# Adjustment costs and factor demand: new evidence from firms' real estate*

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**Abstract**

We study corporate real estate frictions and its effect on firm dynamics. By linking the adjustment of premises to local relocations, we are able to empirically explore the impact of adjustment costs on labor demand. We set and simulate a general equilibrium model with heterogeneous firms that predicts the response of firms to a productivity shock in the presence of fixed adjustment costs on real-estate. Using a large firm-level database merged with local real estate prices, we then exploit variations in the tax on capital gain to document a causal effect of adjustment costs on firms' labor demand and derive new results on the causes and implications of firms' local relocation.

**JEL classification:** D21, D22, H25, J21, O52, R30

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# 1 Introduction

Recently, a lot of effort has been devoted to identifying cross-country differences in productivity and income per capita through the lens of misallocation of firm-level resources. This literature was pioneered namely by Restuccia and Rogerson (2008) and Hsieh and Klenow (2009). The latter propose a methodology to measure potential gains from reducing the dispersion of marginal revenue products of inputs across firms. Their work has since been replicated in a number of countries[1] and always conclude that misallocation induces significant productivity losses. Yet, as underlined by Restuccia and Rogerson (2017), identifying the causes of misallocating resources toward less productive firms remain a first-order question. In this paper, we consider the role of adjustment costs associated with corporate real estate transactions as a source of misallocation of production factors.

Misallocation of production factors has been chiefly traced to policy distortions (Olley and Pakes, 1996; Restuccia and Rogerson, 2008; Hsieh and Klenow, 2009 and, in the case of France, Garicano et al., 2016 and Gourio and Roys, 2014) but adjustment costs are innately mentioned as impediments to the optimal allocation of resources. For example, Asker et al. (2014) link the dispersion of static measures of capital misallocation to the dynamic choice of production inputs. Yet, the main frictions that have been studied are usually very "reduced-form" (see e.g. Cooper and Haltiwanger, 2006) or focuses on a specific sector as in Gavazza (2011).[2]

In this paper, we study corporate real estate adjustment frictions that affect firms in all sectors of the economy. The relevance of studying corporate real estate in this context is substantiated by recent findings on the role of land in the misallocation of production factor. Duranton et al. (2015) use micro data on Indian firms and find that misallocation of manufacturing output is mostly due to an inefficient allocation of land across firms. In addition, the nature of these real estate transactions offer a way to identify their effects on firms' dynamics and factor reallocation by linking the adjustment of firms' premises to local relocations. Among many fixed costs associated with such relocation, we exploit observable heterogeneity induced by the tax on realized capital gains from the selling of the previous premises, that depend on the dynamics of local real estate prices since the acquisition date. Using a large firm-level database merged with local real estate prices, we document sizable effects of the adjustment costs on firms' labor demand and derive new results on the causes and implications of firms' local relocation.

Our empirical identification relies on the equivalence between the alteration of the premises' volume and local relocation of single establishment firms. This equivalence matters because relocation costs vary across firms and across time and because the underlying determinants of those costs are observable for both non-relocating and relocating firms. This equivalence is warranted by the argument put forward by Schmenner (1980) that on-site expansion, out-site expansion (branching)

[1] See for example Calligaris (2015); Dias et al. (2016) and Libert (2017).

[2] With some notable exceptions regarding labor input, see Hamermesh (1989); Caballero et al. (1997); Cooper and Willis (2009) and Bloom (2009). In the case of capital Caballero et al. (1995); Cooper and Haltiwanger (2006) and Bloom (2009) explore the effect of different structures of costs and uses firm-level data to test their empirical relevance.

and relocation are not substitute to one another and that the latter is the only option for many firms when it comes to adapting the size of the premises.[3] Firms' relocation is actually a fairly frequent event: with definitions that will be clarified below, we find that 1.7% of French firms relocate their activities to a neighbouring city, on average, each year. In line with our argument on the intertwining of factors' adjustment and relocation, this yearly propensity to relocate reaches more than 4% for firms at the upper workforce growth decile.

To guide our empirical investigations, we build a general equilibrium model with heterogeneous firms to derive predictions on the effect of the level of the fixed costs associated with real estate adjustment on the workforce growth across the productivity shocks distribution. In this framework, profit-maximizing firms are heterogeneous with respect to their productivity level and make decisions on labor and real estate inputs in a context of adjustable real estate inputs conditional on paying a non-convex cost. The level of these adjustment costs deter some firms from optimally adjusting their real estate inputs to the new productivity level and the complementarity between real estate and labor in the production process implies that it also affects firms' labor demand. We derive the existence of an interval of inaction for the difference in size between the optimal premises and the occupied ones in which firms prefer not to adjust their real estate inputs. Such an interval is a classical result of the literature on investment with non-convex adjustment costs (see e.g. Grossman and Laroque, 1990). In our framework, this non-relocating interval entails that firms affected by low positive productivity shocks operate in sub-optimally small premises whereas those affected by low negative productivity shocks operate in sub-optimally large premises. The complementarity between real estate and labor leads these firms to restrain employment growth as compared to the counter-factual employment growth that would be observed had those firms adjusted real estate. We show that the interval of inaction widens with the level of the adjustment costs and so do the number of firms affected.

We then test these predictions and give support toward a causal effect using data on single-establishment firms and their location covering mainland France from 1994 to 2013. Our empirical study focuses on inter-municipality relocations occurring over a short distance that leave the economic environment of the firm (e.g, localized aggregate increasing return, real estate prices or wages) largely unaltered and are more likely to be primarily triggered by the inappropriateness of the site's characteristics.[4] We study the effect of adjustment costs of real estate by exploiting two types of heterogeneity in relocation costs. First, by comparing firms that own their premises and firms that rent them. Second by restricting to real estate owners and by exploiting the latent tax on

[3]On-site expansion, especially in the non-manufacturing sector and/or in urban areas, is often an option that has to be discarded because access to adjacent land or premises is constrained. Informal talks with market participants indicate that sublease of unused premises has been at a very early stage of development over the studied period. Out-site expansion is potentially associated with additional on-going costs resulting from fixed expenses per establishment and important losses of synergies. This point is further discussed in Section 2.

[4]Focusing on local relocations is also justified by the fact that in such cases, employees are more likely to remain in the firm; which is not the case for relocations over longer distances: Weltevreden et al. (2007) shows that when the relocation distance exceeds 20km, most employees quit there jobs in anticipation of the relocation decision.

realized capital gains affecting real estate assets that owning firms must pay when they relocate.[5] Heterogeneity in the level of this tax naturally come from the way it is designed. In a nutshell, the tax base is determined by the size of the real estate assets, the acquisition date and the dynamic of local prices since this acquisition. This scheme introduces important variability across firms and across time in the level of the relocation costs. We document that higher relocation costs lower firms' propensity to relocate and constrain employment growth of the growing firms. Our baseline results suggest that a reduction of the relocation costs, through a decrease of the share of the real estate market value that would be paid as a tax on capital gains of 1 standard deviation, would decrease the propensity to relocate of affected firms by 10 to 30% and would raise the yearly employment growth rate of the growing firms by 5%. Such reduction in the adjustment costs would therefore result in an important increase in job creation and job reallocation in the most productive firms. Additional empirical evidences suggest that this reduction in the adjustment costs would foster optimal allocation of factor inputs.

Our identification strategy shares similarities with the literature on the effect of tax friction on real estate transactions and households' mobility. Dachis et al. (2012), Best and Kleven (2013) and Hilber and Lyytikäinen (2013) all study the effect of transaction tax on *residential* real estate dynamic and find large aggregate effects. Hilber and Lyytikäinen (2013) exploit cut-off values in the tax associated with housing transactions to claim that an increase in transaction cost by 2 to 3 percentage points reduces mobility by 30%; this is only true for short distance relocations, suggesting that frictions may lead to misallocation of dwellings in the housing market. In the same vein, this paper is also related to the literature that studies the impact of the tenure status in the residential housing market on job mobility and labor market outcomes. This literature typically finds that a high share of home-owners impairs the good functioning of the local labor market because of the real estate transaction costs associated with home-owners relocation (Oswald, 1996, Battu et al., 2008, Munch et al., 2008).

The paper is organized as follows: section 2 presents stylized facts on the interaction between relocation behavior and employment dynamics. Section 3 presents a theoretical framework development to formulate testable predictions on firms' behavior. Section 4 presents our empirical analysis, findings and comments and section 5 concludes.

## 2 Background

Little is known about firms' local relocations and their connection to firms' employment dynamism. Most of the existing literature has rather focused on explaining the determinants of relocation and the choice of the destination. It is acknowledged that, although external factors (characteristics of potential new sites) are at play in the choice of the place of relocation, internal factors (size,

[5] Indeed, for single-establishment firms holding the real estate assets in which they operate, a relocation is necessarily associated with the sale of previously occupied premises if we make the reasonable assumption that limited access to funding prevents the firms from concomitantly owning various premises.

age, tenure status, sector and growth) are the main predictors of firms' relocation decision (see for example Pellenbarg et al., 2002 and Brouwer et al., 2004). This first section sheds light on stylized facts supporting our views that there exists a close relationship between firms' local relocation and factors' adjustment. After briefly presenting the databases, we look at some general characteristics of firms' relocation. We then document that employment dynamics and local relocations are closely intertwined.

### 2.1 Data

To derive our results, we use a firm level database with information on a large number of French firms over the period 1994-2013 called `FiBEn`. `FiBEn` is built by the Bank of France from fiscal documents and contains detailed information on flow and stock accounting variables, notably on real estate assets, as well as information on firms' activities, location and workforce. We restrict to single-establishment firms that remain below 250 employees[6]. Below this threshold, 85.7% of the firms are single-establishment. The firm reports the code of its current municipality and we use changes in this code to detect inter-municipality relocations. This database is then merged with local residential real estate prices. Namely, we use the *Notaires*-INSEE[7] apartment price indices built by Fougère and Poulhes (2012) which are based on the data collected by the French solicitor association to derive capital gains on real estate assets. Residential housing prices are used in this study because French corporate real estate prices at the local level are not available over the studied period.[8] We describe our dataset and the variable construction in more detail in Appendix A.

### 2.2 Firms' mobility in France

Our firm-level database allows to identify inter-municipality relocations of single-establishment firms between 1994 and 2013. We observe $124,191$ single-establishment firms over an average period of 9.93 years. Among these firms, $22,057$ have relocated their activities to another municipalities over the period of observation; that is approximately 18% of the sample. Half of the relocations concerns a relocation where the municipality of departure and the municipality of settlement are distant by less than 8km. For a little more than 70% of the relocations, this distance is inferior to 15km. These first empirical results are in line with other studies that report statistics on the distance between the place of departure and the place of settlement of relocating firms. They find that local relocations account for the large majority of the relocations (Pen and Pellenbarg, 1998; Delisle and Laine, 1998; Weltevreden et al., 2007 and Knoben et al., 2008). In France, Delisle and Laine (1998) document that 6.2% of the firms had relocated between 1989 and 1992, with more than three quarters of the inter-municipality relocations being characterized by a distance inferior to

[6]This size restriction is made to limit measurement errors in real estate volume and location, see Appendix A for more details.

[7]Solicitor is the English equivalent for the French word *notaire* and INSEE is the French National Statistical Bureau.

[8]As noted by Fougère et al. (2017), there is evidence that, at the national level, prices in the different segments of the real estate market, and notably residential and corporate real estate, follow similar trends

23km and Jourdan (2004) reports a yearly frequency of relocation around 2% from 1996 to 2001. Similarly, in Netherlands, Weltevreden et al. (2007) shows that between 1999 and 2006, most relocations are made within the same labor market area. We hereafter define as “local” a relocation that is characterized by a distance of less than 15km, between the municipality of departure and the municipality of settlement.[9] The distribution of the relocating distance is given in Figure A1 in Appendix A.

Table 1 presents some basic descriptive statistics to compare relocating firms to a control group made of static firms. We notice that relocating firms do not differ much by their size, their employment level and their profitability (even if some of those small differences are statistically significant). Slightly larger differences are observed for the age of the firm; static firms being in average 1.8 year older than relocating firms. Yet, sizable and statistically significant differences are observed regarding two characteristics: (i) the yearly mean employment growth over the observation period: while the mean yearly workforce growth of relocating firms is equal to 5.3%, it is 2.5% for static firms; (ii) the tenure status of the firm: 26% of the relocating firms report real estate holdings while this share is equal to 39% for static firms.

### 2.3 Relocating behavior and workforce growth

The average workforce growth of relocating firms reported in Table 1 suggests that relocation is markedly related to factors' adjustment. In order to explore this relationship, we rank firms according to their mean yearly workforce growth rate over the observation period. In each percentile of this average workforce growth distribution, we compute the propensity to relocate by dividing the number of observed local relocations by the number of observations in this percentile. The results are presented in Figure 1 where average employment growth has been residualized on a complete set of sector-*département* dummies. We find that firms located in the first two deciles (*resp.* in the three last deciles) in the workforce growth distribution, which corresponds to an average yearly workforce growth rate below −4.0% (*resp.* above 1.5%), have a much higher propensity to relocate than firms characterized by limited change in their workforce size.

These results are robust to restricting to different sectors or areas. One could for example believe that service firms are more prone to relocate than manufacturing ones and are in larger quantities in major cities which are rich and dynamic areas where firms grow faster. In Appendix B, we report the results of a similar analysis focusing on Paris (Figure B1a), Lyon (Figure B1b) and Marseilles (Figure B1c) areas which are the three largest cities in France. We also present the relationship between the propensity to relocate and employment growth in the whole country excluding these three areas in Figure B1d. We can see that the U-shaped relationship is robust to such stratification and seems

[9] Following this definition 73.4% of the relocations observed in our sample are local. There is of course a degree of arbitrariness in setting such a threshold. As mentioned before, it reflects the idea that relocations over farther distance are more likely to alter the local economic conditions and might require that the existing employees change their place of residence, inducing higher costs and new risks. All our subsequent results are robust to using different thresholds or to defining as local the relocations occurring within the local labor market area based on commuter flows from census data, see Appendix D.

Table 1: Key summary statistics - relocating locally and static firms

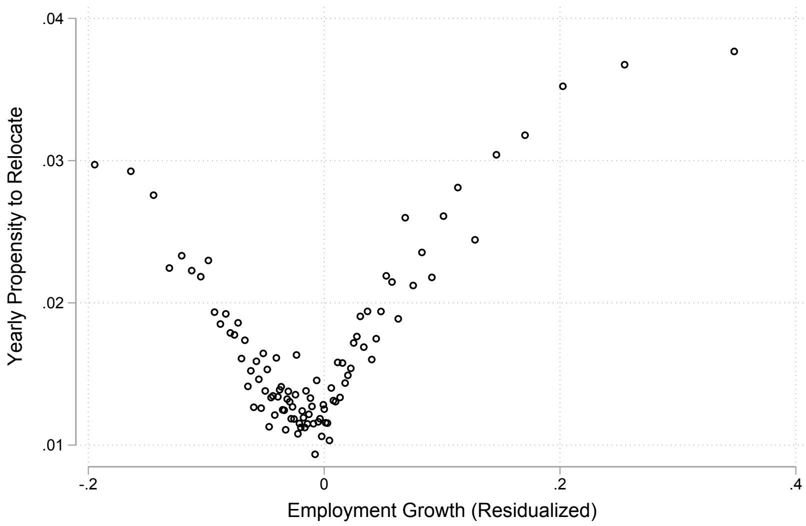
| | Mean | | Difference | |
|---|---|---|---|---|
| | Relocating locally | Static | | |
| Employment | 18.9 | 20.1 | -1.17*** | (0.19) |
| Sales | 3.14 | 2.98 | 0.16*** | (0.06) |
| Balance Sheet size | 2.11 | 2.27 | -0.16 | (0.20) |
| Profits | 0.135 | 0.124 | 0.011*** | (0.0013) |
| Age | 12.0 | 13.8 | -1.8*** | (0.11) |
| Employment growth | 5.3% | 2.5% | 2.8%*** | (0.0013) |
| Real estate owner | 26% | 39% | 13%*** | (0.004) |
| Nb of obs. | 18,193 | 105,998 | - | |

**Notes**: This table shows the mean of different key variables, in initial year of observation, for firms that locally relocate and for firms that neither relocate nor shift towards a multi-establishment structure over the observed period. Employment is given in full-time equivalent (FTE) number of workers as reported by the firm; Employment growth in the mean yearly percentage change in FTE over the observation period; Sales are in millions of euros; Balance Sheet size is the net value of the assets reported in the balance sheet and is given in millions of euros; Profits is the Earning Before Interest and Tax margin (i.e., EBIT to Sales ratio); Age is the number of year since company's incorporation; Real estate owner is a dummy variable equal to 1 if the firm reports real estate holdings and 0 otherwise. Source: `FiBEn`, see Appendix A for more detail about the data. The latest column show the mean and standard deviation of the difference between the two coefficients and the Student t-stat on the nullity of this difference. ***, ** and * indicate that the null hypothesis of this test is rejected at the 1%, 5% and 10% level of significance, repectively.

to be, as expected, stronger in the Paris area where on-site expansion is arguably more constrained. Finally, Figures B1e and B1f report the results when focusing on service industries (Figures B1e) and manufacturing firms (Figures B1f). The link looks stronger in the service industries, where relocating costs are clearly lower and on-site expansion is more constrained.

In the following section, we develop a theoretical framework that relies on this link between real estate adjustment and local relocations.

Figure 1: Propensity to relocate and employment growth




**Notes**: Employment growth is taken as the average employment growth over the period of observation and residualized on a set of sector-*département* dummies. The propensity to relocate is calculated as the number of observed local relocation divided by the number of years of observations. These two variables are averaged for each percentiles of the distribution of the residualized employment growth. The first and the last percentiles have been removed to focus on the core of the distribution. Period of observation: 1994-2013. Source: `FiBEn`, see Appendix A for more details about the data.

# 3 Model

In this section, we develop a standard model of monopolistic competition with heterogeneous firms. Firms observe an idiosyncratic change in their productivity level and decide to adjust the size of their premises or to do nothing. In the former case, a fixed adjustment cost must be paid which we interpret as a relocation cost. Firms then adjust freely their other production factors, in particular their workforce. The model predicts the existence of an interval of inaction: firms that did not received a sufficient productivity shock (in absolute value) would find it more profitable not to adjust their premises. Finally, we simulate the model using information on the productivity distribution and relocation behavior of French firms.

## 3.1 Model setup

### 3.1.1 Demand

There is a continuum of products $i \in [0, 1]$ and a final sector using all products $i$ as inputs to produce $Y$ with a CES technology:

$$Y = \left[ \int_0^1 y(i)^{1-\varepsilon} di \right]^{\frac{1}{1-\varepsilon}}. \quad (1)$$

where $\varepsilon$ is the inverse of the elasticity of substitution.

The conditional demand function for $y(i)$ can be written as

$$y(i) = \left[\frac{P}{p(i)}\right]^{\frac{1}{\varepsilon}} Y, \tag{2}$$

where $P$ is the final good price and $p(i)$ is the price of $y(i)$. From the zero profit condition of the final good producer, we obtain:

$$P = \left[\int_0^1 p(i)^{\frac{\varepsilon-1}{\varepsilon}} di\right]^{\frac{\varepsilon}{\varepsilon-1}}. \tag{3}$$

### 3.1.2 Production

Each product $i$ is produced by a monopolistic firm indexed by $i$ with a Cobb-Douglas production function using labor and real estate as inputs.[10] These firms differ by their parameters $\theta(i)$ such that:

$$y(i) = \theta(i)\left(\frac{l(i)}{\alpha}\right)^{\alpha}\left(\frac{r(i)}{1-\alpha}\right)^{1-\alpha}. \tag{4}$$

$\theta(i)$ can be understood in many different ways, it can measure a firm-specific demand shock, technology level or the quality of product $i$ as in Aghion and Howitt (1992) or managerial ability as in Garicano et al. (2016), in what follows we will refer to it as the firm productivity. Labor and real estate are mobile across firms in the intermediate sector. The endogenous market wage, $w$, and the endogenous market price of one unit cost of real estate, $u$ - the user cost of real estate capital or equivalently its renting rate - are thus the same across all firms.

Each firm $i$ considers the demand function and takes into account the fact that prices $p(i)$ adjust to:

$$p(i) = \frac{Y^{\varepsilon}P}{\theta(i)^{\varepsilon}}\left(\frac{l(i)}{\alpha}\right)^{-\alpha\varepsilon}\left(\frac{r(i)}{1-\alpha}\right)^{-(1-\alpha)\varepsilon}, \tag{5}$$

hence, firm $i$'s revenue is given by:

$$p(i)y(i) = \Omega(i)\left(\frac{l(i)}{\alpha}\right)^{\alpha(1-\varepsilon)}\left(\frac{r(i)}{1-\alpha}\right)^{(1-\alpha)(1-\varepsilon)}, \tag{6}$$

where $\Omega(i) = \theta(i)^{1-\varepsilon}Y^{\varepsilon}P$ is the revenue productivity (Foster et al., 2008 and Hsieh and Klenow, 2009).

[10] We consider the first production factor to be labor. More generally, this aggregates all the production factors that are not subject to non-convex adjustment cost. In particular, including non real estate capital stock as an input won't affect our theoretical prediction if we assume that adjustment costs in real estate are not affected by the level of capital stock. Hence.

### 3.1.3 Resource constraint

We consider a closed economy where a representative consumer owns the intermediate firms, real estate assets and provide labor. Aggregate labor and real estate are in fixed-supply and we set them to $L_s$ and $R_s$, respectively.[11]

### 3.1.4 The problem of the firm

At the beginning of the period, each firm observe its productivity level $\theta(i)$ and subsequently decides to adjust its labor and real estate. While labor can be adjusted without frictions, we consider that the volume of real estate can only be altered conditional on relocating. This condition relies upon the constrained on-site expansion and the constrained sublease of vacated premises hypotheses. We denote $z(i)$ the decision variable with $z(i) = 1$ if firm $i$ relocates and $z(i) = 0$ otherwise. Relocating is associated with costs that we will specify below in order to relate them to actual costs faced by relocating firms. In this theoretical framework, we model these costs as proportional to the volume of the (previous) endowed premises. This specification aims at capturing the fact the fixed costs vary with the size of the premises and at simplifying mathematical expressions. Formally, the costs are equal to $\zeta r_0(i)$, where $r_0(i)$ is firm $i$'s initial premises volume and $\zeta$ is a non-negative real number.[12]

Because of the fixed adjustment costs, a firm may decide to remain in its latest premises even if its productivity level has changed (see Cooper et al., 1999 and Cooper and Haltiwanger, 2006 for a thorough discussion on the implication of non-convex adjustment costs on investment decision).

The price of both inputs are taken as given by the profit maximizing firms. Finally, firm $i$'s decision problem can be written:

$$\max_{z(i)\in\{0,1\}} \left[ z(i) \max_{\substack{r(i)>0;l(i)>0\\p(i)>0}} [\pi(i, r(i)) - ar_0(i)] + (1 - z(i)) \max_{\substack{l(i)>0\\p(i)>0}} [\pi(i, r_0(i))] \right], \tag{7}$$

where $\pi(i, r(i))$ denotes the profit function of firm $i$ defined as $p(i)y(i) - wl(i) - ur(i)$. In what follows, we shall call $\pi^{(1)}(i)$ the optimal profit in the case of a relocation and $\pi^{(0)}(i)$ in the case of no relocation.

## 3.2 Solving the model

We consider the following situation: at $t = 0$, $\zeta = 0$ and consequently all the firms have an optimal friction-less level of input. To simplify the exposition, we will in addition assume that they all have

[11]The fixed aggregate supply of both labor and real estate is a strong assumption which is likely to exacerbate the response of prices in our model. We make this choice for two reasons. First because it simplifies the exposition of the model which does not focus on the response of input prices but rather on the firm's decision. Second since as documented by Chapelle and Eymeoud (2018), real-estate is much more inelastic in France than in the US.

[12]Notice also that the predictions of the model are unaltered if we introduce linear or/and convex adjustment costs in addition to those fixed costs. We focus on the consequences of changes in the value of parameter $\zeta$, that is to say of the parameter governing the level of the fixed costs, because we observed firm level variation with respect to fixed costs in the data.

the same level of productivity $\theta_0$. We study the long-run impact of an heterogeneous change in productivity level when $\zeta > 0$ by comparing the new steady-state equilibrium resulting from these structural changes. In what follow, we assume that each firm draw its final productivity level $\theta(i)$ from a known distribution with cumulative distribution function $F_\theta$.

### 3.2.1 Decentralized equilibrium

The equilibrium is defined by a vector of allocation $\{r(i), l(i), y(i), z(i), Y\}$ and a vector of prices $\{P, p(i), u, w\}$ such that:

- Given $\theta(i)$, $u$ and $w$, $\{r(i), l(i), z(i), p(i)\}$ maximize firm $i$'s profit for every $i$ as defined in equation (7) (and $r(i) = r_0(i)$ if $z(i) = 0$).
- Final good producing competitive firm chooses $y(i)$ for all $i$ to produce $Y$ by maximizing its profit taking $p(i)$ as given.
- Labor and real estate markets clear.

### 3.2.2 The friction-less case

In the simple case where $\zeta = 0$, we show in Appendix C.1 that our model yields the following optimal allocation:

$$z(i) = 1 \; ; \; l(i) = \frac{\theta(i)^{\frac{1-\varepsilon}{\varepsilon}}}{\int_0^1 \theta(i)^{\frac{1-\varepsilon}{\varepsilon}} di} L_s \text{ and } r(i) = \frac{\theta(i)^{\frac{1-\varepsilon}{\varepsilon}}}{\int_0^1 \theta(i)^{\frac{1-\varepsilon}{\varepsilon}} di} R_s \;\forall i \in [0,1] \tag{8}$$

Normalizing $P$ to 1, we show that prices are endogenously set as follows:

$$u = (1-\varepsilon)\frac{1-\alpha}{R_s} Y \; ; \; w = (1-\varepsilon)\frac{\alpha}{L_s} Y \text{ and } p(i) = \frac{1}{\theta(i)} \left( \int_0^1 \theta(i)^{\frac{1-\varepsilon}{\varepsilon}} di \right)^{\frac{\varepsilon}{1-\varepsilon}} \tag{9}$$

and that aggregate production is equal to:

$$Y = \left( \int_0^1 \theta(i)^{\frac{1-\varepsilon}{\varepsilon}} di \right)^{\frac{\varepsilon}{1-\varepsilon}} \left( \frac{L_s}{\alpha} \right)^{\alpha} \left( \frac{R_s}{1-\alpha} \right)^{1-\alpha}. \tag{10}$$

In particular, without friction, this model generates an optimal factor allocation in the sense that the allocation maximizes $Y$ and is uniquely determined by the distribution of productivity and aggregate inputs supply.

### 3.2.3 The case with frictions

Labor adjustment being friction-less, $l$ always satisfies the first order conditions. Conversely, $r$ only satisfies first-order conditions if $z = 1$, otherwise $r = r_0$. If $z = 1$, it is easy to show that a firm with productivity level $\theta$ has a profit:[13]

$$\pi^{(1)}(\theta) = \frac{u\varepsilon}{(1-\alpha)(1-\varepsilon)} r^{\star}(\theta) - \zeta r_0 \tag{11}$$

where $r^{\star}(\theta)$ denotes the optimal volume of real estate conditional on $z(\theta) = 1$.

Whereas if $z(\theta) = 0$:

$$\pi^{(0)}(\theta) = \frac{u(1-\alpha(1-\varepsilon))}{(1-\alpha)(1-\varepsilon)} r^{\star}(\theta)^{\frac{\varepsilon}{1-\alpha(1-\varepsilon)}} r_0^{\frac{(1-\alpha)(1-\varepsilon)}{1-\alpha(1-\varepsilon)}} - u r_0. \tag{12}$$

The relocation condition, $\pi^{(1)}(\theta) > \pi^{(0)}(\theta)$, can be written as a simple condition on $\frac{r^{\star}(\theta)}{r_0}$, the relative change in size between the optimal premises following the shock and the endowed premises:

$$\frac{u\varepsilon}{(1-\alpha)(1-\varepsilon)} \left( \frac{r^{\star}(\theta)}{r_0} - \frac{1-\alpha(1-\varepsilon)}{\varepsilon} \left( \frac{r^{\star}(\theta)}{r_0} \right)^{\frac{\varepsilon}{1-\alpha(1-\varepsilon)}} \right) + u > \zeta. \tag{13}$$

Note that $r^{\star} \propto \theta^{\frac{1-\varepsilon}{\varepsilon}}$ so condition (13) is equivalent to a condition on $\theta$. We show in Appendix C.2 that, as long as $\zeta < u$, there exist threshold values $L(\zeta)$ and $U(\zeta)$ such that if $\theta$ is included in $[L(\zeta), U(\zeta)]$ it is optimal for a firm of productivity $\theta$ not to relocate. We label this interval the "non-relocating interval". With these notations, the share of relocating firms $S(\zeta)$ is defined as:

$$S(\zeta) = \int_{\theta \in \mathbb{R}} z(\theta) dF_{\theta}(\theta) = 1 - \int_{\theta = L(\zeta)}^{U(\zeta)} dF_{\theta}(\theta)$$

In Appendix C.2, we also show that the width of this non-relocating interval is increasing with the fixed costs, that is to say:

$$\frac{dS(\zeta)}{d\zeta} < 0$$

The existence of such an interval of inaction is a classical result of the literature on lumpy and intermittent adjustments resulting from fixed lump-sum cost per adjustment decision (the (S,s) rules). This literature typically finds a range of inaction defined by two outer adjustment points between which the agent allows a state variable to diverge from its optimal value.[14]

The intuition for the existence of such an interval in our framework is straightforward in the case of a growing firm. Because the final level of productivity of the firm has increased, its profits can be optimized by using a larger amount of inputs. But since altering the level of inputs requires to pay a fixed cost, the final level of productivity has to be large enough so that the difference between the profits when factors optimally adjust and when factors' adjustment is constrained covers these

[13] As all firms start with the same initial conditions and face the same problem conditional on $\theta$, they are identical at the final steady-state and we index their quantity by $\theta$.

[14] See Bertola and Caballero (1990) for a survey on discontinuous adjustment control policy and Grossman and Laroque (1990)'s model of consumer durable purchase for an example of such a range of inaction. Perhaps more closely related to our result, Gobillon and Le Blanc (2004) study residential mobility and find that the difference in terms of utility between the relocating household and the non-relocating household linearly depends on the square value of the difference between optimal housing stock and the previously occupied housing stock.

fixed costs. Similarly, when the firm is declining - its level of productivity has decreased - its profits can be improved by trimming down the amount of inputs. Reducing the amount of input is also associated with a fixed cost that is worth to be paid only if the profits saved by optimally adjusting the production factor are substantial enough. That is to say, if the final level of productivity is low enough.

**Asymmetry:** Using a local polynomial approximation of the difference between $\pi^{(1)}(i)$ and $\pi^{(0)}(i)$, we show analytically in Appendix C.2 that $|\delta_r(i)^+| > |\delta_r(i)^-|$. This result indicates that the difference between optimal premises' size and occupied premises' size that triggers relocation is higher in absolute value when the firm grows than when it declines. It implies that the minimum intensity of the productivity shock entailing firms relocation is stronger when this shock is positive than when it is negative.We show in the same appendix that this asymmetry is growing with the parameter $\zeta$ and declining with the parameter $\varepsilon$. This asymmetrical effect of the costs on firm's relocation behavior is a second order consequence of the decreasing return to scale of our production function. Indeed, as shown in Elsby and Michaels (2014), as long as the adjustment costs are small in magnitude, the aggregate dynamics are approximately invariant at the first order. While such an approximation is sensible in the case of labor frictions, and even for investment in equipment, it is less the case for real estate where we can consider that $\zeta$ is relatively close to $u$ in magnitude. Finally, and although this is not taken into account *per se* in the current model, firms affected by a too negative shock are in practice likely to exit the market. This would result in an empirical asymmetry in the aggregate response to a productivity shift in the presence of adjustment costs.

## 3.3 Calibration and simulation

### 3.3.1 Setup

To study general equilibrium effects in a model with non-zero adjustment costs, we run simulations of the model. In practice, firms face different fixed costs per unit of real estate $\zeta$. For each firm, $\zeta$ can be defined as the sum of a component that depends on observed and unobserved characteristics (age, size, sector, management quality etc...) and a component that capture the fiscal cost $\tau$ capturing the tax on capital gain. As we shall see below, $\tau$ can be measured in the data, is only paid by real estate owner firms ($s = 1$) and is largely defined by local price dynamics.

We make the assumption that $\zeta$ and $\theta$ are orthogonal, and can be characterized by a distribution $F_\zeta$ and $F_\theta$ respectively. Hence, for each category of firms (renters, $s = 0$ or owners $s = 1$) we define:

$$S(s) \equiv \mathbb{E}_{(\theta,\zeta)}[z|s] = \int_\zeta \int_\theta z(\theta, \zeta, s) dF_\theta(\theta) dF_\zeta(\zeta)$$

We make the simplifying assumption that $\zeta$ can only take one value for each value of $s$ that we denote $\zeta^{(s)}$. In our data, we observe $z$ and $\theta$ for all firms as well as $S(s)$ for $s = 1$ and $s = 0$. The goal of this calibration is to find a value of $\zeta^{(1)}$ and $\zeta^{(0)}$ that match: (i) the empirical distribution of productivity shocks $\theta_1/\theta_0$ (ii) the share of relocating firms $S(1)$ and $S(0)$.

### 3.3.2 Results

In order to measure the distribution of productivity, we use our firm level data. Unfortunately, the distribution of $\theta_0$ and $\theta_1$ is unobservable because of the presence of adjustment costs $\zeta$. We therefore proceed as follow. First we consider the sample of real-estate renting firms with the underlying idea that these firms are less constrained (i.e., that $\zeta^{(0)}$ is sufficiently small). Second, we estimate the level of TFP using the methodology described in Levinsohn and Petrin (2003), accounting for the level of labor, equipment and real-estate capital and measure its variation from 1994 to 2013. We use the empirical distribution of this variation and fit a normal distribution with parameter $\mu$ and $\sigma$ as a measure of the productivity shock $\theta_1/\theta_0 - 1$. Third, we set the value of $L_s$ and $R_s$ based on the empiric, solve the model and measure $S(1)$ and $S(0)$ for any given $\zeta$. Finally, we consider the value of $\zeta$ that matches the share $S(1)$ and the value of $\zeta$ that matches $S(0)$ and compare the difference between these two values to the average fiscal cost $\tau$. Table 2 describes the parameters we used in the calibration.

We simulate the model using $N = 10,000$ firms which draw a productivity shock from the normal distribution with mean $\mu$ and variance $\sigma^2$. Our function objective is to find values for $Y$, $w$ and $u$ built from the individual decisions of the $N$ firms and satisfying all market clearing conditions. Based on this numerical resolution of the model, we explore the effect of the frictions on individual firms' behaviour and aggregate outcomes. We study the behaviour of the model for values of $\zeta$ ranging between 0 and 1. As seen in Figure 2, which report the share of relocating firms for different values of $\zeta$, the empirical values of $S(1)$ and $S(0)$ corresponds to a unit cost $\zeta$ respectively equal to 0.58 and 0.82 (i.e. 580 and 820 euros per square meter). Compared to the values of $\tau$, this means that in our framework, we are able to identify more than 50% of the difference in mobility between real-estate owners and renters.

**Individual employment growth dynamism** In the model with frictions, the non-relocating interval generates discontinuities at the bounds of the interval in the reaction of firms' labor demand to productivity shocks. Those discontinuities directly result from the complementarity between real estate and labor in the production function that conditioned optimal labor demand to the amount of real estate input. Crossing the thresholds for productivity shocks that trigger relocation has a direct impact on the firm's employment dynamics. We illustrate this effect by simulating firms' labor demand, across the whole distribution of $\theta$, for varying levels of friction $\zeta$ (respectively 0, 0.58 and 0.82, corresponding respectively to no friction, the average level of frictions for renters and owners). Those experiments are presented in Figure 3.

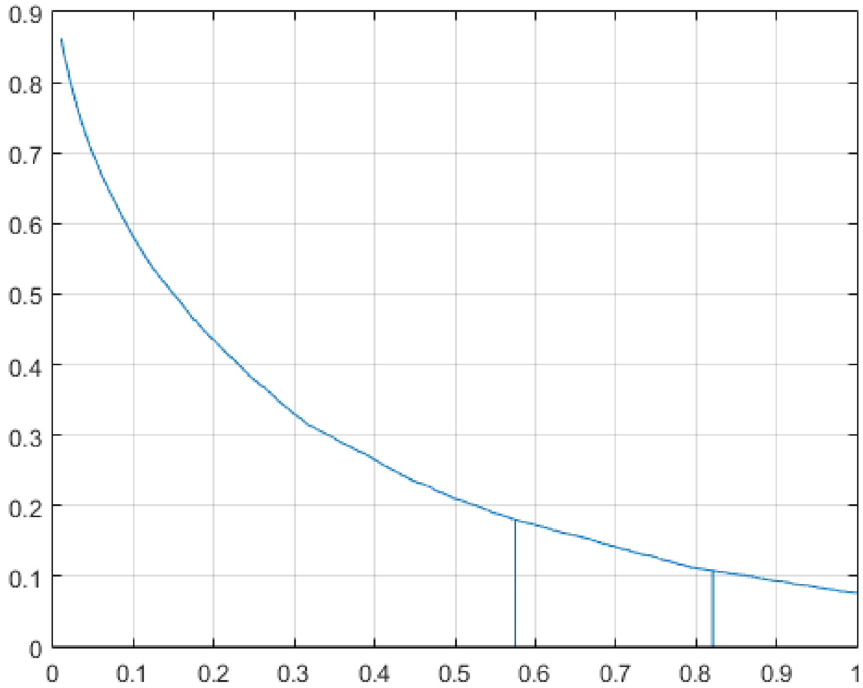
Absent any adjustment costs (red plain line ; $\zeta = 0$), because real estate and employment jointly adjust for any productivity shocks, employment smoothly varies with changes in productivity and no discontinuity is observed as described in the friction-less model. When introducing adjustment

Table 2: Parameters used in the calibration exercise

| Parameter | Description | Value | Source |
|---|---|---|---|
| $\tau$ | Average value of the tax on realized capital gain per square meter for real-estate owners (in thousand of euros) | 0.13 | See Section 4.2.2 |
| $L_s/N$ | Average employment per firm | 25 | FiBEn |
| $R_s/(NL_s)$ | Average real-estate volume per employee in squared meter | 25 | FiBEn |
| $\varepsilon$ | Inverse elasticity of substitution in the CES | 0.25 | Hottman et al. (2016) |
| $\alpha$ | Output elasticity of labor | 0.925 | INSEE (see notes below) |
| $S(1)$ | Share of relocating firms among real-estate owners from 1994 to 2013 | 10.8% | Table D1 |
| $S(0)$ | Share of relocating firms among real-estate renters from 1994 to 2013 | 18.0% | Table D1 |
| $\mu$ | Mean of the normal distribution of productivity shock. Fitted from the evolution of TFP for real-estate renters | 0.17 | FiBEn |
| $\sigma$ | Standard deviation of the log normal distribution of productivity shock. Fitted from the evolution of TFP for real-estate renters | 0.16 | FiBEn |

**Notes:** $\alpha$ is measured as the average ratio of the market value of structures and land over the aggregate value added of Non-Financial Corporations since 1979, based French aggregate series produced by the

Figure 2: Share of relocating firms for different values of $\zeta$




costs, two regimes appear. Outside of the non-relocating interval, firms jointly adjust real estate and employment leading to similar dynamics as in the friction-less case.[15] Within the non-relocating interval, employment adjusts to productivity shocks more sluggishly because of the predetermined level of real estate. Comparing the dynamics associated with two levels of fixed-costs (blue dotted lines ; $\zeta = 0.58$, black dashed line $\zeta = 0.82$), we observe that, as already noticed, the non-relocating interval widens with $\zeta$.

**Workforce growth distribution** Ultimately, we are interested in deriving the effect of the adjustment costs on moments of the workforce growth distribution. As the fixed costs associated with real estate adjustment rise, a higher share of firms are located in the non-relocating interval. Within this interval, firms affected by positive shocks are stuck in under-sized premises that constrain employment growth whereas firms affected by negative shocks operate in over-sized premises that slow down job destruction. When studying how frictions affect the mean employment growth, we are capturing those two opposite effects. The differentiated effect of adjustment costs on employment growth depending on the sign of the productivity shock can be highlighted by studying positive and negative productivity shocks separately. We plot the mean employment growth as a function

[15] Although not visible in this graph, small differences between the curves outside the intervals of inaction exist and result from general equilibrium effects.

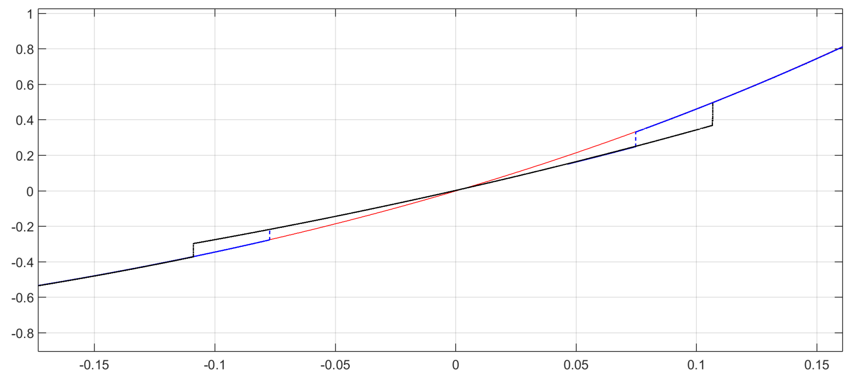



Figure 3: Employment growth as a function of productivity shocks for different values of $\zeta$

of $\zeta$, conditional on positive and negative productivity shocks respectively in the left-hand side and right-hand side panels of Figures 4. The mean employment growth of firms affected by a positive productivity shocks is sharply decreasing with $\zeta$ whereas $\zeta$ has a less marked positive impact on the employment dynamics of firms stricken by negative productivity shocks, which echo the asymmetry results discussed above.

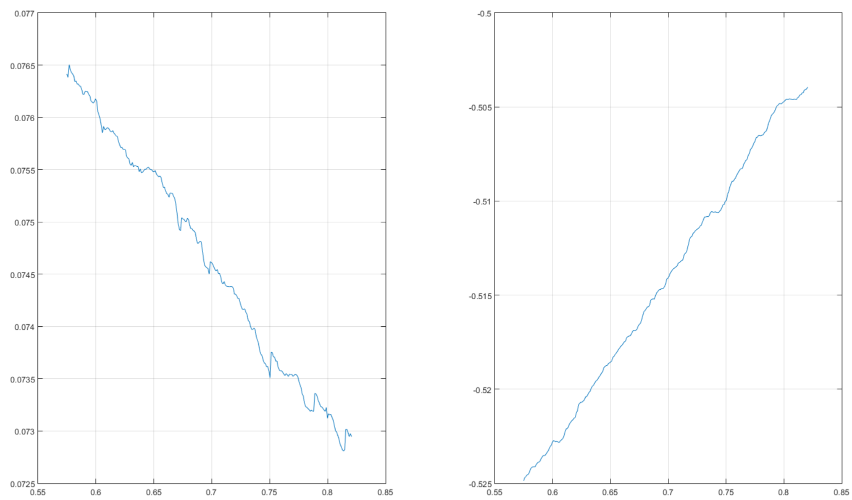



Figure 4: Average employment growth between the two values of $\zeta$ corresponding to real-estate owners and real-estate renters for growing (left-hand side panel) and declining (right-hand side panel) firms.

**Aggregate effects of the frictions** The allocation of labor across firms primarily governs the dynamics of output. In this model where aggregate supplies of corporate real estate and labor are fixed, the effect of the frictions on aggregate output is exclusively channeled by the allocation of inputs across firms. Because the allocation of labor is only mildly impaired by the frictions, we obtained

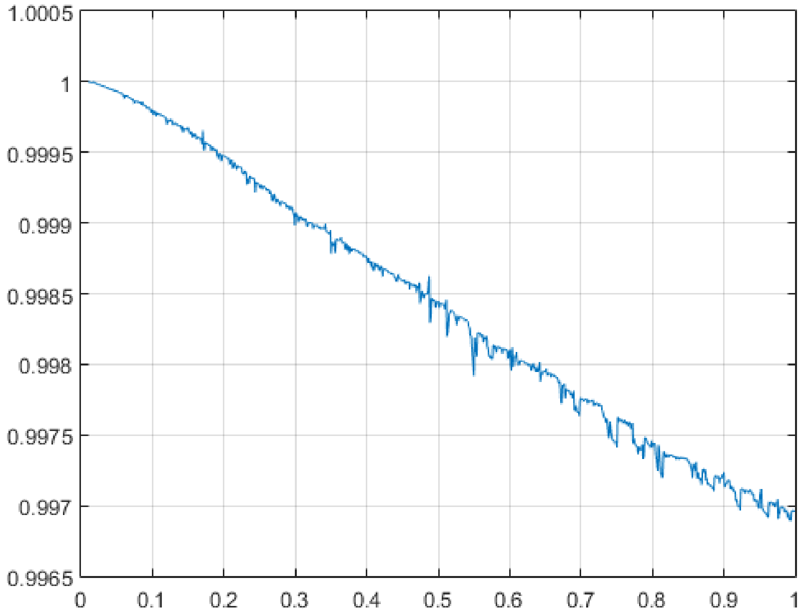



Figure 5: Aggregate output as a function of $\zeta$ (no friction = 1)

negative, but small, effect of the frictions on the aggregate output (Figure 5).

Our general equilibrium model sets input prices so that the real estate and the labor markets both clear. Figures 6 present the dynamics of the equilibrium inputs' prices when $\zeta$ rises. While the negative impact of the adjustment costs on the weighted average productivity of labor puts downward pressures of the wages (left panel),[16] the distortion induced by the real estate adjustment costs increases the equilibrium price of real estate (right panel). The reason for this result is the following. A rise in $\zeta$ implies that more firms are locked in their premises. The supply cut induced by this additional non-relocating firms is larger than the counter-factual optimal real estate size that would be used by those non-relocating firms. As a result, a rise in $\zeta$ has a larger negative impact on aggregate supply than on aggregate demand and causes a sharp increase in $u$.[17]

The results of this calibration should of course be considered with cautious as they are very model specific and rely on various assumptions. The goal of our exercise is to show that with reasonable parameter values, our model is able to qualitatively simulate the dynamics of firms resulting from a change in productivity in the presence of real-estate adjustment costs, and to predict the reaction of aggregate quantities. One interesting additional insight of the model is to give an (gross) order of magnitude of the fixed cost of relocation per unit of real-estate, 580 and 820 euros per square meter. Given the average size of a firm, this corresponds to a fixed cost of around 360,000 euros for renters

[16] In their model, Garicano et al. (2016) also find a negative effect of the regulation on wage.

[17] As already mentioned, this effect is exacerbated by the assumption that real-estate is in fixed supply.

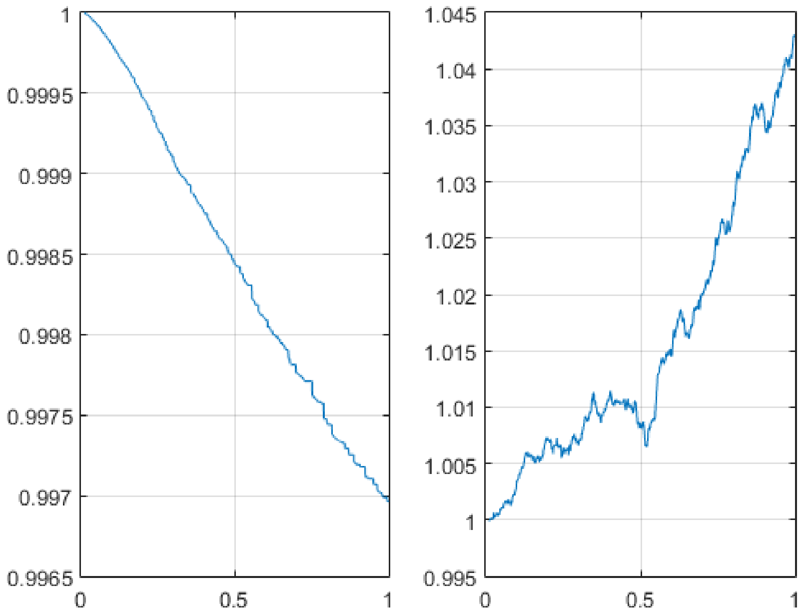



Figure 6: Equilibrium inputs' price (respectively wage and real-estate prices) as a function of $\zeta$ (no friction = 1)

and 510,000 for owners (respectively around 10% and 7% of annual sales for the average firm). In addition, note that the magnitude of these fixed costs are within the same order of magnitude as the renting cost $u$, which is in line with the intuition described regarding the asymmetry. In the next section, we turns to a more reduced form empirical analysis of the effect of these frictions on employment growth, making use of our rich firm level dataset.

# 4 Further empirical evidence

In this section, we use the firm-level dataset described in section 2 to test the predictions of the model and to give support to the view that real estate frictions distort relocation decisions and generate lower employment dynamics. To do so, the more natural approach would be to estimate the direct effect of a relocation on employment growth. Obviously such an approach would be problematic as it wouldn't allow us to identify the sense of the causality we are mostly interested in: i.e. that relocation allow firms to relax their capacity constraints and to adjust their workforce. For illustration purpose, we will nevertheless first show that indeed, firms that relocate experience a contemporaneous increase in their workforce growth rate (in absolute value). We then proceed in a two-step procedure in order to give support toward the sense of this correlation. We first show that relocation costs as measured by the latent capital gains is negatively correlated with the occurrence of a premises adjustments and we then measure the direct effect of those adjustment costs on the workforce growth distribution.

We argue that based on the nature of the tax on capital gain, and the fact that this tax is only paid upon relocation, the only channel through which the it can be correlated with employment growth is through its impact on the likelihood of relocation. We also argue that omitted confounding factors affecting both local real estate prices (and then the latent tax on capital gains) and relocation or employment growth are likely to run against the negative effect of capital gains on relocation and employment growth documented in our analysis. Any appreciation of real-estate prices that would follow a positive local demand shock is expected to play against our effect by fostering local business activities and employment growth while our results and predictions point toward a negative effect of the magnitude of capital gains on growth.

## 4.1 Local relocation and overall employment dynamics

Our first set of regressions aims at exhibiting the correlation between relocation and employment dynamics. Based on the model, we expect that among growing (resp. declining) firms, the ones that relocate are characterized by higher (resp. lower) employment growth rates than the ones that do not. We know from Figure 1 that this is true without conditioning on any observable or unobservable characteristics. To gain further insight into this relationship, we consider the following model (14) and estimate its parameter using quantile regressions.

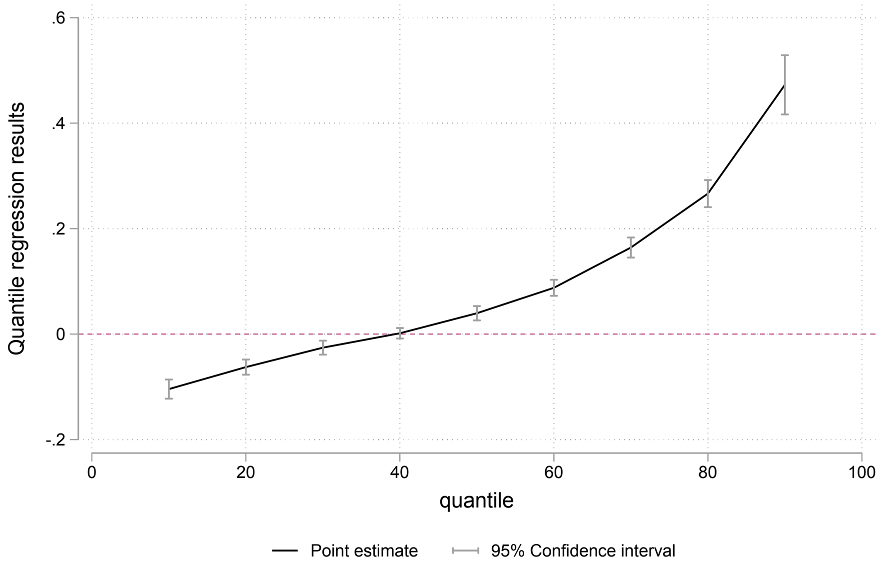
$$\Delta l_i = \beta_1 z_i + \beta_2 X_i + \varepsilon_{i,s,d}. \tag{14}$$

In this equation, $\Delta l_i$ is the average growth of employment over the period of observation, $z_i$ is the yearly frequency of (local) relocation (the number of relocations over the number of years of observation) and $X_i$ is a vector of firm specific characteristics taken at the initial year of observation (age, size...). $\varepsilon_{i,s,t}$ includes fixed effects at the sector times *département* level $(s, d)$ plus an idiosyncratic error. We allow for correlation of this error terms within each group of *département* and sector.

This estimation allows us to emphasize the heterogeneous effect of a relocation across the distribution of employment growth, controlling for observed firm specific features. We plot the coefficient on variable $z_i$ along with confident intervals for different quantiles in Figure 7. Results echo those of Figure 1, namely that relocating is associated with a different effect depending on the firm's position in the distribution of average employment growth. This effect changes sign around the $40^{th}$ percentile, which corresponds to an average employment growth of 0.

**Robustness:** we perform various sensitivity checks which are details in Appendix D.1. In particular, we show that results presented in Figure 7 are robust to changes in the definition of a local relocation, to considering different time periods and to exclude municipalities subject to a place-based program.

Figure 7: Relocation and employment dynamics - Quantile regression results




**Notes**: This graph plots the coefficients on the observed frequency of local relocation during the observed period from a cross-section quantile regression with employment growth as a dependent variable (equation (14)) residualized on a *département*-sector fixed effect. We plot the coefficient obtained for each of the quantile: 0.1, 0.2 etc...along with the 95% confidence interval. Regression also includes control variables: Age and Size (both taken in the first year of observation). Confidence intervals at the 95% level have been estimated with a variance-covariance matrix built with 40 bootstrap replications.

## 4.2 Adjustment costs and relocation dynamics

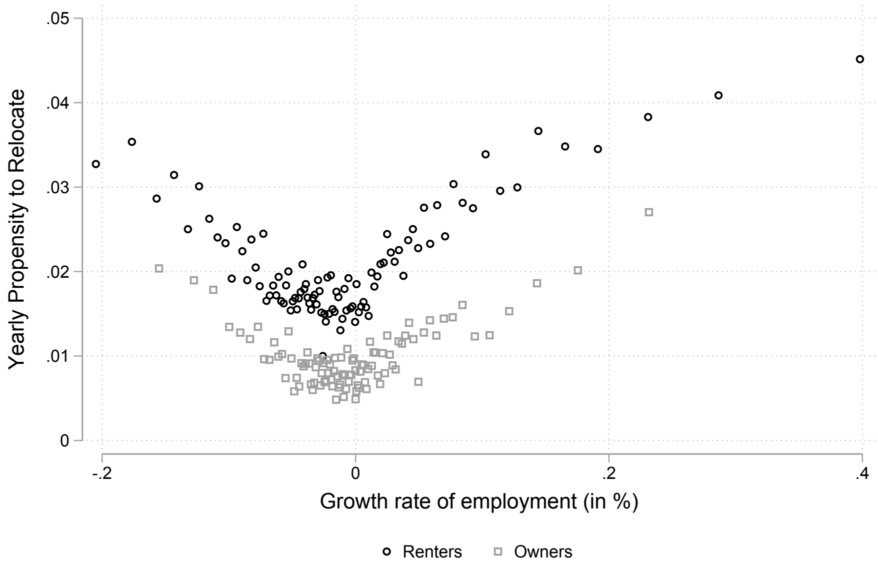
### 4.2.1 Owners and Renters

The correlation exhibited in the previous exercise does not inform about whether firms' employment dynamics is indeed distorted by relocation frictions. To give support to this story, we first need to find an observable measure of relocation costs that is heterogeneous across firms.

One first natural candidate is the tenure status (whether the firm owns or rents its premises). Relocating is indeed less costly for renting firms than for real estate owning firms. For example, owners pay legal fees associated with real estate transactions and taxes triggered by the sales of their previous real estate assets. Besides, searching costs are likely to be higher for this type of firms. We therefore expect different relocation behaviors between real estate owning firms and renting firms (this was the difference we exploited in Section 3.3). This intuition is confirmed by Figure 8 where we replicate Figure 1 but splitting between owners and renters. It clearly appears that not only renting firms relocate on average more often than others, they also exhibit smaller changes in their workforce for a given propensity to relocate as compared to owners.

However, the choice of the tenure status is not exogenous and is likely to depend on unobservable growth prospects. One can for example imagine that a firm expecting significant increases in its workforce would prefer to rent its premises in order to be more flexible. This would cause a reverse causality issue preventing us from associating a difference in the relocating behavior or the

Figure 8: Propensity to relocate and employment growth: owners vs renters




**Notes**: See Figure 1. Owners and renters have been selected on the first year they appear in the dataset based on their reported volume of real estate. Period of observation: 1994-2013. Source: `FiBEn`, see Appendix A for more details about the data.

employment dynamics to higher relocation costs. In fact, we show in Table D5 of Appendix D that the group of renting firms and owning firms are different in many aspects.[18] For this reason, we turn to another measure of the relocation costs: the tax on capital gains that a real estate owning firm would have to pay upon relocating.

#### 4.2.2 The tax on capital gain

The tax on capital gains is a tax on the difference between the purchase and selling price of an asset. This tax is only paid by real estate owning firms when they sell their premises. However, we can always proxy its latent level at a yearly frequency using local real estate price dynamics. Based on balance sheet data, we recover the market value of real estate holdings by applying the accrued change in the local real estate prices since the acquisition date (approximated using to the ratio of the accumulated amortizations of buildings over the gross book value of buildings) to the historical value of building. The latent capital gains correspond to the market value minus the the historical value. The tax scheme takes into account the holding period and allows to diminish the amount of capital gains by 10% each year after a five-year holding period (see appendix A.2.2 for more detail). The latent tax $C$ is obtained by multiplying the marginal corporate income tax $\tau$, which has been equal to 33% in France over the studied period, and the tax base, determined by the interaction

[18]Note that those are observable differences which we can always control for in a regression, but unobservable differences between these two groups are also likely to exist (risk aversion, network connections...).

between the acquisition date, the local dynamics of real estate prices since this acquisition and the volume of the premises.

Formally:

$$C_{i,t} = \tau \left[ p^d_t(1 - A(T_{i,t})) - p^d_{t-T_{i,t}} \right] r_{t-T_{i,t}} \; \max\left[0, (1 - 0.1 \max(T_{i,t} - T_0))\right], \tag{15}$$

where $p^d_t$ is the local observed real estate price level (taken at the *département* level), $T_{i,t}$ is the difference between year $t$ and the date of acquisition of real estate, $r_{t-T_{i,t}}$ is the volume of the premises at the date of acquisition and $\tau$, $T_0$ are two parameters equal to 33% and 5 years respectively.

For the sake of comparability across firms, we normalize the amount of the latent tax by dividing it by the market value of real estate assets in order to obtain the share of the proceeds from the sale that would be paid under the heading of "tax on capital gains" in the event of the sale of real estate assets. The firm level variation for this quantity is driven by the interaction of the timing of the acquisition of the premises and the local price dynamism since this acquisition, the latter being mostly driven by household and larger firms that we are not considering in our analysis. In addition, because the latent tax level varies with the interaction of these two factors, the impact of each of these factors considered individually can be controlled for in our analysis. The variable that we denote $Tax_{i,t}$ can theoretically takes values between 0 and the marginal corporate income tax $\tau$.[19] We observe large variation across firms, with a little less than half of the real estate owners being unaffected by the tax on capital gain ($Tax = 0$), notably because the tax scheme takes into a account the holding period, and an overall average value of 3.8% that reaches 7.7% conditional on being non null with a standard deviation of 5%. To get a sense of these rather high values, one may keep in mind that real estate prices have been multiplied by 2.5 in nominal terms between 1998 and 2008.

### 4.2.3 Frictions and relocation

We run various regressions to show that higher relocation costs, as proxied by the tenure status or, for owning firms, by the latent capital gains, are indeed associated with a lower propensity to relocate. More precisely, we run the following specification for firm $i$'s decision to relocate:

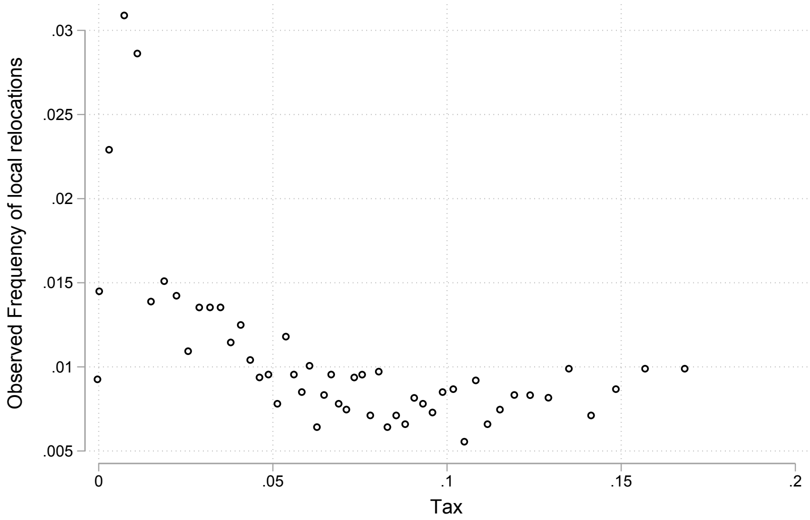
$$z_{i,t} = \mu_1 Te_{i,t} + \mu_2 X_{i,t} + \varepsilon_{i,s,d,t}, \tag{16}$$

where $Te_{i,t}$ is our dummy equal to 1 if the firm reports real estate holdings in initial year of observation and $z$ a dummy variable that takes the value 1 if the firm relocates. We also consider:

$$z_{i,t} = \alpha_1 Tax_{i,t-1} + \alpha_2 X_{i,t} + \varepsilon_{i,s,d,t}, \tag{17}$$

[19]Note that $Tax_{i,t} = \frac{C_{i,t}}{p^d_t(1-A(T_{i,t}))r(t-T_{i,t})} = \tau\left(1 - \frac{p^d_{t-T_{i,t}}}{p^d_t(1-A(T_{i,t}))}\right) \max\left[0, (1 - 0.1\max(T_{i,t} - T_0))\right]$ does not directly depends on the volume of real estate.

Figure 9: Propensity to relocate and relocation costs as measured by the latent tax on capital gains




**Notes**: $Tax$ denotes the share of the proceeds from a potential real estate sale that must be paid as a tax on capital gains. We separate each observations into 100 percentiles of $Tax$ and plot the within percentile share of relocating firms. Period of observation: 1994-2013. Source: `FiBEn`, see Appendix A for more details about the data.

where $Tax$ has been defined previously. Before estimating these two equations, we plot in Figure 9 the observed probability to relocate and the average value of the variable $Tax$ for each percentile of the distribution of $Tax$. Consistently with our theoretical framework, we find a downward and convex curve. In the regression, and in order to control for firm specific characteristics that are unobservable with our data, we run a firm-fixed effects model. In terms of timing, the dependent variable, $z_{i,t}$ is a binary variable equal to 1 if the firm has relocated locally between $t$ and $t+1$ and the variable $Tax_{i,t}$ is computed at the end of the year.

Results are reported in Table 3: column 1 corresponds to the model presented in equation (16) while columns 2 to 7 correspond to model defined by equation (17), and restrict to real-estate owners. In all specifications, we control for the age and the size of the firm and for a sector×year and *département*×year fixed effect is added. In columns 3 to 7, we also add covariates capturing the age and the volume of the premises owned by the firm, both of which having a direct influence on the propensity to relocate.

From column 1, we see that a real estate owning firm has a 0.6 percentage points lower yearly propensity to relocate than an otherwise observably similar renting firm. In columns 2 to 4, the main coefficient of interest is the one associated with the value of $Tax$, the share of the proceeds from the real estate asset sales that would be paid under the heading of the "tax on capital gains", taken at $t-1$. In columns 5 to 7, we are more agnostic about the timing of the effect and report the coefficients for different lags of $Tax$ as well as the sum of the coefficients. As explained above, the value of $Tax$ results from a marginal tax rate, identical across firms, and a tax base, that varies

Table 3: Relocation cost and relocation choice

| | Dependent variable: dummy for having relocated at $t$ | | | | | | |
|---|---|---|---|---|---|---|---|
| | All | Owners | | | | | |
| | **(1)** | **(2)** | **(3)** | **(4)** | **(5)** | **(6)** | **(7)** |
| Real-Estate Owner Dummy | -0.006*** | | | | | | |
| | (0.000) | | | | | | |
| Size | 0.007 | -0.000 | 0.000 | 0.011 | 0.036 | 0.036 | 0.034 |
| | (0.009) | (0.015) | (0.015) | (0.017) | (0.026) | (0.026) | (0.026) |
| Age | -0.000*** | | | | | | |
| | (0.000) | | | | | | |
| Tax (t-1) | | -0.066*** | -0.066*** | -0.030*** | -0.018** | -0.015* | -0.004 |
| | | (0.004) | (0.004) | (0.005) | (0.008) | (0.008) | (0.007) |
| Tax (t-2) | | | | | -0.015* | -0.021** | -0.012* |
| | | | | | (0.008) | (0.008) | (0.007) |
| Tax (t-3) | | | | | -0.012** | -0.007 | -0.006 |
| | | | | | (0.006) | (0.006) | (0.005) |
| Tax (t-1)+Tax(t-2)+Tax(t-3) | | | | | -0.045*** | -0.043*** | -0.021*** |
| | | | | | (0.007) | (0.007) | (0.006) |
| Real Estate Volume | | | 0.139*** | 0.017 | 0.008 | 0.012 | 0.004 |
| | | | (0.046) | (0.039) | (0.049) | (0.049) | (0.049) |
| Real Estate Age | | | | 0.001*** | 0.001*** | 0.001*** | 0.001*** |
| | | | | (0.000) | (0.000) | (0.000) | (0.000) |
| Fixed Effects | | | | | | | |
| Département × Year | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Sector × Year | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Firm | | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| $R^2$ | 0.128 | 0.141 | 0.141 | 0.142 | 0.148 | 0.148 | 0.148 |
| Observations | 1,261,606 | 551,656 | 551,656 | 551,656 | 426,761 | 426,103 | 426,103 |

**Notes**: Variables definitions are given in Table A3. Column 1 uses all firms while columns 2 to 7 restrict to real estate owners. The dependent variable is a dummy variable equal to 1 if the firm has locally relocated (with a distance below 15km) during year $t$. Columns 6 and 7 use a proxy for $Tax$ (respectively $Tax^{(1)}$ and $Tax^{(2)}$, see 4.2.3) as defined in Appendix D.2. Panel Fixed effect regression with robust standard errors clustered at the firm level reported in parenthesis. ***, ** and * respectively indicate 0.01, 0.05 and 0.1 levels of significance.

across firms and across time. The variability of the tax base across firms and across time results from heterogeneity in the acquisition dates and in the dynamics of local prices since the acquisition. Results suggest that a one standard deviation increase in this tax share is associated with a 0.1 to 0.3 percentage point reduction in the propensity to relocate among real estate owning firms (the average propensity to relocate for these firms is 1% per year).

### Potential concerns

One may be concerned that the level of the latent tax on capital gains is correlated with unobservable growth prospects and that the distributions of changes in productivity is affected by the level of these latent capital gains. However, because the latent capital gains are growing with the positive change in local real estate prices, we are expecting that the higher the latent capital gains, the better the local economic conditions and the more likely the firms are to relocate. We hence argue that any correlation between the latent capital gains and unobservable growth prospects upward bias our coefficient of interest and that the negative effect of the latent tax on the propensity to relocate is an upper bound. In addition, in columns 6 and 7 of Table 3, we have constructed two instruments for $Tax$ that we denote $Tax^{(1)}$ and $Tax^{(2)}$, and have run the same model as in column 5 but replacing $Tax$ by $Tax^{(1)}$ and $Tax^{(2)}$ respectively.

$Tax^{(1)}$ is constructed in the exact same way as $Tax$, but using an index of real estate prices computed at the national level, excluding the area where the firm is based. Formally, we use formula (15) where we replace $p_t^d$ by $\tilde{p}_t{}^d = \sum_{\delta \neq d} w^\delta p_t^\delta$, where $w^\delta$ is the weight of *département* $\delta$ based on its population in 2013.

$Tax^{(2)}$ is also constructed as $Tax$ but instrumenting local prices based on the interaction between housing loan interest rate and local supply elasticity as described in Fougère et al. (2017). We detail the construction of the instrument in Appendix D.2. In a nutshell, local real-estate prices are instrumented by the interaction between housing loan interest rates and local supply elasticity. This strategy relies on the idea that when housing loan interest rates decrease, the demand for real estate increases. If the local supply of housing is very elastic, the increased aggregate demand will translate mostly into more construction rather than higher real estate prices. Conversely, if the supply of housing is very inelastic, the increased demand will translate mostly into higher prices. We thus expect that in a *département* where land supply is more elastic, a drop in housing loan interest rate should have a larger impact on real estate prices. More information on these two instruments, including first-stage and 2SLS estimations (respectively shown in Table D3 and D4), is available on Appendix D.2.

Another potential concern is that the latent tax on capital gains is in fact capturing many different features, and namely the fact that it mechanically decreases with the age of real estate. However, when moving from column 2 to column 4 of Table 3, the coefficient on the latent tax variable is still significant when we control for the volume and age of real-estate.

All these results speak to the intuitive idea that relocation costs dampen the firms' propensity to relocate. By highlighting the role of the latent tax on capital gains, they provide empirical evidence to support our model. They also echo those of the existing literature that emphasized the "lock-in" effect of the tax on capital gains (see for example Yitzhaki, 1979; Feldstein et al., 1980 or Kanemoto, 1996).

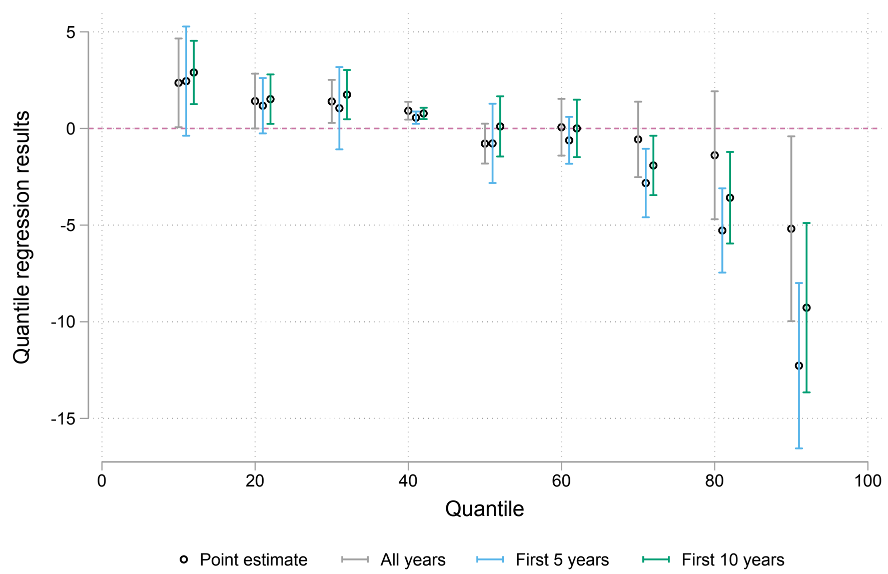
### 4.3 Relocation costs and employment dynamics

We now turn to our second step where we explore the effect of the relocation costs on employment dynamics through its direct negative effect on the propensity to relocate. Our model predicts that the relationship between relocation costs and employment growth differ across the distribution of productivity shocks.

To test this, we restrict to real-estate owning firms and consider the value of $Tax$ as a predictor of relocation. Formally, we estimate the following equation (18) using quantile regressions:

$$\Delta l_i = \phi_1 Tax_i + \phi_2 X_i + \varepsilon_{i,s,d}. \quad (18)$$

Figure 10: Relocation costs and employment growth - Quantile regression results




**Notes**: This graph plots the coefficients on the latent tax on capital gain ($Tax$) from a cross-section quantile regressions with average employment growth over the period of estimation as a dependent variable (equation (16)) residualized on a *département*-sector fixed effect. We plot the coefficient obtained for each of the quantile: 0.1, 0.2, 0.3, 0.4, 0.5, 0.6, 0.7, 0.8 and 0.9 along with the 95% confidence interval. The value of $Tax$ is taken in the first year of observation. The number of observation per firm varies across specification: we consider first all year, then restrict to the first 5 and first 10 years. Regression also includes our usual control variables: Age, Size, Age and Volume of real estate (all taken in the first year of observation). Confidence intervals at the 95% level have been estimated with a variance-covariance matrix built with 40 bootstrap replications.

We estimate equation (18), in cross-section, considering the initial value of $Tax$ as an indicator of the level of relocation cost and using the average employment growth over the observation period. We expect the initial value of $Tax$ to have more statistical power in these alternative specifications. As shown in Figure 10, the results are not much altered by such sampling selection, and establish that relocation costs have an heterogeneous effect on employment over the distribution of employment growth: negative for growing firms and positive for declining firms.

Next, we make use of the panel dimension of our dataset and proceed to a more direct test of the negative impact of relocation cost on employment dynamics. The theory suggests that if $\Delta l^{\star}_{i,t}$ denotes the optimal (unconstrained) employment growth of firm $i$, then the larger the relocation cost $\zeta_{i,t}$, the farther away $\Delta l_{i,t}$ (the actual employment growth) is from $\Delta l^{\star}_{i,t}$. We would therefore like to consider the following model:

$$\Delta l_{i,t} = \Delta l^{\star}_{i,t}\,(1 + \alpha \zeta_{i,t}) + \beta \zeta_{i,t} + \gamma X_{i,t} + \varepsilon_{i,t},$$

where we expect $\alpha < 0$ implying that the correlation between the optimal value of employment growth and the realized one is reduced by relocation cost. We can proxy for $\zeta$ using $Tax$ for real-estate owners, but we do not observe $\Delta l^{\star}_{i,t}$ for which we construct two different measures.

First we use the set of real-estate renting firms, which are less constrained by relocation costs, and project their employment growth on a complete set of year-sector and year-département fixed effects as well as a controls for age and size of the firm. With the estimated coefficients, we predict the "unconstrained" employment growth for real-estate owning firms and assume that this proxy $\Delta l^{r}_{i,t}$ is proportional to $\Delta l^{\star}_{i,t}$.

Second, we construct a demand shock measure at the sector-year-département level. To do so, we use sector-destination level information of imports from the CEPII's database BACI (see Gaulier and Zignago, 2010). For each pair of countries $(i, j)$ and each sector $s$ this database reports the quantity $X_{i,j,s}$ of goods produced by firms of sector $s$ in country $j$ that are imported by country $i$. We predict the variation in the demand of each (French) sector $s$ during year $t$ by considering:

$$D_{s,t} = \sum_{i \neq FR} log\left(\tilde{X}_{i,s,t} / \tilde{X}_{i,s,t-1}\right),$$

where $\tilde{X}_{i,s,t} = \sum_{j \neq FR} X_{i,j,s}$ is the total import of sectors $s$ in country $i$ from all over the world except France (see Mayer et al., 2016; Aghion et al., 2018 for more details). This demand shock identifies exogenous variations of the demand of goods produced by a sector $s$ by looking at how much imports of this product increase all over the world, excluding France to avoid simultaneity. We augment $D_{s,t}$ which is only a sector-year specific measure by a local shock. We chose to use negative changes in unemployment rate at the département-year level $D_{d,t}$. Finally, in order to combine these two aggregate shocks at the sector-year-département, we compute $\omega_{s,d,t}$, the average export intensity (export divided by sales) of single-establishment firms in sector $s$, département $d$ and year $t$ and defined:[20]

$$D_{s,d,t} = D_{s,t}\omega_{s,d,t-1} + (1 - \omega_{s,d,t-1})D_{d,t}$$

[20]Both $D_{s,t}$ and $D_{d,t}$ have been standardized.

Figure B2 shows that $D_{s,d,t-1}$ is indeed correlated with employment growth at $t$, and we consider it to build an estimate of $\Delta l^{\star}_{i,t}$. Specifically, we assume that the demand shock can be linearly mapped into an optimal unconstrained level of employment growth.[21]

Combining these equations yields:

$$\Delta l_{i,t} = \psi_1 S_{i,t} + \psi_2 Tax_{i,t-1} + \psi_3 Tax_{i,t-1} \times S_{i,t} + \psi_4 X_{i,t} + \hat{\varepsilon}_{i,t}, \tag{19}$$

where $S_{i,t}$ is our employment shock, that can be defined either using $\Delta l^{r}_{i,t}$ or using the demand shock as explained above. We estimate this equation for real-estate owning firms with a positive value of $Tax$ including both sector and département fixed effects.[22] Results are presented in Table 4. Columns 1, 2 and 3 consider $\Delta l^{r}_{i,t}$ while columns 4, 5 and 6 use $D_{s,d,t}$. We first use the value of $Tax$ and an OLS estimator in columns 1 and 4 and then turn to an IV specification where we instrument $Tax$ by our instruments $Tax^{(1)}$ and $Tax^{(2)}$. As expected, the coefficient on the interaction between the level of relocation friction and the employment shock is negative. This corroborates the view that real-estate frictions hinder employment dynamics, in line with our theoretical model and insight from Figure 1.

The magnitude implied by these estimates suggests that the tax on capital gain negatively impacts the response of the firm to an employment shock by around 25%. While our model is not perfectly suited to give a precise figure of the effect of a suppression of the tax on capital gain on employment growth, a back of the envelop calculation yields results that comparable to the theory. Indeed, for growing firms (those hit by a positive $DS$) the average value of $DS$ is 0.6. This suggests that setting $Tax$ to 0 would boost employment growth by 0.15 percentage points for these growing firms. This means that for the average growing firm, yearly employment growth could be around 4% larger without the tax on capital gain. This result is close to what was found in Figure 4 where we see that moving from a cost $\zeta^{(1)}$ to $\zeta^{(0)}$ corresponds to an increase of employment growth by around 5%.[23]

## 4.4 Implication in terms of misallocation

Our results suggest that frictions in the real estate market generate a suboptimal allocation of premises volume and in turns of workforce due to the complementarity between the two inputs. To illustrate this, we construct a measure of misallocation based on Olley and Pakes (1996) and following Duranton et al. (2015), by calculating the covariance between the market share of a firm and its labor productivity level (Olley-Pakes covariance). We should expect that areas in which the real estate market is more constrained have a higher Olley-Pakes covariance. In Figure 11, we have

[21] Demand shocks can have heterogeneous effects along the size distribution. In particular, large firms usually responds more positively to an export shock than small firms. Allowing for some heterogeneity with firm size, by interacting our demand shock with the logarithm of employment of the firm $l_{i,t}$ does not affect our results.

[22] Adding additional fixed effects, and in particular time fixed effects decrease the precision of the estimation by capturing too much of the statistical power of the aggregate employment growth shocks.

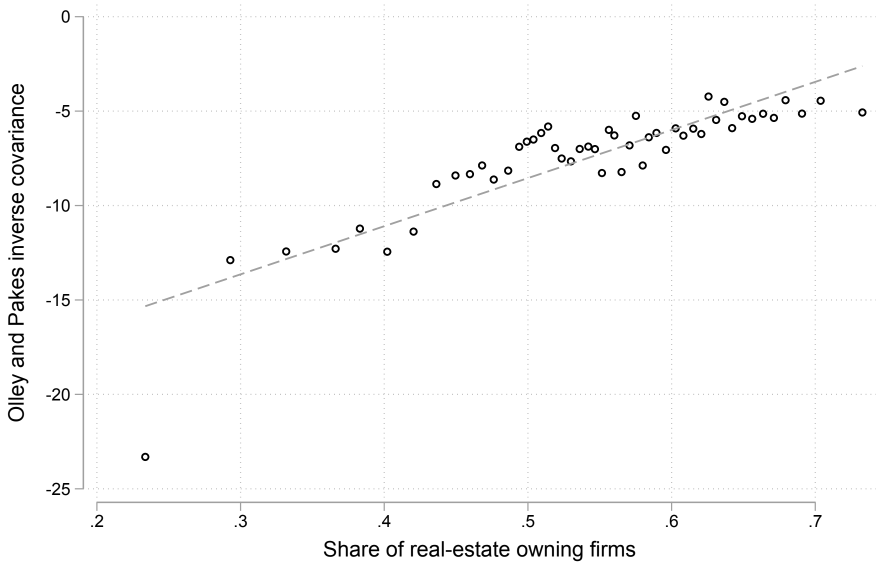
[23] Of course $\zeta^{(1)} - \zeta^{(0)}$ encompass all the differences in relocation cost between real-estate owners and renters and is not only imputable to capital gain taxation.

Table 4: Employment growth and adjustment costs

| | Dependent variable: growth rate of employment at $t$ (in %) | | | | | |
|---|---|---|---|---|---|---|
| | Shock using renters ($\Delta l^r$) | | | Demand shock ($DS$) | | |
| | OLS | IV | IV | OLS | IV | IV |
| | **(1)** | **(2)** | **(3)** | **(4)** | **(5)** | **(6)** |
| Employment Shock $S$ | 0.801*** | 0.783*** | 0.957*** | 1.035*** | 1.146*** | 0.972*** |
| | (0.095) | (0.103) | (0.182) | (0.179) | (0.196) | (0.280) |
| $Tax$ (t-1) | 0.398 | 0.214 | 1.265 | -0.849*** | -0.889*** | -0.897*** |
| | (0.395) | (0.465) | (0.917) | (0.106) | (0.106) | (0.208) |
| $Tax$ (t-1) $\times S$ | -0.114*** | -0.103** | -0.217** | -0.191** | -0.262** | -0.155 |
| | (0.043) | (0.049) | (0.100) | (0.088) | (0.102) | (0.156) |
| Real Estate Volume | 0.499** | 0.493** | 0.509** | 0.272 | 0.269 | 0.271 |
| | (0.246) | (0.246) | (0.251) | (0.168) | (0.167) | (0.166) |
| Real Estate Age | -0.146*** | -0.150*** | -0.154*** | -0.142*** | -0.146*** | -0.146*** |
| | (0.024) | (0.024) | (0.025) | (0.024) | (0.024) | (0.027) |
| Age | 0.038*** | 0.038*** | 0.039*** | -0.060*** | -0.060*** | -0.060*** |
| | (0.005) | (0.005) | (0.006) | (0.004) | (0.004) | (0.004) |
| Size | -17.942*** | -17.929*** | -17.761*** | 2.812* | 2.837* | 2.796* |
| | (6.640) | (6.630) | (6.648) | (1.695) | (1.694) | (1.693) |
| Fixed Effects | | | | | | |
| Département | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Sector | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| $R^2$ | 0.007 | 0.007 | 0.007 | 0.004 | 0.004 | 0.004 |
| Observations | 267,986 | 267,986 | 267,986 | 208,703 | 208,703 | 208,703 |

**Notes**: Variables definitions are given in Table A3. The sample is restricted to real-estate owning firms. The dependent variable is employment growth of the firm between $t-1$ and $t$. Columns 1 and 4 use an OLS estimator while other columns use IV 2SLS estimation procedures. Columns 2 and 5 instrument $Tax$ by $Tax^{(1)}$ and columns 3 and 6 use $Tax^{(2)}$ (see 4.2.3 and Appendix D.2). Period: 1994-2013 for columns 1 to 3 and 1998-2013 for columns 4 to 6 due to availability of local unemployment data. Variable $Tax$, $Tax^{(1)}$ and $Tax^{(2)}$ have been standardized.Robust standard errors clustered at the firm level are reported in parenthesis. ***, ** and * respectively indicate 0.01, 0.05 and 0.1 levels of significance.

Figure 11: Relocation frictions and misallocation




**Notes**: This graph plots the measure of misallocation based on the Olley and Pakes (1996) covariance as presented in subsection 4.4 against the share of real estate owning firms in each *département* and year. Département codes are explained in Table A1. Source: `FiBEn`, see Appendix A for more details about the data.

plotted this covariance against the share of firms that are real estate owners for each *département* and year. The correlation between the two is clearly positive.[24] As in Hsieh and Klenow (2009), misallocation induced by the distortion of the real estate market account for a reduction in aggregate productivity and consequently in aggregate output.

# 5 Conclusion

This paper studies the implications of adjustment costs of real estate assets on firm level factors' demand, in particular employment, and explores the empirical relevance of the theoretical prediction.

We first built a general equilibrium model in which firms make decisions on inputs' adjustment following productivity shocks against a background of fixed adjustment costs of real estate induced by relocation. The model predicts that a relocation is associated with a concomitant adjustment of employment level. The magnitude of those adjustments may differ whether the firm is growing or slackening; the relocation of a growing firms being typically associated with larger change in the workforce. Our model also predicts that relocation costs reduce the propensity to relocate and distort the employment growth distribution with a particularly marked negative impact on firms facing positive productivity shocks.

[24]In Figure 11, we show results for considering all years but considering one specific year won't affect the result and yields a similar upward slopping fitting line.

Second, we confronted these predictions to the data using a large dataset on French firms over the period 1994-2013 and exploited the firm-level heterogeneity in the real estate adjustment costs entailed by the latent tax on real estate capital gains. The results derived from the theoretical framework are confirmed. Relocating is associated with significant adjustment in the workforce size and the level of the adjustment costs reduces the propensity to relocate, and constrains jobs creation of the growing firms. In addition, the empirical analysis allows to isolate a causal effect of real-estate adjustment costs on employment dynamics, using exogenous shocks and instrumental variables.

This paper documents an example of a cost that prevent the optimal adjustment of inputs across firms following productivity shocks which we can partly observe in the data. Such analysis provides evidence of a direct effect of fiscal distortion on misallocation of inputs across firms.

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# ONLINE APPENDIX - NOT FOR PUBLICATION UNLESS REQUESTED

## A Data description

### A.1 Data sources

We use French firm-level data merged with real estate prices at the *département* level.[25]

#### A.1.1 firm-level information

We exploit a large French firm-level database constructed by the Bank of France: `FiBEn`. `FiBEn` is based on fiscal documents, including balance sheet and P&L statements, and contains detailed information on flow and stock accounting variables as well as information on firms' activities, location and workforce size.

The database includes French firms with annual sales exceeding $750,000$ euros or with outstanding credit exceeding $380,000$ euros. It has a large coverage of French medium and large firms. Using a dummy variable indicating if firms operate in more than one establishment, we only retain single establishment firms and we restrict our sample to firms with total headcount below 250 to ensure the validity of this information. We consider firms in the manufacturing or business services sectors and exclude those operating in the retail industry and the hotel and catering industry. Those sectors are indeed characterized by small catchment areas than can be affected by short-distance relocations.[26] We keep firms that declare data over at least three consecutive years. Our panel is unbalanced as firms may enter and exit the sample between 1994 and 2013.[27]

#### A.1.2 Real estate prices

We need real estate prices to compute capital gains on real estate assets as well as real estate volume. Commercial real estate local prices being not available in France, we use residential prices. More precisely, we use the *Notaires*-INSEE[28] apartment price indices built by Fougère and Poulhes (2012) which are based on the data collected by French *notaires* and the methodology developed by the INSEE.[29] These indices take into account changes in the quality of apartments since hedonic characteristics of the flats are used to build the indices. The indices in each *département* are standardized to be equal to 100 in 2000. In addition, we have apartment per square meter prices in each

[25] There are 94 départements in mainland France, a complete list can be found in Table A1. Because of the lack of reliable regarding data on real estate price, we excluded departments 12 (Aveyron), 46 (Lot) and 53 (Mayenne).

[26] Note that keeping those sectors in the database has no effects on the results but are likely to increase measurement errors.

[27] We cannot conclude that a firm exiting the sample has gone bankrupt as it may have merely crossed the above-mentioned declaration thresholds; alternatively it may have been bought by another firm.

[28] Solicitor is the English equivalent for the French word *notaire*

[29] The National Institute of Statistics and Economic Studies, the French National Statistical Bureau.

*département* in 2013. Apartment per square meter prices at the *département* level are collected by the *Chambre des Notaires*. They correspond to the average price per square meter of all apartment transactions registered in a given year.[30] We retropolate apartment prices using the apartment price index to build apartment prices per square meter at the *département* level from 1994 onwards. Prior to 1994, housing price indices used to retropolate the series are taken from Friggit (2009). We use the Paris housing price index (available from 1840 onwards) for *départements* located in the Paris area (*Île-de-France*) and the national housing price index (available from 1936 onwards) for all the other *départements*. We report the evolution of real estate prices given in thousand of 2013 euros in each *Département* in Table A2.

Real estate prices at the *département* level being less precise before 1994, we start our analysis in 1994. We also restrict our study to the firms headquartered in so-called *"départements de France métropolitaine"* (mainland France), excluding overseas territories and Corsica.

## A.2 Variable construction and further descriptive statistics

### A.2.1 Firms mobility

We derive information on firms relocation behavior thanks to the reported location of headquarters. `FiBEn` provides, at annual frequencies, the municipality where the headquarters are located at the end of the year. We identify the occurrence of a relocation when we observe a change in the municipality of the headquarters. Hence, we only identify relocations across municipalities and clearly underestimate the number of relocations.

Besides, in order to insure that the headquarters' relocation coincides with the relocation of the whole firm's activities, we restrict our analysis to single establishment firms. Single establishment firms account for around 80% of the firms registered in `FiBEn`.

We mentioned in the introduction that a concurrent strategy to local relocation might consist in opening new establishments (branching). We find that 2% of the firms initially identified as single-establishment turn to multi-establishment structures. When compared to the 13.2% of firms relocating locally, this finding shows that local relocation is a much more common event than branching.

For each relocation observed we compute the "as-the-crow-flies" distance between the municipality of departure and the municipality of arrival using the latitude and the longitude of the center of the municipality from the National Geographic Institute (IGN). The distance is below 7.5km for 50% of the relocations; it is below 16km for 75 percent of the relocating firms. We report in Figure A1 the histogram of the distances between the place of departure and the place of settlement.

### A.2.2 Real estate assets and capital gains

Real estate assets reported in the balance sheet are not mark-to-market. The market value of firms real estate holdings is important in our analysis because it determines the capital gains on which a

[30] The *Chambre des Notaires de Paris* has registered apartment prices in the database *Bien* from 1992 onwards and the *Notaires de France* started to register those prices for the rest of mainland France in the database *Perval* in 1994.

Table A1: French *Départements* in 2013

| *Département* name | *Département* code | Population | *Département* name | *Département* code | Population |
|---|---|---|---|---|---|
| Ain | 1 | 634,173 | Maine-et-Loire | 49 | 809,505 |
| Aisne | 2 | 538,743 | Manche | 50 | 500,019 |
| Allier | 3 | 343,680 | Marne | 51 | 572,968 |
| Alpes-de-Haute-Provence | 4 | 162,924 | Haute-Marne | 52 | 179,638 |
| Hautes-Alpes | 5 | 140,706 | Mayenne | 53 | 307,831 |
| Alpes-Maritimes | 6 | 1,081,821 | Meurthe-et-Moselle | 54 | 729,664 |
| Ardèche | 7 | 323,543 | Meuse | 55 | 190,550 |
| Ardennes | 8 | 278,970 | Morbihan | 56 | 747,458 |
| Ariège | 9 | 153,011 | Moselle | 57 | 1,047,013 |
| Aube | 10 | 308,085 | Nièvre | 58 | 212,111 |
| Aude | 11 | 370,056 | Nord | 59 | 2,607,174 |
| Aveyron | 12 | 278,062 | Oise | 60 | 822,858 |
| Bouches-du-Rhône | 13 | 2,007,684 | Orne | 61 | 286,256 |
| Calvados | 14 | 693,277 | Pas-de-Calais | 62 | 1,466,483 |
| Cantal | 15 | 146,299 | Puy-de-Dôme | 63 | 646,537 |
| Charente | 16 | 354,586 | Pyrénées-Atlantiques | 64 | 670,434 |
| Charente-Maritime | 17 | 639,596 | Hautes-Pyrénées | 65 | 228,304 |
| Cher | 18 | 311,768 | Pyrénées-Orientales | 66 | 472,033 |
| Corrèze | 19 | 238,713 | Bas-Rhin | 67 | 1,118,009 |
| Côte-d'Or | 21 | 533,023 | Haut-Rhin | 68 | 763,716 |
| Côtes-d'Armor | 22 | 599,438 | Rhône | 69 | 1,816,373 |
| Creuse | 23 | 119,381 | Haute-Saône | 70 | 238,181 |
| Dordogne | 24 | 418,219 | Saône-et-Loire | 71 | 555,840 |
| Doubs | 25 | 536,474 | Sarthe | 72 | 572,135 |
| Drôme | 26 | 501,154 | Savoie | 73 | 429,253 |
| Eure | 27 | 599,518 | Haute-Savoie | 74 | 791,094 |
| Eure-et-Loir | 28 | 435,171 | Paris | 75 | 2,218,536 |
| Finistère | 29 | 907,423 | Seine-Maritime | 76 | 1,255,587 |
| Gard | 30 | 748,509 | Seine-et-Marne | 77 | 1,391,429 |
| Haute-Garonne | 31 | 1,335,366 | Yvelines | 78 | 1,424,411 |
| Gers | 32 | 191,639 | Deux-Sèvres | 79 | 372,586 |
| Gironde | 33 | 1,542,964 | Somme | 80 | 571,595 |
| Hérault | 34 | 1,123,990 | Tarn | 81 | 386,004 |
| Ille-et-Vilaine | 35 | 1,039,983 | Tarn-et-Garonne | 82 | 255,666 |
| Indre | 36 | 225,590 | Var | 83 | 1,041,681 |
| Indre-et-Loire | 37 | 606,164 | Vaucluse | 84 | 554,619 |
| Isère | 38 | 1,253,614 | Vendée | 85 | 667,970 |
| Jura | 39 | 259,455 | Vienne | 86 | 433,682 |
| Landes | 40 | 405,213 | Haute-Vienne | 87 | 375,363 |
| Loir-et-Cher | 41 | 332,775 | Vosges | 88 | 371,792 |
| Loire | 42 | 761,357 | Yonne | 89 | 340,884 |
| Haute-Loire | 43 | 227,509 | Territoire de Belfort | 90 | 145,074 |
| Loire-Atlantique | 44 | 1,358,627 | Essonne | 91 | 1,279,864 |
| Loiret | 45 | 670,906 | Hauts-de-Seine | 92 | 1,603,379 |
| Lot | 46 | 173,021 | Seine-Saint-Denis | 93 | 1,573,959 |
| Lot-et-Garonne | 47 | 334,106 | Val-de-Marne | 94 | 1,372,018 |
| Lozère | 48 | 76,204 | Val-d'Oise | 95 | 1,210,318 |

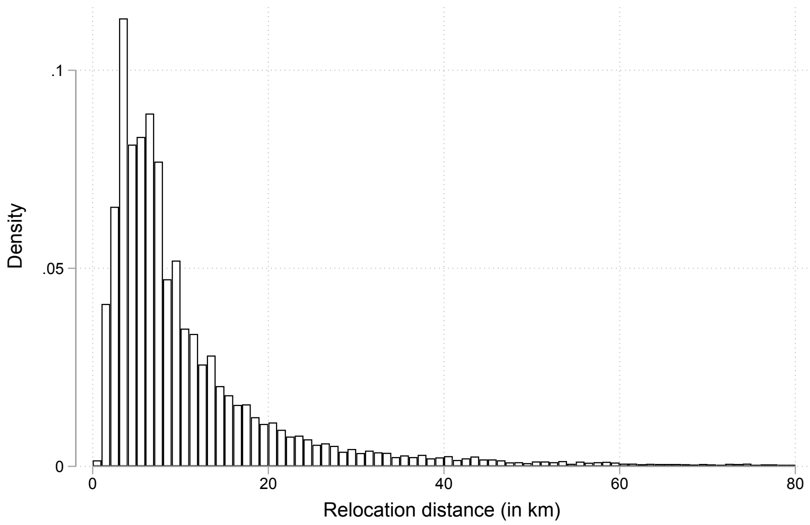
**Notes**: List of French *département* (mainland France) in 2013 and population. The codes presented in this table are consistent from 1994 to 2013. Source: INSEE.

Table A2: Real estate prices and propensity of relocation across *départements*

| ***Département*** | (1) | (2) | (3) | (4) | ***Département*** | (1) | (2) | (3) | (4) | ***Département*** | (1) | (2) | (3) | (4) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **1** | 1,101 | 0.76 | 1.89 | 1.19% | **33** | 2,032 | 0.81 | 2.60 | 1.78% | **66** | 559 | 0.91 | 2.00 | 0.97% |
| **2** | 657 | 0.83 | 1.36 | 0.87% | **34** | 1,212 | 1.50 | 2.75 | 1.52% | **67** | 1,831 | 1.25 | 2.15 | 1.36% |
| **3** | 399 | 0.43 | 1.05 | 1.13% | **35** | 1,593 | 1.32 | 2.28 | 1.14% | **68** | 1,236 | 0.59 | 1.52 | 1.28% |
| **4** | 183 | 0.81 | 1.87 | 1.03% | **36** | 305 | 0.47 | 1.06 | 0.75% | **69** | 3,396 | 1.74 | 2.77 | 2.51% |
| **5** | 217 | 0.71 | 2.15 | 0.77% | **37** | 902 | 0.97 | 2.02 | 1.65% | **70** | 357 | 0.50 | 1.03 | 0.73% |
| **6** | 1,452 | 1.96 | 3.75 | 1.31% | **38** | 2,230 | 1.24 | 2.16 | 1.45% | **71** | 987 | 0.73 | 1.14 | 0.95% |
| **7** | 426 | 0.68 | 1.40 | 1.06% | **39** | 541 | 0.54 | 1.33 | 0.69% | **72** | 687 | 0.66 | 1.39 | 1.05% |
| **8** | 431 | 0.57 | 1.13 | 1.14% | **40** | 473 | 1.01 | 2.30 | 0.79% | **73** | 894 | 1.36 | 2.61 | 1.50% |
| **9** | 196 | 0.97 | 1.72 | 0.86% | **41** | 513 | 0.70 | 1.47 | 0.70% | **74** | 1,571 | 1.38 | 3.26 | 1.44% |
| **10** | 532 | 0.49 | 1.28 | 1.20% | **42** | 1,511 | 0.66 | 1.14 | 1.17% | **75** | 4,990 | 2.89 | 8.14 | 3.40% |
| **11** | 396 | 0.93 | 2.11 | 0.49% | **43** | 401 | 0.41 | 1.12 | 0.82% | **76** | 1,672 | 0.98 | 1.93 | 1.71% |
| **13** | 2,932 | 1.07 | 2.54 | 1.43% | **44** | 1,738 | 1.13 | 2.52 | 1.32% | **77** | 2,005 | 1.16 | 2.69 | 1.56% |
| **14** | 888 | 1.66 | 2.37 | 1.59% | **45** | 925 | 1.05 | 1.80 | 1.16% | **78** | 1,746 | 1.65 | 3.78 | 2.12% |
| **15** | 199 | 0.52 | 1.30 | 0.68% | **47** | 528 | 0.40 | 1.15 | 1.00% | **79** | 591 | 0.60 | 1.19 | 0.90% |
| **16** | 535 | 0.42 | 1.02 | 1.07% | **48** | 110 | 0.68 | 1.49 | 0.37% | **80** | 672 | 1.02 | 2.08 | 0.86% |
| **17** | 827 | 1.70 | 2.97 | 0.83% | **49** | 1,400 | 0.96 | 1.70 | 1.10% | **81** | 656 | 0.81 | 1.45 | 0.70% |
| **18** | 438 | 0.72 | 1.26 | 0.87% | **50** | 637 | 0.77 | 1.51 | 1.09% | **82** | 344 | 0.51 | 1.39 | 0.48% |
| **19** | 331 | 0.52 | 1.18 | 0.68% | **51** | 1,044 | 1.15 | 1.93 | 0.96% | **83** | 1,123 | 1.30 | 3.08 | 1.34% |
| **21** | 846 | 0.97 | 2.00 | 1.45% | **52** | 275 | 0.70 | 1.10 | 0.51% | **84** | 882 | 0.92 | 1.91 | 0.93% |
| **22** | 905 | 0.92 | 1.60 | 0.93% | **54** | 801 | 0.73 | 1.62 | 1.60% | **85** | 1,240 | 1.35 | 2.33 | 0.68% |
| **23** | 139 | 0.47 | 0.94 | 0.42% | **55** | 209 | 0.48 | 1.13 | 0.75% | **86** | 640 | 1.18 | 1.59 | 0.98% |
| **24** | 601 | 0.64 | 1.35 | 1.03% | **56** | 1,020 | 1.15 | 2.08 | 1.01% | **87** | 515 | 0.71 | 1.22 | 0.86% |
| **25** | 892 | 0.77 | 1.64 | 1.14% | **57** | 1,068 | 0.80 | 1.59 | 1.41% | **88** | 629 | 0.57 | 1.11 | 0.77% |
| **26** | 1,015 | 0.63 | 1.46 | 1.05% | **58** | 243 | 0.47 | 0.95 | 0.86% | **89** | 486 | 0.86 | 1.40 | 0.96% |
| **27** | 716 | 0.90 | 1.67 | 1.27% | **59** | 3,185 | 1.08 | 2.39 | 1.79% | **90** | 169 | 0.67 | 1.21 | 1.53% |
| **28** | 625 | 1.11 | 2.01 | 1.09% | **60** | 1,006 | 1.45 | 2.35 | 1.50% | **91** | 1,819 | 1.28 | 2.69 | 2.30% |
| **29** | 1,191 | 0.45 | 1.37 | 0.85% | **61** | 404 | 0.47 | 1.00 | 0.94% | **92** | 2,511 | 2.27 | 5.26 | 3.51% |
| **30** | 853 | 0.88 | 1.92 | 1.08% | **62** | 1,625 | 1.25 | 2.02 | 1.33% | **93** | 1,943 | 1.48 | 3.20 | 2.71% |
| **31** | 1,830 | 1.04 | 2.39 | 1.60% | **63** | 954 | 0.60 | 1.68 | 1.18% | **94** | 1,888 | 1.87 | 4.19 | 2.47% |
| **32** | 261 | 0.51 | 1.44 | 0.25% | **64** | 1,127 | 0.99 | 2.36 | 1.32% | **95** | 1,330 | 1.17 | 2.76 | 2.08% |
| **33** | 2,032 | 0.81 | 2.60 | 1.78% | **65** | 272 | 0.62 | 1.54 | 1.10% | | | | | |

**Notes**: This table presents some descriptive statistics across *départements*. Column 1 gives the number of mono-establishments firms observed across the time period 1994-2013, column 2 gives the level of real estate prices in 1994 in thousands euros of 2010 per square meters, column 3 gives the level of real estate prices in 2013 in thousands euros of 2010 per square meters and column 4 gives the percentage of firms that have relocated, on average, each year over the period 1994-2013. *Départements* names are given in Table A1. Source: `FiBEn`, INSEE

Figure A1: Histogram of the distances between the place of departure and the place of settlement




**Notes**: This Figure plots the distribution of the as-the-crow-flies distances between the place of departure and the place of settlement of a relocating firm. For the sake of readability, we restrict our analysis to relocations characterized by a distance inferior to 50km ; the percentile 90 in the distances distribution is 60km and the percentile 99 is around 600km. Period of observation: 1994-2013. Source: authors calculations based on `FiBEn`.

tax is levied in the event of a sale.

Nevertheless, firm's balance sheets provide information on gross value of land and buildings and on accumulated amortizations of buildings. The gross value of land and buildings corresponds to their historical value adjusted by accounting reevaluations. A proxy for the mean age of real estate assets can be recover thanks to the ratio of the accumulated amortizations of buildings over the gross book value of buildings when we assume that buildings are linearly amortized.[31]

We do not have precise information on the location of the firm's real estate assets. Consequently, we use the *département* where the firm is headquartered as a proxy for the location of real estate assets.[32] In order to recover the market value of real estate units held by the firm, we multiply the historical value of real estate holdings by the accrued changes in the real estate prices in the headquarters's *département* since the average acquisition date. We eventually obtain, for each firm×year observation, the market-value of real estate holdings.

With the market-value, we can compute the capital gains on real estate assets by subtracting the historical value to the market-value. The amount of realised capital gains does not necessarily constitute the fiscal base. Indeed, the tax scheme takes into a account the holding period. After a five-year holding period the gains retained in the tax base are diminished by 10% each year; so that

[31] The accounting standard for the length of the amortization period depends on the nature of the buildings. We retain an average length of 25 years following Chaney et al. (2013).

[32] As we restrict our analysis to single-establishment firms, this is a mild assumption.

Table A3: Variable descriptions

| Variable | Description |
|---|---|
| Employment | Full-time equivalent (FTE) number of workers as reported by the firm. |
| Real Estate Owner | Dummy variable equal to one if the firm reports real estate assets in its balance-sheet. |
| Relocation | Number of local relocations over the observed period divided by the size of this period. |
| Age | Number of years since company's incorporation. |
| Size | Net value of the assets reported in the balance sheet in constant million of euros of 2010. |
| Age of Real Estate | Average age, in years, of real estate assets held by the firm. |
| Tax | Share, in %, of the proceeds from the real estate asset sales that would be paid under the heading of the tax on capital gains if the real estate assets were to be sold by the firm in a given year. |
| Volume of Real Estate | Numbers of square meters normalised the net value of the balance sheet. |

**Notes**: This table gives the definition of the variables used in the empirical analysis. For a detailed description of these variables construction, see appendix A.

after a fifteen-year holding period the firm is not anymore subject to the tax.

For each firm×year observations, we build a variable indicating the share of the proceeds that would paid by the firm under the heading of tax on capital gains in the event of a sale of the real estate assets. This variable varies with:

(i) The marginal tax rate: constant across firms and equal to the corporate tax rate as capital gains are added to the net income of the firm.

(ii) The dynamics of real estate prices since the acquisition date: varying with the *département*.

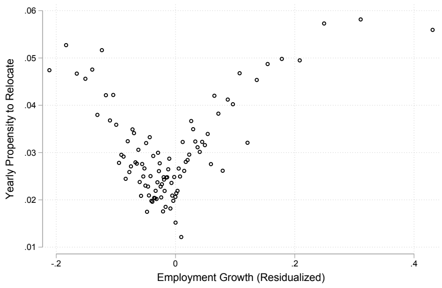
(iii) The length of time since acquisition: varying with the acquisition date and the year in which the firm is observed.

### A.2.3 Variable desciption

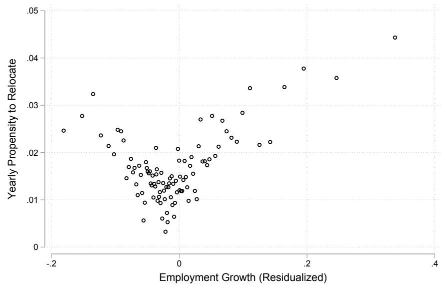
Variable description and construction is summarized in Table A3.

# B Additional Figures

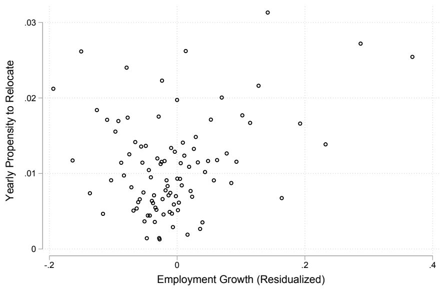
Figure B1: Propensity to relocate and employment growth



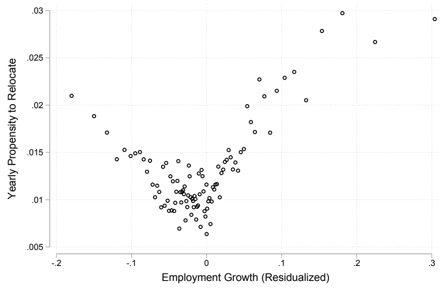

(a) Within *Île-de-France* (Paris area)



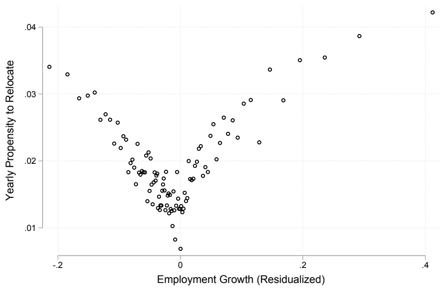

(b) Within *Rhône-Alpes* (Lyon area)



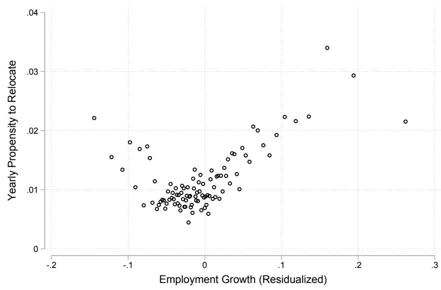

(c) Within *PACA* (Marseille Area)




(d) Without Paris, Marseille and Lyon areas



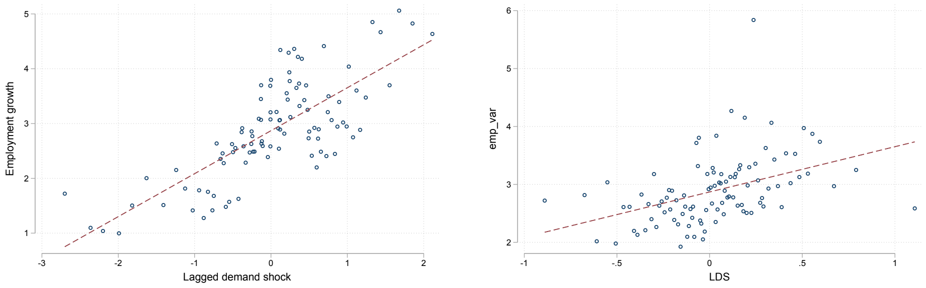

(e) Within service industries




(f) Within manufacturing industries

**Notes**: see Figure 1. Period of observation: 1994-2013. Figure (a) only includes observations from Lyon Area (Region *Rhone-Alpes*, Départements 01, 07, 26, 38, 42, 69, 73, 74), Figure (b) only includes observations from Paris Area (Region *Ile de France*, Départements 75, 77, 78, 91, 92 ,93 ,94 ,95). Figure (c) only includes observation from Marseille Area (Region *Provence-Alpes-Cote-d'Azur*, Départements 04, 05, 06, 13, 83, 84), Figure (d) excludes all observations from Paris, Lyon and Marseille areas. Source: `FiBEn`

Figure B2: Demand shock and employment growth




(a) Raw correlation (b) Absorbing year fixed effects

**Notes**: these two graphs group the demand shock (see section 4.3 variable into 100 equal-sized bins and compute the mean of this variable and of employment growth within each bin. Left-hand side panel does not apply any treatment to the data while right-hand side panel absorb a year fixed effect. Source: `FiBEn`

# C Theory appendix

## C.1 Model without friction

In a model without friction, each intermediate firm maximizes its revenue by choosing $r(i)$ and $l(i)$. First order conditions yields:

$$l(i) \quad = \alpha \left[\frac{\Omega(i)(1-\varepsilon)}{w}\right]^{\frac{1}{\varepsilon}} \left(\frac{w}{u}\right)^{\frac{(1-\alpha)(1-\varepsilon)}{\varepsilon}} \tag{20}$$

$$r(i) \quad = (1-\alpha)\left[\frac{\Omega(i)(1-\varepsilon)}{u}\right]^{\frac{1}{\varepsilon}} \left(\frac{w}{u}\right)^{\frac{-\alpha(1-\varepsilon)}{\varepsilon}} \tag{21}$$

which implies that firm $i$'s output price is a fixed markup over its marginal costs:

$$p(i) \quad = \frac{1}{1-\varepsilon}\frac{w^{\alpha}u^{1-\alpha}}{\theta(i)} \tag{22}$$

and hence:

$$P = \frac{1}{1-\varepsilon}(w^{\alpha}u^{1-\alpha})\left(\int_0^1 \theta(i)^{\frac{1-\varepsilon}{\varepsilon}}di\right)^{\frac{\varepsilon}{\varepsilon-1}} \tag{23}$$

We can then write:

$$y(i) = \theta(i)\left[\Omega(i)(1-\varepsilon)\right]^{\frac{1}{\varepsilon}}\left(w^{\alpha}u^{1-\alpha}\right)^{\frac{-1}{\varepsilon}} = \theta(i)^{\frac{1}{\varepsilon}}(1-\varepsilon)^{\frac{1}{\varepsilon}}YP^{\frac{1}{\varepsilon}}\left(w^{\alpha}u^{1-\alpha}\right)^{\frac{-1}{\varepsilon}} \tag{24}$$

using the value of $P$ yields:

$$y(i) = \theta(i)^{\frac{1}{\varepsilon}}\left(\int_0^1 \theta(i)^{\frac{1-\varepsilon}{\varepsilon}}di\right)^{\frac{1}{\varepsilon-1}} Y \tag{25}$$

from the FOCs, note that

$$wl(i) + ur(i) = \theta(i)^{\frac{1-\varepsilon}{\varepsilon}} w^\alpha u^{1-\alpha} \left( \int_0^1 \theta(i)^{\frac{1-\varepsilon}{\varepsilon}} di \right)^{\frac{1}{\varepsilon-1}} Y \tag{26}$$

on the other hand:

$$p(i)y(i) = \frac{w_t^\alpha u^{1-\alpha}}{1-\varepsilon} \theta(i)^{\frac{1-\varepsilon}{\varepsilon}} \left( \int_0^1 \theta(i)^{\frac{1-\varepsilon}{\varepsilon}} di \right)^{\frac{1}{\varepsilon-1}} Y \tag{27}$$

We then show that the profit is equal to the production up to a markup

$$\pi(i) = \frac{\varepsilon}{1-\varepsilon} (w^\alpha u^{1-\alpha}) \theta(i)^{\frac{1-\varepsilon}{\varepsilon}} \left( \int_0^1 \theta(i)^{\frac{1-\varepsilon}{\varepsilon}} di \right)^{\frac{1}{\varepsilon-1}} Y \tag{28}$$

and

$$\int_0^1 \pi(i) di = \frac{\varepsilon}{1-\varepsilon} (w^\alpha u^{1-\alpha}) \left( \int_0^1 \theta(i)^{\frac{1-\varepsilon}{\varepsilon}} di \right)^{\frac{\varepsilon}{\varepsilon-1}} Y \tag{29}$$

From market clearing condition

$$\begin{aligned} L_s = & \int_0^1 l(i) di \\ R_s = & \int_0^1 r(i) di \\ PY = & \int_0^1 p(i)y(i) di, \end{aligned} \tag{30}$$

we can show that in equilibrium:[33]

$$Y = \left( \frac{L_s}{\alpha} \right)^\alpha \left( \frac{R_s}{1-\alpha} \right)^{1-\alpha} \left( \int_0^1 \theta(i)^{\frac{1-\varepsilon}{\varepsilon}} di \right)^{\frac{\varepsilon}{1-\varepsilon}} \tag{31}$$

plugging into $\Omega(i)$ yields:

$$(1-\varepsilon)\Omega(i) = \theta(i)^{1-\varepsilon} \left( \frac{L_s}{\alpha} \right)^{\varepsilon\alpha} \left( \frac{R_s}{1-\alpha} \right)^{\varepsilon(1-\alpha)} \left( \int_0^1 \theta(i)^{\frac{1-\varepsilon}{\varepsilon}} di \right)^{\varepsilon} (w^\alpha u^{1-\alpha}). \tag{32}$$

we can rewrite:

$$l_t(i) = \theta_t(i)^{\frac{1-\varepsilon}{\varepsilon}} \left( \frac{L_s}{\alpha} \right)^\alpha \left( \frac{R_s}{1-\alpha} \right)^{(1-\alpha)} \left( \int_0^1 \theta(i)^{\frac{1-\varepsilon}{\varepsilon}} di \right)^{-1} \left( \frac{u}{w} \right)^{1-\alpha} \tag{33}$$

We know that $\frac{r(i)}{l(i)} = \frac{R_s}{L_s} = \frac{(1-\alpha)w}{\alpha u}$, hence:

[33] This result comes from the fact that the market clearing condition implies: $YP = \int_0^1 p(i)y(i)di$ and that $\frac{L_s}{R_s} = \frac{l(i)}{r(i)}$.

$$l(i) = \theta(i)^{\frac{1-\varepsilon}{\varepsilon}} \left(\frac{L_s}{\alpha}\right)^{\alpha} \left(\frac{R_s}{1-\alpha}\right)^{(1-\alpha)} \left(\int_0^1 \theta(i)^{\frac{1-\varepsilon}{\varepsilon}} di\right)^{-1} \left(\frac{L_s}{\alpha}\right)^{1-\alpha} \left(\frac{R_s}{1-\alpha}\right)^{\alpha-1} \tag{34}$$

Finally:

$$l(i) = \frac{\theta(i)^{\frac{1-\varepsilon}{\varepsilon}}}{\int_0^1 \theta(i)^{\frac{1-\varepsilon}{\varepsilon}} di} L_s \text{ and } r(i) = \frac{\theta(i)^{\frac{1-\varepsilon}{\varepsilon}}}{\int_0^1 \theta(i)^{\frac{1-\varepsilon}{\varepsilon}} di} R_s \tag{35}$$

Normalizing $P$ to 1 ; we obtain:

$$u = (1-\varepsilon)\frac{1-\alpha}{R_s} Y \tag{36}$$

and

$$w = (1-\varepsilon)\frac{\alpha}{L_s} Y \tag{37}$$

and

$$p(i) = \frac{1}{\theta(i)} \left(\int_0^1 \theta(i)^{\frac{1-\varepsilon}{\varepsilon}} di\right)^{\frac{\varepsilon}{1-\varepsilon}} \tag{38}$$

### C.2 Existence of an interval of inaction

The relocating condition $d = \pi^1 - \pi^0 > 0$ is a function of $\Delta_r \equiv \frac{r^\star}{r_0}$ and we have:

$$d(\Delta_r) = \frac{u}{(1-\alpha)(1-\varepsilon)} \left(\varepsilon(1+\Delta_r) - (1-\alpha(1-\varepsilon))(1+\Delta_r)^{\frac{\varepsilon}{1-\alpha(1-\varepsilon)}}\right) + u - \zeta. \tag{39}$$

The function $d$ is differentiable and continuous in $\Delta_r$. It is straightforward to show that $d$ is decreasing with $\Delta_r$ when $\Delta_r < 0$ and increasing with $\Delta_r$ when $\Delta_r > 0$. The function $d$ takes the value $u - \zeta$ when $\Delta_r$ equals $-1$, $-\zeta$ when $\Delta_r$ equals 0 and tends to the infinity when $\Delta_r$ tends to infinity. Hence, if $u > \zeta$, there exist only two values of $\Delta_r$, one being negative and the other positive, such that $d = 0$. We denote them $\Delta_r^-$ and $\Delta_r^+$, respectively. The function $d$ is negative when $\Delta_r$ is between $\Delta_r^-$ and $\Delta_r^+$ and positive otherwise. Then, $\Delta_r^-$ and $\Delta_r^+$ are the bounds of the non-relocating interval. We can easily show that $|\Delta_r^-|$ and $|\Delta_r^+|$ are increasing in $\zeta$.

We explore further the properties of the bounds of the non-relocating interval when $\Delta_r$ is close to 0 using a third-order local approximation of the function $d$ around 0: $d(\Delta_r) = 0$ is roughly equivalent to:

$$\frac{2((1-\alpha)(1-\varepsilon)) + \varepsilon}{3(1-\alpha(1-\varepsilon))}\Delta_r^3 - \Delta_r^2 + \frac{2\zeta(1-\alpha(1-\varepsilon))}{u\varepsilon} \approx 0 \tag{40}$$

Let us denote $P$ the above-derived polynomial of degree 3. We can easily show that $P'$ is negative when $\Delta_r$ is between 0 and $\frac{2(1-\alpha(1-\varepsilon))}{2(1-\varepsilon)(1-\alpha)+\varepsilon}$ and positive otherwise. $P$ goes to $-\infty$ in $-\infty$ and to $+\infty$ in $+\infty$. We can also show that $P(0) > 0$ and $P\left(\frac{2(1-\alpha(1-\varepsilon))}{2(1-\varepsilon)(1-\alpha)+\varepsilon}\right) < 0$ when $u >> \zeta$. Then, $P$

has three real roots, $\lambda_1$, $\lambda_2$ and $\lambda_3$ with $\lambda_1 < 0 < \lambda_2 < \lambda_3$. The two roots that are solutions to our problem $\pi^1 - \pi^0 = 0$ are $\lambda_1$ and $\lambda_2$ while $\lambda_3$ is only an artifact due to the third order approximation generating large error as $\Delta_r$ is far from 0. We know from usual properties of polynomials on degree 3 that:

$$\begin{aligned} &\lambda_1 + \lambda_2 + \lambda_3 = \tfrac{3(1-\alpha(1-\varepsilon))}{2((1-\alpha)(1-\varepsilon))+\varepsilon} \\ &\lambda_1\lambda_2 + \lambda_1\lambda_3 + \lambda_2\lambda_3 = 0 \\ &\lambda_1\lambda_2\lambda_3 = \tfrac{-6\zeta(1-\alpha(1-\varepsilon))^2}{u\varepsilon(2(1-\alpha)(1-\varepsilon)+\varepsilon)} \end{aligned} \tag{41}$$

From which we obtain:

$$\lambda_1 + \lambda_2 = (\lambda_1\lambda_2)^2 \frac{u\varepsilon(2(1-\alpha)(1-\varepsilon)+\varepsilon)}{6\zeta(1-\alpha(1-\varepsilon))^2} > 0 \tag{42}$$

which implies $|\Delta_r^+| > |\Delta_r^-|$.

We also have:

$$\sqrt{\lambda_1 + \lambda_2}^3 = \sqrt{\lambda_1 + \lambda_2}\frac{2((1-\alpha)(1-\varepsilon))+\varepsilon}{3(1-\alpha(1-\varepsilon))} + \sqrt{\frac{6\zeta(1-\alpha(1-\varepsilon))^2}{u\varepsilon(2(1-\alpha)(1-\varepsilon)+\varepsilon)}} \tag{43}$$

From which we deduce that $\sqrt{\lambda_1 + \lambda_2}$ is increasing in $\zeta$ and decreasing in $\varepsilon$.

# D Additional empirical results

## D.1 Robustness of results in section 4.1

### Different definition of local relocations

In our baselines methods, we have defined a relocation to be "local" if the distance between the municipalities of departure and the municipalities of arrival is below 15km. As shown in Figure A1, this corresponds to a large share of all the inter-municipalities relocations we observe in the data. Table D1 also shows how increasing this threshold marginally affects the frequency of relocations, both for real estate owners and renters.

Table D1: Frequency of relocations

| | Share of relocating firms | |
|---|---|---|
| | Owners | Renters |
| Distance < 15km | 10.8% | 18.0% |
| Relocations from 15km to 25km | 1.6% | 2.4% |
| Relocations from 25km to 35km | 0.7% | 0.9% |
| Other relocations | 2.8% | 2.8% |
| | | |
| Within Labor Market Area relocations | 9.0% | 13.1% |

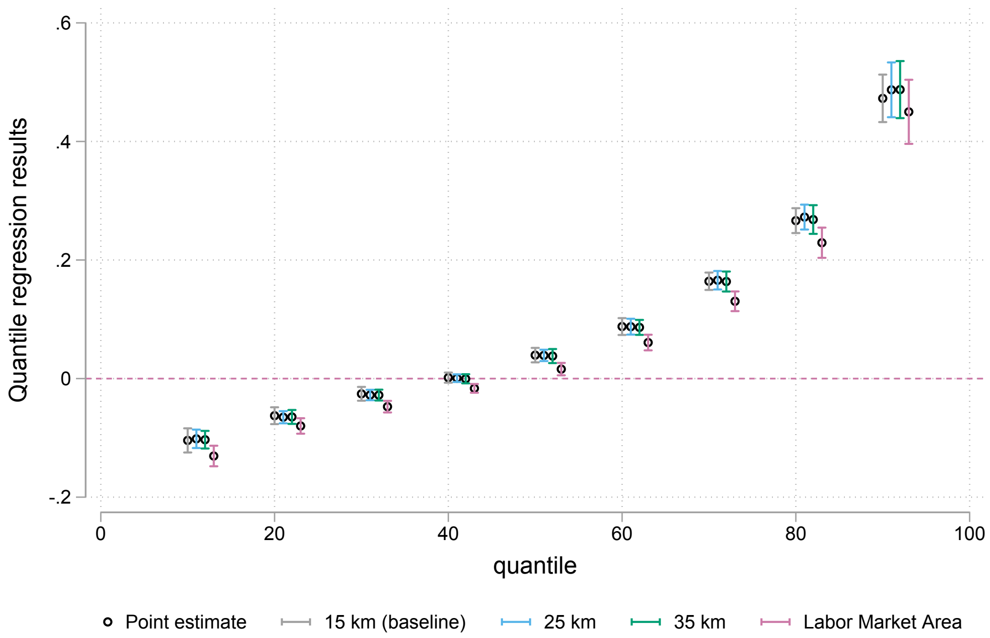
**Notes**: This table present the share of firms that have relocated at least once from 1994 to 2013. Relocations is split into four categories: local relocation (up to a distance of 15km), relocations at a distance ranging between 15 and 25km, relocations at a distance ranging between 25 and 35km, relocations at a distance above 35km and relocation within a Labor Market Area (*Zone d'Emploi*).

In Figure D1, we show the result of an estimation of equation (14) using quantile regressions and changing the definition of a "local" relocation. In this Figure, we have plotted the point estimates and confidence intervals for each ventile. Blue bins repeats our baseline results and considers a threshold distance of 15km while yellow and red bins use thresholds of 25km and 35km respectively. Black bins consider a relocation to be "local" if it is done within a *Zone d'Emploi* (Labor Market Area). We clearly see that our results are not sensitive to the definition of a local relocation.

### Considering different time periods

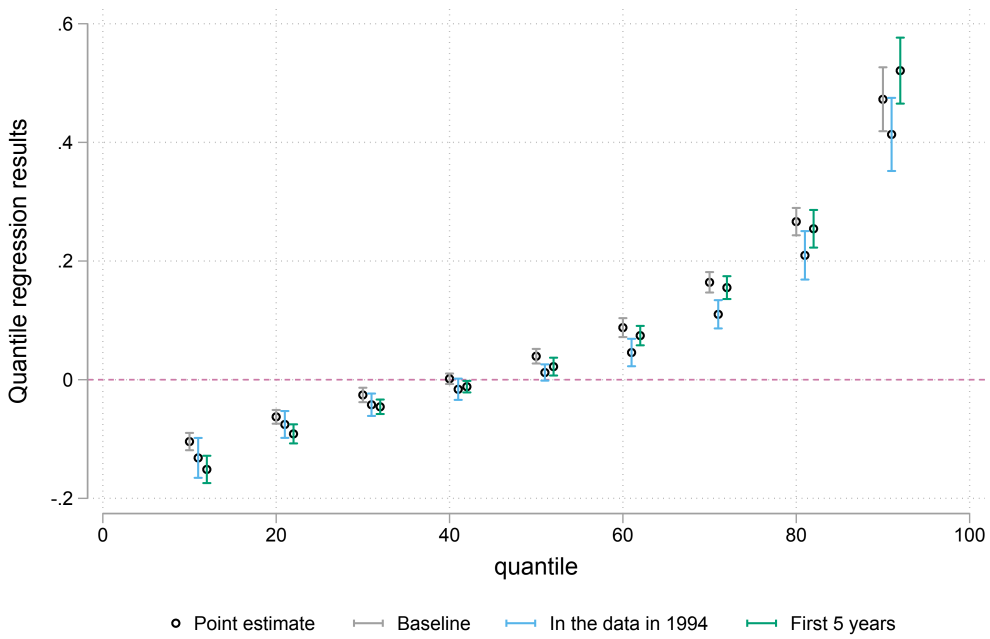
In our baseline regression presented in Figure 7, we take all the characteristics of the firms in the first year it appears in the data. However, this year can be different across firms beause of entries and exits into the dataset between 1994 and 2013. In this section, we show that our results are only marginally affected if we (i) restrict to firms that enter the dataset in 1994 (that is we do not consider entry); (ii) restrict to the first five years following entry in the dataset when computing aggregate employment and the frequency of relocation. These results are presented in Figure D2.

Figure D1: Robustness on the definition of local relocation




**Notes:** see Figure 7. Point estimates and confidence intervals presented in this graph are based on the same regression, but with different definition of local relocations: within a 15km, 25km, 35km radius or within the same labor market area ("Zone d'Emploi") respectively.

Figure D2: Robustness on the sample definition




**Notes:** see Figure 7. Point estimates and confidence intervals presented in this graph are based on the same regression, but with different sampling: all firms over the period 1994-2013, firms that are in the data in 1994, over the whole 1994-2013 period and all firms but considering only the first 5 years following their entry into the data respectively.

**Agglomeration effect**

One may worry that our regression capture agglomeration effects. As documented by Delgado et al. (2014) and Combes et al. (2012), regional clusters can result in an increasing growth rate of nearby firms that benefit from spillover, even if competition is stiffer. Firms are likely to be attracted by such clusters and subsequent employment growth may be affected by the new site. However, comparing the characteristics between the municipality of departure and the municipality of settlement for growing relocating firms and declining relocating firms does not show support for this alternative mechanism, as far as local relocations are concerned. Indeed, agglomeration effect would predict that growing firms relocate to larger or denser cities, or to cities where the industry in which they operate is more represented while declining firms would act conversely. Yet, in the data, we observe that both growing and declining firms tend to relocate to smaller and less dense municipalities where the level of concentration in the industry as well as its overall size are larger (see Table D2).[34] This rather corroborates the results on the urban sprawling, documented in the Paris area by Delisle and Laine (1998).[35] We do not observe any significant asymmetrical behavior between growing and declining firms in that respect.

**Place based program**

The displacement effect of publicly funded place-based programs has been documented in recent contributions (Givord et al., 2013; Mayer et al., 2015 for the French $ZFUs$ (*Zone Franche Urbaine*) and Overman and Einio, 2012 for the Local Enterprise Growth Initiative in the UK which shares similarities with the French program). Those programs are often blamed for causing a shift of economic activity from areas that do not benefit from the program to areas that do. In turns, this mechanism could offer an alternative explanation to the linkages between workforce growth and local relocations; that is to say an explanation that do not rely on premises' size constraint. If firms relocate in order to benefit from a more generous tax system that enables them to increase their workforce, we would observe a positive correlation between the occurrence of a local relocation and an increase in the workforce. Note, however, that this mechanism would not be able to account for the left branch in the documented U-shaped relationship between employment growth and location relocation presented in Figure 1. We check that this alternative mechanism does not alter our main results by excluded from our database firms that are located less than 15km away from a $ZFU$.[36]

[34]In Table D2, we compare the characteristics of the municipalities of departure and destination for both growing and declining firms. We see that overall, firms relocate to smaller and less dense areas where their sector is more concentrated and larger. However, we do not observe any significantly different behavior across the two groups of firms except as far as density is concerned. The difference in density disappear when the Paris area is excluded from the sample.

[35]This results could also be related to the idea that firms switch to mass production and relocate to specialized cities where production costs are lower as put forward by Duranton and Puga (2001)

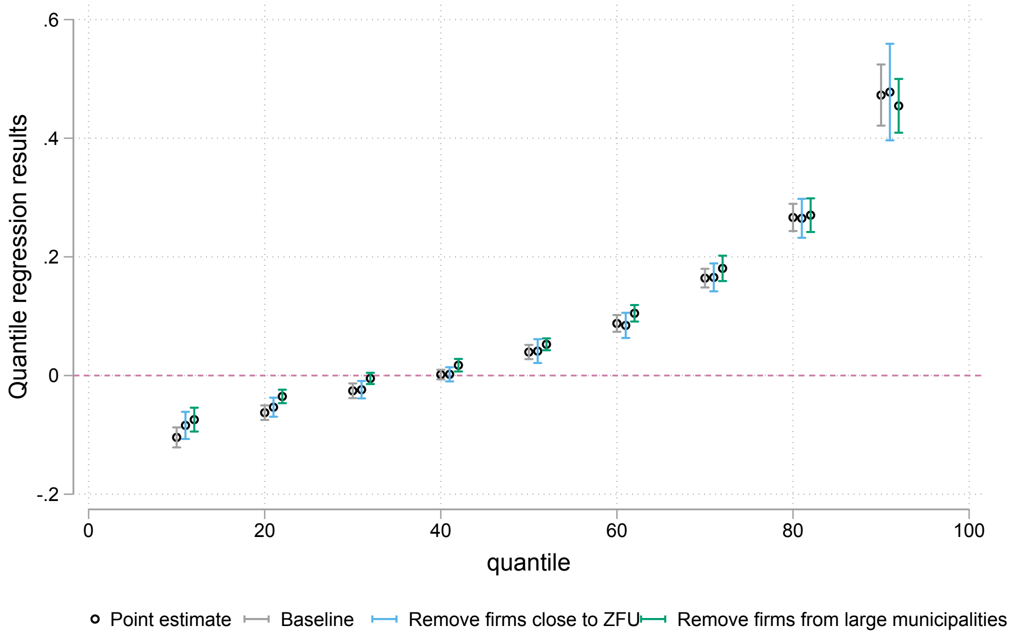
[36]An alternative would consist in focusing on big firms. There are indeed size restrictions to be eligible to the favorable tax scheme offered within the limits of a $ZFU$; in particular, firms with headcount higher than 50 are not eligible. There is also often a less stringent criterion related to total sales. Nevertheless, our study being conducted on single establishment firms, this would restrict our database to a small number of observations.

Table D2: Statistics on changes in local characteristics following a relocation - Growing firms and declining firms

| | Mean | | Difference |
|---|---|---|---|
| | Declining firms | Growing firms | |
| Population | -52.4 | -41.9 | -10.5 |
| | | | (8.15) |
| Density | -0.80 | -0.67 | -1.28** |
| | | | (0.65) |
| Herfindahl index | 0.021 | 0.016 | 0.004 |
| | | | (0.005) |
| Local sectoral size | 0.017 | 0.019 | -0.002 |
| | | | (0.006) |
| Nb of obs. | 7,634 | 11,215 | - |

**Notes**: This table shows the mean changes in some local characteristics following a relocation. We differentiate the firms for which we observed an overall increase in the headcount from firms for which we observe a overall decline in the headcount over the observation period. The statistics reported correspond the difference between the value observed in the municipality of settlement in the year of the relocation and the value observed in the municipality of departure prior to the relocation. Population is in thousands inhabitants in 1990 at the municipality level. Density, at the municipality level, in thousands inhabitants per square kilometer. The Herfindahl index is computed at the 2-digit sector×municipality×year level. Finally, the local sectoral size is the sum of the sales at the 2-digit sector×municipality×year level. The Period of observation: 1994-2013. Source: INSEE and FiBEn, see section A for more detail about the data.

Figure D3: Robustness: place-based programs




**Notes:** see Figure 7. Point estimates and confidence intervals presented in this graph are based on the same regression, but without including firms that are ever located less than 15km away from a ZFU (*Zone Franche Urbaine*) and after having removed largest municipalities (Paris, Lyon and Marseille areas).

In doing so, we discard all the potential relocation that could conduct a firm to relocate to a $ZFUs$. We estimate equation (14) with this restricted sample and present the results in Figure D3.

## D.2 Instrument for capital gain taxation

The level of the latent at $t$ tax on capital gain is mainly driven by local housing price dynamics between data $t$ and the date of acquisition of the real estate, which in turns is unlikely to result from the firm's employment decision (all the more that we are considering relatively small firms). However different concerns regarding the endogeneity of this variable may arise. One might for example believe that capital gain is likely to be larger in dynamic areas where employment growth is larger. Measurement errors may also bias our estimates. Although these biases would play *against* our effect that larger tax on capital gain deter employment dynamics, we built two instruments that are presented below.

### D.2.1 Instrument based on national prices

A first instrument ($Tax^{(1)}$) is constructed in the exact same way as $Tax$, but using an index of real estate prices computed at the national level, excluding the area where the firm is based. Formally, we use formula (15) where we replace $p_t^d$ by $\tilde{p}_t{}^d = \sum_{\delta \neq d} w^\delta p_t^\delta$, where $w^\delta$ is the weight of *département*

$\delta$ based on its population in 2013 (see Table A1). The intuition for this instrument is that local price variations are parallel across départements (to some extent, see Fougère et al., 2017), yet, by excluding the area where the firm is located, we abstract from potential reverse causality from large firms' performance on real-estate prices.

### D.2.2 Instrument based on supply elasticities

As noted in Fougère et al. (2017),[37] real estate prices may be correlated with the investment opportunities of real estate-holding firms. Following Himmelberg et al. (2005), Chaney et al. (2012), and Cvijanović (2014), we try to address this source of endogeneity by instrumenting local real estate prices by the interaction between housing loan interest rates and local supply elasticity. This strategy relies on the idea that when housing loan interest rates decrease, the demand for real estate increases. If the local supply of land is very elastic, the increased aggregate demand will translate mostly into more construction rather than higher real estate prices. Conversely, if the supply of land is very inelastic, the increased demand will translate mostly into higher prices. We thus expect that in a *département* where land supply is more elastic, a drop in housing loan interest rate should have a larger impact on real estate prices. For *département* $d$, in year $t$, we estimate the following equation for predicting real estate prices:

$$lnPrice_t^d = \gamma SupplyElasticity^d \times ir_t + \varepsilon_{it} \tag{44}$$

where $SupplyElasticity^d$ is the estimated supply elasticity at the *département* level and $ir_t$ is the real interest rate at which banks lend to households at the aggregate level. $\varepsilon_{it}$ are error terms clustered at the *département* level.

We use the local land supply elasticity estimated by Chapelle and Eymeoud (2018) in a recent contribution. These authors replicate the method introduced by Saiz (2010), for estimating the inverse supply elasticity at the urban area level. More precisely, they use a long difference in residential real estate prices and in population between 1999 and 2012. With the help of their estimates, we build the supply elasticity at the *département* level by weighting each urban area supply elasticity by its 2012 population share in the *département*. The housing loan rates at the aggregate level are provided by the Banque de France.

We then conduct an instrumental variable (IV) strategy where real estate prices are instrumented by the interaction between interest rates and supply elasticity. In the second-stage equation, we simply use predicted prices $\widetilde{lnPrice_t^d}$ obtained from the estimation of equation (44).

### D.2.3 First-Stage results

To check that these two instruments are indeed good predictors of the tax on capital gain, we run various first-stage estimations and report results in Table D3. Specifically, we consider the sample

[37] Most of the following is directly based on Fougère et al. (2017).

of real-estate owning firms and look at the contemporaneous correlation between $Tax^{(1)}$ and $Tax$ (columns 1 and 4), $Tax^{(2)}$ and $Tax$ (columns 2 and 5) and their joint correlation (columns 3 and 6), once we control for sector-year, département-year and firm fixed effects.

Table D3: First-stage regressions

| | Dependent variable: $Tax$ | | | | | |
|---|---|---|---|---|---|---|
| | **(1)** | **(2)** | **(3)** | **(4)** | **(5)** | **(6)** |
| $Tax^{(1)}$ | 0.871*** | | 0.799*** | 0.838*** | | 0.788*** |
| | (0.002) | | (0.003) | (0.003) | | (0.003) |
| $Tax^{(2)}$ | | 0.634*** | 0.078*** | | 0.570*** | 0.062*** |
| | | (0.003) | (0.003) | | (0.003) | (0.003) |
| Size | 0.021*** | 0.058** | 0.020*** | 0.010 | 0.033*** | 0.011* |
| | (0.006) | (0.023) | (0.006) | (0.006) | (0.012) | (0.006) |
| Real Estate Volume | | | | -0.001*** | -0.002*** | -0.001*** |
| | | | | (0.000) | (0.000) | (0.000) |
| Real Estate Age | | | | -0.000*** | 0.000*** | -0.000*** |
| | | | | (0.000) | (0.000) | (0.000) |
| Fixed Effects | | | | | | |
| Département × Year | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Sector × Year | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Firm | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| $R^2$ | 0.930 | 0.808 | 0.932 | 0.932 | 0.815 | 0.933 |
| Observations | 551,656 | 551,656 | 551,656 | 551,656 | 551,656 | 551,656 |

**Notes**: Variables definitions are given in Table A3. OLS estimations of the first stage regression associated with instruments $Tax^{(1)}$ and $Tax^{(2)}$ as defined in Section 4.2.3. Robust standard errors clustered at the firm level reported in parenthesis. ***, ** and * respectively indicate 0.01, 0.05 and 0.1 levels of significance.

### D.2.4 2SLS estimation

We next use these two instruments to replicate results of columns 2 and 4 of Table 3 but using 2SLS estimations. Table D4 show the results as well as the corresponding F-statistic on the excluded instruments and overidentification tests. Columns 1 and 4 instrument $Tax$ using $Tax^{(1)}$, columns 2 and 5 instrument $Tax$ using $Tax^{(2)}$ and columns 3 and 6 use both instruments jointly. Note that the Hansen-Sargan test does not reject the validity of the instruments once additional covariates are included (column 6). The estimated magnitudes imply that an increase of one percentage point of $Tax$ corresponds to a reduction of the likelihood to relocate by around 3%.

Table D4: Relocation cost and relocation choice - 2SLS estimations

| | Dependent variable: dummy for having relocated at *t* | | | | | |
|---|---|---|---|---|---|---|
| | **(1)** | **(2)** | **(3)** | **(4)** | **(5)** | **(6)** |
| $Tax$ (t-1) | -0.071*** | -0.077*** | -0.071*** | -0.034*** | -0.029*** | -0.034*** |
| | (0.005) | (0.005) | (0.005) | (0.006) | (0.007) | (0.006) |
| Size | 0.000 | 0.001 | 0.001 | 0.011 | 0.011 | 0.011 |
| | (0.015) | (0.015) | (0.015) | (0.017) | (0.017) | (0.017) |
| Real Estate Volume | | | | 0.000 | 0.000 | 0.000 |
| | | | | (0.000) | (0.000) | (0.000) |
| Real Estate Age | | | | 0.001*** | 0.001*** | 0.001*** |
| | | | | (0.000) | (0.000) | (0.000) |
| Fixed Effects | | | | | | |
| Département × Year | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Sector × Year | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| Firm | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| $R^2$ | 0.141 | 0.141 | 0.141 | 0.142 | 0.142 | 0.142 |
| F-stat on the excluded instruments | 139,236 | 61,361 | 71,197 | 99,749 | 42,662 | 51,409 |
| Sargan-Hansen J-stat (p-value) | | | 0.042 | | | 0.239 |
| Observations | 551,656 | 551,656 | 551,656 | 551,656 | 551,656 | 551,656 |

**Notes**: Variables definitions are given in Table A3. IV 2SLS estimations of equation (17) using $Tax^{(1)}$ (col 1 and 4), $Tax^{(2)}$ (col 2 and 5) and both (col 3 and 6) respectively. Instruments are defined in Section 4.2.3. Robust standard errors clustered at the firm level reported in parenthesis. ***, ** and * respectively indicate 0.01, 0.05 and 0.1 levels of significance.

### D.3 Additional results

#### Difference between owners and renters

Table D5 shows the difference between real estate owning firms and renters. We see that the latter are significantly smaller, younger ans grow faster than the former. real estate renters also relocate more frequently which is consistent with the view that they face lower moving costs than real estate owners.

Table D5: Summary statistics - Owners and Renters

| | Mean | | Difference | |
|---|---|---|---|---|
| | Owners | Renters | | |
| Employment | 26.8 | 15.8 | 11.0*** | (0.14) |
| Sales | 3.88 | 2.49 | 1.39*** | (0.043) |
| BS Size | 2.75 | 1.76 | 0.99*** | (0.14) |
| Age | 18.6 | 10.6 | 8.1*** | (0.079) |
| Employment growth | 1.6% | 3.7% | -2.1%*** | (0.099) |
| Frequency of Relocation | 1.2% | 2.5% | -1.3%*** | (0.034) |
| Nb of obs. | 46,034 | 78,109 | - | |

**Notes**: This table shows the mean of different key variables, in initial year of observation, for firms that own their real estate (Owners) and for firms that rent their real estate (Renters). Employment is given in full-time equivalent (FTE) number of workers as reported by the firm; Employment growth in the mean yearly percentage change in FTE over the observation period; Sales are in millions of euros; BS size is the net value of the assets reported in the balance sheet and is given in millions of euros; Profits is the Earning Before Interest and Tax margin (i.e., EBIT to Sales ratio); Age is the number of year since company's incorporation; Frequency of Relocation is the number of local relocation divided by the number of years of observation for the firm. Source: `FiBEn`, see Appendix A for more detail about the data. The latest column show the mean and standard deviation of the difference between the two coefficients and the Student t-stat on the nullity of this difference. $***$, $**$ and $*$ indicate that the null hypothesis of this test is rejected at the 1%, 5% and 10% level of significance.