_{0,m} = \tau) + \sum_{q=1}^{10} \eta_q \mathbb{1}\{m \in q\} + \epsilon_{m,t},$$

η is a vector of coefficients for decile-specific trends for municipalities based on the number of residents and the value of sales in services per capita at the municipality level in the pre-period. The regression of the exit probability is run at the firm-level. Standard errors are clustered at the municipality level. 90% confidence intervals. Entry and Employment measures are normalized per 1,000 residents.

Figure 12: Heterogeneous Responses in Employment and Exit by Incumbents - Robustness
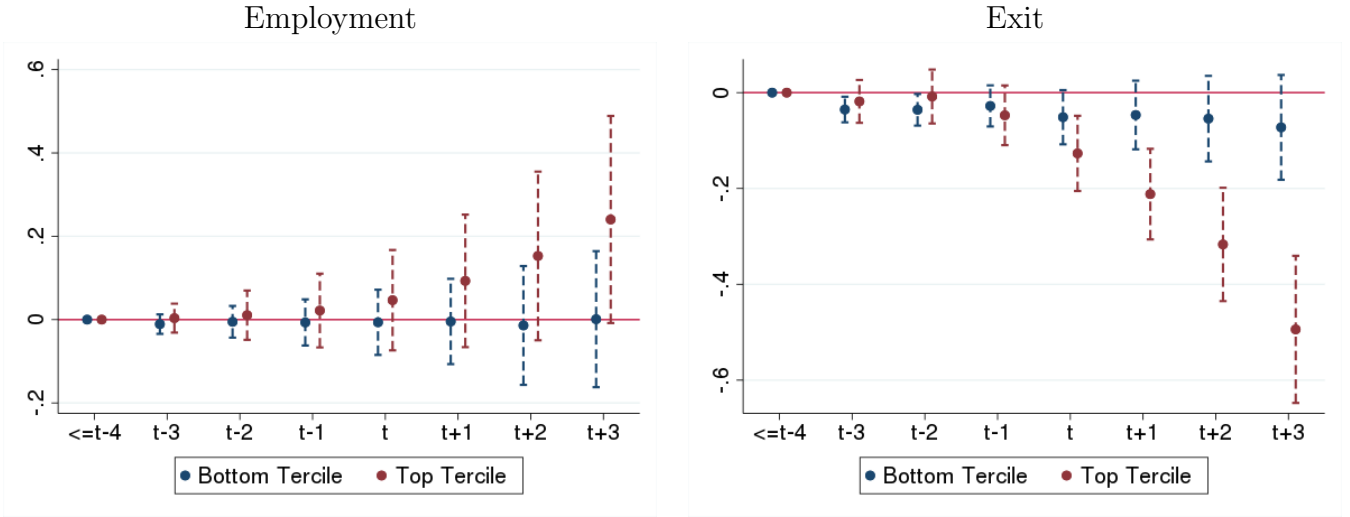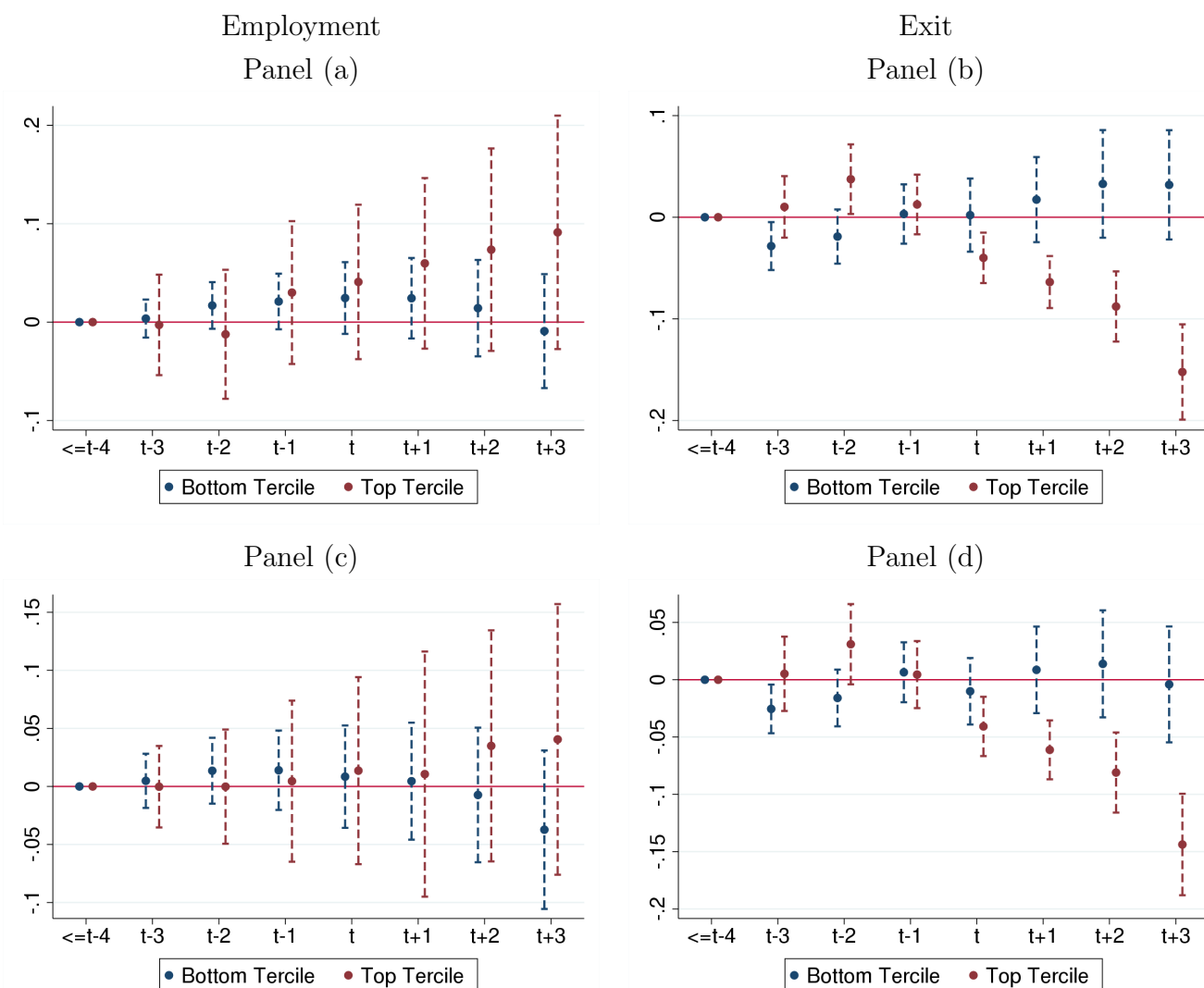

The figures show estimates of β_τ from the regression of municipality-level aggregates of the top and bottom terciles of firms productivity as measured in 2004. Differently from the main specification, we rank firms based on sales per employees within 3-digit sector of activity and municipality. That is, we rank across all age groups. Therefore:

$$y_{m,t} = \alpha_m + \delta_t + \sum_{\tau=-7}^{\tau=3} \beta_\tau \mathbb{1}(t - \tau_{0,m} = \tau) + \sum_{q=1}^{10} \eta_q \mathbb{1}\{m \in q\}t + \epsilon_{m,t},$$

where $y_{m,t}$ = {total employment per 1,000 residents; total exit per 1,000 residents}. $\tau_{0,m}$ corresponds to the year in which the One-Stop Shop opened in municipality m. η is a vector of coefficients for decile-specific trends for municipalities based on the number of residents and the value of sales in services per capita at the municipality level in the pre-period. Standard errors are clustered at the municipality level. 90% confidence intervals. In Panel (b) we also allow for a 3-digit sector of activity fixed effect interacted with the municipality fixed effect.

Figure 13: Heterogeneous Responses in Employment and Exit by Incumbents. Decile-Specific Trends

Employment
Panel (a)

Exit
Panel (b)

Panel (c)

Panel (d)

These figures show estimates of β_τ from the regression of municipality-level aggregates of firms in the top and bottom terciles of the productivity distribution in 2004. Specifically, we run:

$$y_{m,t} = \alpha_m + \delta_t + \sum_{\tau=-7}^{\tau=3} \beta_\tau \mathbb{1}(t - \tau_{0,m} = \tau) + \sum_{q=1}^{10} \eta_q \mathbb{1}\{m \in q\} + \epsilon_{m,t},$$

where $y_{m,t} = \{$total employment per 1,000 residents; total exit per 1,000 residents$\}$. $\tau_{0,m}$ corresponds to the year in which the One-Stop Shop opened in municipality m. η is a vector of coefficients for decile-specific trends for municipalities based on the number of residents and the value of sales in services per capita at the municipality level in the pre-period. Panels (a) and (b) use the ranking of firms' productivity within 3-digit sector of activity, municipality and age group. Panels (c) and (d) rank firms within 3-digit sector of activity and municipality. Employment and exit are normalized per 1,000 residents. Standard errors are clustered at the municipality level. 90% confidence intervals.

A.2 Derivations and Proofs

Proof of Proposition 1

Proof. Given our assumption on production being linear in labor, we have that $l_i = \frac{y_i}{a_i}$. Using the expression for y_i under CES in (11), we get

$$l_i = \frac{y_i}{a_i} = \left(\frac{\sigma}{\sigma-1}\frac{1}{a_i}\right)^{-\sigma}\frac{1}{a_i}P^\sigma Y. \tag{18}$$

Since we have that under CES $p_i = \frac{\sigma}{\sigma-1}\frac{1}{a_i}$, we can replace P and get

$$l_i = a_i^{\sigma-1}M^{\frac{\sigma}{1-\sigma}}[\mathbb{E}(a^{\sigma-1})]^{\frac{\sigma}{\sigma-1}}Y. \tag{19}$$

Since we need an expression for l_i that only depends on exogenous variables, we now solve for Y in closed-form. Consider

$$\frac{l_i}{l_j} = \left(\frac{a_i}{a_j}\right)^{\sigma-1}. \tag{20}$$

We know that $L = \int_0^M l_i di$, then

$$L = \int_0^M \left(\frac{a_i}{a_j}\right)^{\sigma-1}l_j di = l_j a_j^{1-\sigma}\int_0^M a_i^{\sigma-1}di. \tag{21}$$

Hence

$$l_j = a_j^{\sigma-1}\left[\int_0^M a_i^{\sigma-1}di\right]^{-1}L. \tag{22}$$

Using the fact that $y_i = a_i l_i$ and that $Y = \left(\int_0^M y_i^{\frac{\sigma-1}{\sigma}}di\right)^{\frac{\sigma}{\sigma-1}}$ we get the following:

$$y_j^{\frac{\sigma-1}{\sigma}} = a_j^{\sigma-1}\left[\int_0^M a_i^{\sigma-1}di\right]^{\frac{1-\sigma}{\sigma}}L^{\frac{\sigma-1}{\sigma}}.$$

Raising both sides to $\frac{\sigma-1}{\sigma}$ and integrating we finally get:

$$Y = [\mathbb{E}(a^{\sigma-1})]^{\frac{1}{\sigma-1}}M^{\frac{1}{\sigma-1}}L. \tag{23}$$

As a final step we need an expression for L. Using the equation for labor supply and the normalization $w = 1$ we get:

$$L = P^{-\nu} = \left(\int_0^M \left(\frac{\sigma}{\sigma-1}\right)^{1-\sigma}a_i^{\sigma-1}di\right)^{-\frac{\nu}{1-\sigma}} = \left(\frac{\sigma}{\sigma-1}\right)^{-\nu}M^{-\frac{\nu}{1-\sigma}}[\mathbb{E}(a^{\sigma-1})]^{-\frac{\nu}{1-\sigma}} \tag{24}$$

Plugging both (23) and (24) into (19) we get:

$$l_i = a_i^{\sigma-1}M^{-\left(\frac{1-\sigma+\nu}{1-\sigma}\right)}\left(\frac{\sigma}{\sigma-1}\right)^{-\nu}[\mathbb{E}(a^{\sigma-1})]^{-\frac{\sigma-1-\nu}{\sigma-1}}. \tag{25}$$

Taking logs and computing $\frac{\partial \ln l_i}{\partial \ln M}$ we get that

$$\frac{\partial \ln l_i}{\partial \ln M} > 0 \quad \text{if} \quad \sigma < 1 + \nu.$$

This proves the first result of the Proposition. The second result follows from computing $\frac{\partial^2 \ln l_i}{\partial \ln M \partial \ln a_i}$ from (25). We get,

$$\frac{\partial^2 \ln l_i}{\partial \ln M \partial \ln a_i} = 0 \quad \forall i.$$

$\square$

Proof of Proposition 2

Proof. This follows immediately from (24), once we take logs and compute $\frac{\partial \ln L}{\partial \ln M}$. $\square$

Proof of Proposition 3

Proof. We start from the equation for the elasticity ε_i defined in (17). Taking logs we get

$$\ln \varepsilon_i = \ln \left(1 + \frac{\gamma}{s_i} \right),$$

so that

$$\frac{\partial \ln \varepsilon_i}{\partial \ln M} = -\gamma \frac{1}{\left(1 + \frac{\gamma}{s_i} \right)} \frac{\partial s_i}{\partial \ln M}. \tag{26}$$

While the first ratio of (26) is positive, we now need to sign $\frac{\partial s_i}{\partial \ln M}$. We start from the expression for s_i in (16), and substitute the expression for p_i in (15) and for $\overline{\ln p}$ equal to

$$\overline{\ln p} = \int_0^M \frac{1}{M} \ln p_i di = \int_0^M \frac{1}{M} \ln \left(\left(1 + \frac{s_i}{\gamma} \right) \frac{1}{a_i} \right) di = \int_0^M \frac{1}{M} \ln \left(1 + \frac{s_i}{\gamma} \right) di - \overline{\ln a}. \tag{27}$$

We then get the following expression for s_i:

$$s_i = \frac{1}{M} + \gamma \left[\int_0^M \frac{1}{M} \ln \left(\frac{s_j}{\gamma} + 1 \right) dj - \overline{\ln a} \right] - \gamma \ln \left(1 + \frac{s_i}{\gamma} \right) + \gamma \ln a_i,$$

which we rewrite as

$$s(a_i) = \frac{1}{M} + \gamma \left[\int \ln \left(\frac{s_j}{\gamma} + 1 \right) dF(a_j) \right] - \gamma \overline{\ln a} - \gamma \ln \left(1 + \frac{s_i}{\gamma} \right) + \gamma \ln a_i.$$

Taking derivatives with respect to $\ln M$ we get

$$\frac{\partial s(a_i)}{\partial \ln M} = \frac{1}{1 + \frac{\gamma}{1 + \frac{s(a_i)}{\gamma}}} \left(-\frac{1}{M} + \gamma \int \frac{1}{1 + \frac{s(a_j)}{\gamma}} \frac{\partial s(a_j)}{\partial \ln M} dF(a_j) \right). \tag{28}$$

Further deriving with respect to $\ln a_i$ we get:

$$\frac{\partial^2 s(a_i)}{\partial \ln M \partial \ln a_i} = -\frac{1}{1 + \frac{\gamma^2}{\gamma + s(a_i)}} \frac{1}{\left(1 + \frac{s(a_i)}{\gamma}\right)^2} \frac{\partial s(a_i)}{\partial \ln a_i} \frac{\partial s(a_i)}{\partial \ln M}. \tag{29}$$

Given that the first three components of the right hand side are all positive, the sign of $\frac{\partial^2 s(a_i)}{\partial \ln M \partial \ln a_i}$ is determined by the sign of $\frac{\partial s(a_i)}{\partial \ln M}$. Suppose that there exists an a_i such that $\frac{\partial s(a_i)}{\partial \ln M} = 0$, then $\frac{\partial^2 s(a_i)}{\partial \ln M \partial \ln a_i} = 0 \ \forall i$. This means that $\frac{\partial s(a_i)}{\partial \ln M}$ cannot change sign. If so, then by continuity there exists an a_i such that $\frac{\partial s(a_i)}{\partial \ln M} = 0$, implying that $\frac{\partial s(a_i)}{\partial \ln M} = 0 \ \forall i$, which contradicts the statement that $\frac{\partial s(a_i)}{\partial \ln M}$ changes sign. This means that $\frac{\partial s(a_i)}{\partial \ln M}$ satisfies one of these three cases: (i) it is always zero, (ii) it is always positive, (iii) it is always negative.

To determine which is the case, consider the following:

$$\int s(a_i) dF(a_i) = \frac{1}{M}.$$

By totally differentiating both sides by $\ln M$ we get that

$$\int \frac{\partial s(a_i)}{\partial \ln M} dF(a_i) = -\frac{1}{M}. \tag{30}$$

Hence

$$\frac{\partial s(a_i)}{\partial \ln M} < 0 \qquad \forall i. \tag{31}$$

This implies

$$\frac{\partial \ln \varepsilon_i}{\partial \ln M} > 0, \quad \forall i$$

.

$\square$

Proof of Proposition 4

Proof. We start from $l_i = \frac{s_i E}{p_i a_i}$. We take logs and replace the expression for $\ln p_i$ from (15). We then get

$$\ln l_i = \underbrace{\ln s_i - \ln\left(1 + \frac{s_i}{\gamma}\right)}_{\equiv \Phi(s_i)} + \ln E. \tag{32}$$

In order to derive $\frac{\partial^2 \ln l_i}{\partial \ln M \partial \ln a_i}$, we start from

$$\frac{\partial \Phi(s_i)}{\partial \ln M} = \frac{\gamma}{s_i(\gamma + s_i)} \frac{\partial s_i}{\partial \ln M}. \tag{33}$$

Then

$$\frac{\partial^2 \ln l_i}{\partial \ln M \partial \ln a_i} = -\frac{\gamma}{(s_i(\gamma + s_i))^2} \underbrace{\frac{\partial s_i}{\partial \ln a_i}}_{>0} (2s_i + \gamma) \underbrace{\frac{\partial s_i}{\partial \ln M}}_{<0} + \frac{\gamma}{(s_i(\gamma + s_i))} \underbrace{\frac{\partial^2 s_i}{\partial \ln M \partial \ln a_i}}_{>0} > 0. \tag{34}$$

$\square$

Proof of Proposition 5

Proof. Let us start from the expression for labor supply $L = P^{-\nu}$, where we used the normalization $w = 1$. We know that $P = exp(\overline{\ln P})$, with

$$\overline{\ln P} = \int \left(\ln \left(1 + \frac{s_i}{\gamma} \right) - \ln a_i \right) dF(a_i). \tag{35}$$

Then

$$\frac{\partial \overline{\ln P}}{\partial \ln M} = \frac{1}{1 + \frac{s_i}{\gamma}} \frac{\partial s_i}{\partial \ln M}. \tag{36}$$

From (31) we know that $\frac{\partial s_i}{\partial \ln M} < 0$, hence $\frac{\partial \overline{\ln P}}{\partial \ln M} < 0$. Since $\ln L = -\nu \overline{\ln P}$, aggregate labor L increases after the reform. $\qquad \square$