Frictions in the corporate real-estate market, firms' relocation and employment*

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February 15, 2017

Abstract

The size of the premises in which firms operate clearly imposes an upper limit to their business volume and their employment level and may be a potential hindrance to the growth of dynamic firms. In this paper, we develop a partial equilibrium model in which a representative firm makes a decision on relocation and employment level considering the firm-level productivity path and the costs associated to relocation. We predict that relocation costs primarily hinder the employment growth of firms affected by an increase in productivity. Confronting these results using French firm-level data over the period 1994-2013, and covering all sectors, we find that,(i) local relocations have sizable effects on employment growth of both growing and declining firms; (ii) higher relocation costs lower firms' propensity to move; (iii) higher relocation costs constrain job creation of the most dynamic firms. We find that the highlighted mechanism has substantial macroeconomic effect: our preferred estimates suggest that a reduction of the relocation costs, through the removal of one of the identified tax friction, increases the firms' propensity to move by 11% and raises the yearly employment growth rate of the 10% fastest growing firms by 4%.

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

Keywords: Corporate real-estate; Firms' relocation; Adjustment costs; Misallocation of resources

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1 Introduction

Frictions to residential mobility and their detrimental effect on the functioning of the labor market have been extensively discussed by the economic literature (see, for example Dohmen, 2005). Firms' ability to relocate their activities throughout their life cycle and the consequences of those relocations on economic activities remain however a largely unexplored topic.

This paper studies the consequences of the costs associated with the adjustments of the size of firms' premises on employment dynamics. The size of the premises in which firms operate clearly imposes an upper limit to their business volume and their employment level and may be a potential hindrance to the growth of the most dynamic firms. The profit of declining firms may also be impaired by the costs induced by over-sized premises. As argued by Schmenner, 1980, on-site expansion, out-site expansion (branching) and relocation are not necessarily substitute to one another and the latter is the only option for many firms.[1] Firms' relocation is actually a fairly frequent event: with definitions that will be clarified below, we find that 1.7% of the French firms relocate their activities to a neighbouring city, on average, each year. In line with our argument on constrained on-site growth, this yearly propensity to relocate reaches 4.1% for firms in the upper decile in the average workforce growth distribution.

We propose a model and use firm-level data to show that the local relocation of activities has a significant impact on employment growth. We also find that higher costs associated with relocation primarily affect jobs creation of firms characterised by productivity increase and foster sub-optimal allocation of inputs across firms.

Most of the existing literature has 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 decision to relocate, internal factors (size, age, tenure status, sector and growth) are often identified as the main predictors of firms' relocation. Notably, expansion and the need for more suitable premises are the most cited forces causing relocation (see for example Pellenbarg, Van Wissen, and Van Dijk, 2002 and Brouwer, Mariotti, and Ommeren, 2004). In this study, we go one step further and explore the effects of relocation on the growth of firms. In our framework, a representative profit-maximizing firm makes decisions on labor and real-estate inputs in a context where real-estate inputs can be adjusted conditional on paying associated costs. Because of the complementarity between real-estate and labor in the production process, the level of the adjustment costs, which deter relocation, affects the firms' employment. High costs discourage firms from adapting their building size following a positive productivity shock resulting

[1] On-site expansion, especially in the non-manufacturing sector and/or in urban areas, is often an option that has to be discarded. 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

in constrained jobs creation and sub-optimal allocation of labor and real-estate assets. We find that: (i) relocating firms are characterized by larger variations in their number of employees and workforce adjustments are contemporaneous with the move; (ii) relocation have larger impacts on growing firms than on declining firms; (iii) adjustment costs have a negative effect on the propensity to move and this deterrence affects the employment growth of the most dynamic firms.

To test these predictions, we rely on data on French firms and their location from 1994 to 2013.[2] Our empirical study focuses on relocations occurring over a short distance, that is to say on relocations that leave the economic environment of the firm (e.g, localized aggregate increasing return, real-estate prices or wages) typically unaltered and that are primarily triggered by the inappropriateness of the site's characteristics.[3] Studying the consequences of local relocations on employment growth, we find that relocating firms are characterized by either large increase or, to a lesser extend, large decline in their workforce. The effect of relocations on employment is indeed larger for growing firms, suggesting stiffer constraint (prior to the move) on this category of firms. To assess the role of relocation costs, we rely on two peculiarities of these costs. First, firms that own their premises and firms that rent them face markedly different relocation costs. We compare the moving behaviour and the employment dynamics for these two categories of firms. Second, to deal with the unobserved heterogeneity across the two groups of firms, we focus on real-estate owners and exploit the heterogeneity introduced by the French tax system on realised capital gains affecting real-estate assets. This is indeed a tax that owning firms have to pay when they relocate.[4] In short, 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 interesting variability across firms and across time in the level of the relocation costs that we exploit to assess their impact. Based on those two analyses, we document that higher relocation costs lower firms' propensity to move and constrain job creation of the most dynamic firms. Our baseline results suggest that a reduction of the relocation costs, through the removal of the tax on real-estate capital gains, increases the propensity to move of affected firms by 11% and raises the yearly employment growth rate of the 10% fastest growing firms by 4%.

Our results should be put into perspective with the literature on misallocation of resource (Olley and Pakes, 1996; Hsieh and Klenow, 2009 and Asker, Collard-Wexler, and Loecker,

[2]We ensure an equivalence between the notion of firm and establishment by focusing on the behaviour of single-establishment firms. This is a restriction imposed by the nature of our dataset where we can only observe firm-level data and have no information whatsoever on establishments, in particular on their location.

[3]Focusing on local move is also justified by the fact that employees are likely to remain in the firm; such is not the case for moves over long distances: Weltevreden et al., 2007 shows that when the relocation distance exceeds 20km, most employees quit there jobs in anticipation of the moving decision.

[4]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.

2014) and especially of land. Using microdata on Indian firms, Gilles Duranton et al., 2015 find that misallocation of manufacturing output comes mostly from misallocation of land. This can be the consequence of long-terms choices of firms regarding their real-estate that cannot adjust to the shorter terms production fluctuation. Our results can also be considered in parallel with the emerging literature on the effect of tax friction on real-estate transactions and households' mobility. Dachis, Gilles Duranton, and Turner, 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 moves, suggesting that moving frictions may lead to misallocation of dwellings in the housing market.

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

2 Background

We know little about the firms' relocation and their interaction with firms' growth. This first section intends to highlight some important stylized fact supporting our views that there is a clear relationship between firms' mobility and employment dynamics. First, we look at some general characteristics of firms' relocation. Second, we document that employment dynamics and local moves are closely intertwined and that this interaction is affected by the tenure status. The following results use a micro database with information on a large number of French firms over the period 1994-2013 including their location, their tenure status (renter or owner), their real-estate assets, their age and their employment. We further describe our dataset in Appendix A.

2.1 Firms' mobility in France

Our firm-level database allows to identify inter-municipality relocation of single-establishment firms between 1993 and 2013 with total headcounts below 250 employees. We observe $155,583$ single-establishment firms over an average period of 9.75 years. Among these firms, $30,589$ have relocated their activities to another municipalities over the period of observation; that is approximately 20% of the firms. Half of the moves concerns a relocation where the municipality of departure and the municipality of settlement are distant by less than 7.5km. For almost 75% of the moves, 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 moving firms. They find that local moves account for the large majority of the moves (Pen and Pellenbarg, 1998; Delisle and Laine, 1998; Weltevreden et al., 2007 and Knoben, Oerlemans, and Rutten, 2008). In France, Delisle and Laine, 1998 document that 6.2% of the firms had moved between 1989 and 1992 with more than three quarters of the inter-municipality moves being characterized by a distance inferior to 23km. 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 move that is characterized by a distance of less than 15km, between the municipality of departure and the municipality of settlement.[5] The distribution of the relocating distance is given in Appendix A.

Table 1 presents some basic descriptive statistics to compare moving firms to a control group made of static firms.[6] We notice that moving firms do not differ much by their size, their employment level and their profitability (even if some of those differences are statistically significant). Slightly larger differences are observed for the age of the firm; static firms being in average 2.1 year older than moving firms. However, notable 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 moving firms is equal to 2.4%, it is 0.6% for static firms; (ii) the tenure status of the firm: 26% of the moving firms report real-estate holdings while this share is equal to 40% for static firms.

2.2 Propensity to move and workforce growth

The mean workforce growth of moving firms reported in table 1 suggests that the propensity to relocate activities is markedly related to workforce dynamics. 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 move by dividing the number of observed local moves by the number of observations in this percentile. These results are presented in Figure 1. 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 move than firms characterized by limited change in their workforce size.

Although striking, these results could be driven by different propensity to relocate across

[5] Following this definition 73.4% of the moves observed in our sample are local. There is a degree of arbitrariness in setting such a threshold. As mentioned before, it reflects the idea that moves over farther distance 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 defining as local the moves occurring within the local labor market area based on commuter flows from census data.

[6] In this control group made of static firms, we have excluded firms identified as having shifted towards a multi-establishment structure.

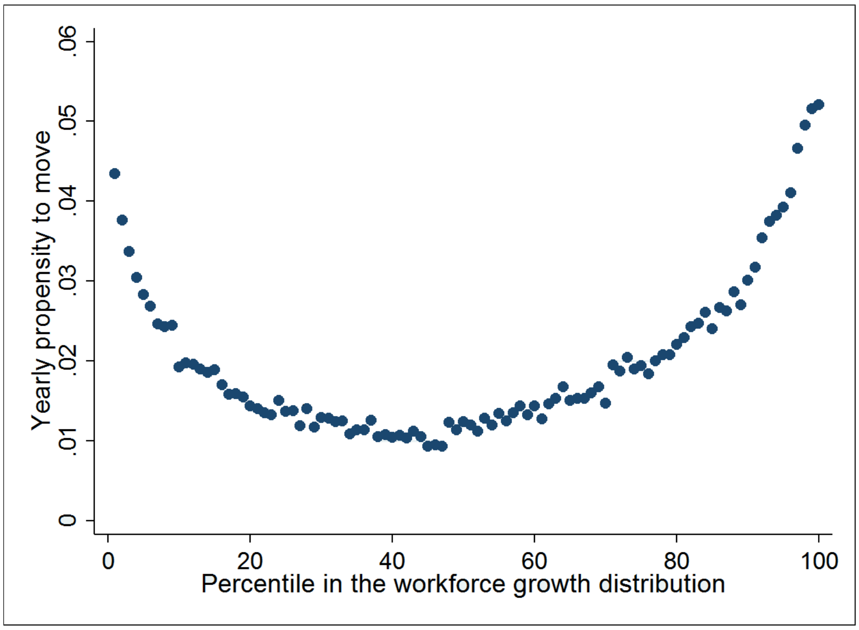
Table 1: Key summary statistics - locally moving and static firms

	Mean		Difference
	Locally moving	Static	
Employment	18.96	19.94	0.97***
			(0.17)
Sales	3.15	2.92	-0.22***
			(0.053)
BS size	2.27	2.06	-0.21
			(0.16)
Profits	0.075	0.072	0.003***
			(0.0008)
Age	12.23	14.38	2.14***
			(0.10)
Employment growth	0.024	0.006	-0.018***
			(0.0008)
Real-estate owner	0.26	0.40	0.14***
			(0.003)
Nb of obs.	23,253	114,061	-

Notes: $***pvalue < 0.01$, $**pvalue < 0.05$, $*pvalue < 0.10$.
Standard errors in brackets.

Notes: This table shows the mean of different key variables, in initial year of observation, for firms that relocate locally 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; BS size is the net value of the assets reported in the balance sheet and is given in millions of euros; Profits is the EBIT 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. Period of observation: 1994-2013. Source: FiBEn, see Appendix A for more detail about the data.

Figure 1: Propensity to move at different percentiles of employment growth



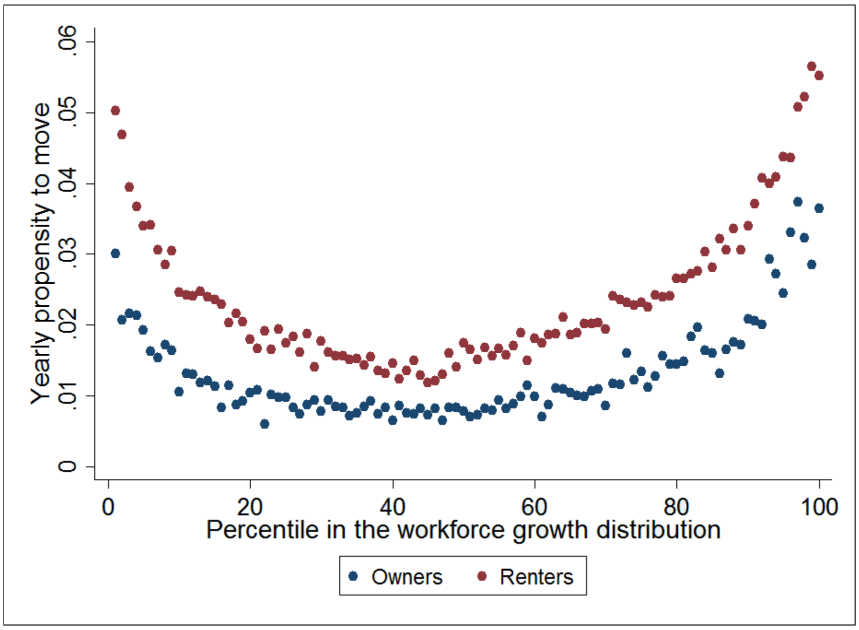
Notes: This Figure plots the propensity to move (y-axis) against the percentile in the employment growth distribution (x-axis). Employment growth is taken as an geometric average over the observed period. Observed propensities to move are calculated in each percentile as the number of move observed divided by the number of firm×year observations. Period of observation: 1994-2013. Source: FiBEn, see Appendix A for more details about the data.

sectors or across geographical areas and can be therefore attributed to a sectoral composition effect. One could think 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 in which firms grow faster. In Appendix B, we report the results of a similar analysis focusing on Paris (Figure B1), Lyon (Figure B2) and Marseille (Figure B3) areas which are the three largest cities in France. We also present the relationship between the probability to move and employment growth in the whole country but excluding these three areas in Figure B4. We can see that the U-shaped relationship is robust to these stratifications and seems to be indeed stronger in the Paris area where on-site expansion is more constrained. Finally, Figures B5 and B6 report the results when focusing on service industries (Figures B5) and manufacturing firms (Figures B6). The link seems to be stronger in the service industries, where moving costs are arguably lower and on-site expansion is arguably more constrained.

Moving is less costly for renting firms than for real-estate owning firms. Indeed, 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 probably higher for this type of firms. We therefore expect differing relocation behaviour between real-estate owner firms and renting firms. We thus proceed as in Figure 1 and plot in Figure 2 the propensity to move against the percentile in the overall employment growth distribution, differentiating renting firms and real-estate holding firms. It clearly appears that real-estate owners exhibit larger changes in their workforce for a given propensity to move as compared to renters. This result is in line with the idea of higher real-estate adjustment costs faced by real-estate owners.

We propose, in the following section, a simple theoretical framework able that accounts for those empirical evidences.

Figure 2: Propensity to move at different percentiles of employment growth: owners vs renters



Notes: This Figure plots the propensity to move (y-axis) against the percentile in the employment growth distribution (x-axis). Employment growth is taken as an geometric average over the observed period. The red dots are for firms that do not report real-estate asset in the initial year of observation (renting firms) and the blue dot for firms that report real-estate holdings in the initial year of observation (owning firms). Observed propensities to move are calculated in each percentile and each subgroup as the number of move observed divided by the number of firm×year observations. Period of observation: 1994-2013. Source: FiBEn, see Appendix A for more detail about the data.

3 A simple model

We propose a theoretical framework which aims at understanding the joint decisions of mobility and employment dynamics. In this model, firms freely adjust their workforce to an exogenous market wage and to the business cycle. While optimizing the employment level, firms take into account a loss associated with congestion that is increasing in the number of employees per unit of real-estate. In order to reduce such a loss, the firms can choose to adjust the size of their premises and pay adjustment costs. One of the main contributions of this model is to account for the peculiarities of the costs associated with firms' relocation and to show how those peculiarities explain the interaction between relocation and employment.

3.1 Model set-up

We consider a representative firm living for 3 periods. The firm makes a decision on its workforce, on its relocation and, upon relocating, on the size of its new premises. The size of the premises is expressed in real-estate units which can be seen as a given amount of square meters. The firm either owns the real-estate assets in which it operates or rents them.[7] This distinguishes two types of firms which will be respectively referred to as the owning firm and the renting firm in the rest of this paper. The precise sequence of events is as follows:

- In period $t = 0$, the firm is endowed with premises R_0 (either rented or owned) of value $p_0 R_0$ and chooses a workforce L_0.
- In period $t = 1$, the firm can either choose to adapt its premises from R_0 to R, at unit price p_1, and pay a cost associated with this relocation or choose to remain in its previous premises. In both cases, the firm optimally adjusts its workforce L given its premises' size and the productivity level.
- In period $t = 2$, the firm disappears. The owning firm sells its premises at a unit price p_2.

3.2 Profit function

The production function uses only labor as an input and is equal to:

$$Y_t = \theta_t \, L_t^{\alpha}, \, t = \{0, 1\} \tag{1}$$

where θ_t is the firm's productivity in period t and aims at capturing every unobservable feature that can affect the productivity of inputs (quality of the workforce; sectoral and local components; etc.); α is the elasticity of production to labor.

[7] The tenure status is exogenous and time-invariant in this model. This hypothesis is discussed in subsection 3.3.

In period 0 and 1, the firm faces congestion losses resulting from the inadequacy between its workforce and its premises size. These congestion losses are increasing in the ratio $\frac{L}{R}$; that is to say the number of employees per real-estate unit. We denote P the increasing and convex function of $\frac{L}{R}$ that associates to each ratio $\frac{L}{R}$ a loss. This specification aims at introducing the idea that a firm staying in its premises cannot increase its workforce indefinitely without facing either production losses or additional costs. In turns, this implies that at some point, increasing labor will results in decreasing profits. This idea relates to the definition of congestion as presented by Färe and Svensson, 1980: "*(...) if a proper subset of production factors (inputs) is kept fixed, increases in the others may obstruct output*". In practice, these congestion costs translate in productivity losses resulting from sub-optimal production processes or higher bargained wages resulting from employees' disutility of overcrowding.

The firm can either owns or rents its premises. In this latter case, it accesses a competitive market where the renting rate of one real-estate unit over the period t, is equal to $\dfrac{1}{\beta}p_t - \tilde{p}_{t+1}$ with β the discount factor equal to $\frac{1}{1+r}$ where r is the risk free rate, p_t is the market price of one unit of real-estate asset in period t and $\tilde{p}_{t+1}$ is the expected market price in period $t+1$, so that external real-estate investor expects no profit over the period t. For this renting rate to be positive, expected price increase between period t and $t+1$ has to be no greater than $\dfrac{1-\beta}{\beta}$. That is a condition that we assume to be true in order to obtain finite demand for real-estate assets.[8] We do not include in this user cost the taxes on real-estate transactions because they are accounted for in the relocation costs.[9] Assuming that the owning firm borrows at the risk-free interest rate r, we have a user cost of real-estate capital equal to the renting rate of real-estate.

We then define the profit function in period t (excluding relocation costs) as:

$$\Pi(L_t, R_t) = \theta_t L_t^{\alpha} - wL_t - (\frac{1}{\beta}p_t - \tilde{p}_{t+1})R_t - P\left(\frac{L_t}{R_t}\right) \tag{2}$$

where w is the exogenous market wage in period 0 and 1. In what follows, we assume that $\dfrac{P''\left(\frac{L}{R}\right)\frac{L}{R}}{P'\left(\frac{L}{R}\right)} \geq \dfrac{2\alpha-1}{1-\alpha}$ to ensure the concavity of this profit function (see Appendix C.1).[10]

[8] In a general equilibrium model, this condition would be derived endogenously. If firms anticipate a level of inflation that exceed this threshold, then there would be an infinite demand for real-estate and price in period 1 would increase.

[9] Notice that those taxes on transaction are not taken into account in the renting rate of a real-estate unit. This is because those costs are not applicable or arguably negligible compared to the other flows when R is held over a long period of time.

[10] Note that this condition is not very restrictive. For example, when $P(x) = \mu x^{\nu}$ it is verified if $\alpha \leq \frac{\nu}{1+\nu}$.

3.3 Relocation costs

Upon moving the firm makes a decision on the size of its new premises, conditional on paying relocation costs. These costs are different depending on whether the firm rents or owns its premises. Our model does not aim at explaining the choice of this tenure status which is assumed to be exogenous and time-invariant. Considering the possibility of a tenure status transition would not significantly alter our mechanism because the cost of the relocation is largely determined by the initial tenure.[11]

3.3.1 Owning firm

The relocation costs of the owning firm, C^o, can be decomposed into three components:

(i) The legal fees associated with the acquisition of real-estate assets: $C^{o,L}$.

(ii) The tax on capital gains associated with the sales of real-estate assets: $C^{o,T}$.

(iii) A dead-weight cost denoted: $C^{o,D}$.

Formally, these costs can be written as follows:

$$
\begin{aligned}
C^{o,L}(R) &= \gamma p_1 R \\
C^{o,T}(R) &= \tau \max\{p_1 - p_0, 0\} R_0 + \beta\tau \max\{\tilde{p}_2 - p_1, 0\} R \\
C^{o,D} &= \delta_o
\end{aligned}
$$

where γ is the legal fees paid by the buyer expressed as a share of the transaction value; τ is the tax rate on capital gains and δ_o is a dead-weight cost. Notice that the tax on capital gains is only paid on assets held over one period, it is hence a tax whose payment is only triggered by relocation; this is why it is not included in the user cost of real-estate capital. This features is introduced to take into account the fact that the tax base declines with the length of the ownership period and eventually cancels after some years.[12] The parameter δ_o aims at capturing the costs associated with the interruption of the activities or any type of disorganization in the production process during the period of the move as well as direct search costs and moving expenses. Hence the total moving costs for real-estate-owners is:

[11] Exogenous tenure status is a simplification which does not allow to properly question the role of credit constraints. In this model, we introduce the firm's tenure status, thought as resulting from path dependency, to have an additional dimension of heterogeneity in relocation costs and study their consequences on the firm's behaviour. In the data, the date of incorporation (older firms own more real-estate) as well as local determinants (the larger the city in which the firm is incorporated, the lower the share of real-estate in the firms' balance-sheet) are found to be important predictors of the tenure status. Notice that the time-invariance hypothesis is also motivated by the fact that we observe few tenure status transition contemporaneous to the moves: 6% of the moving firms take advantage of the move to acquire real-estate assets and around 3% percent start to rent real-estate after the move.

[12] In France, the tax base declines after 5 years and linearly goes to zero in 10 years.

$$C^o(R) = C^{o,L}(R) + C^{o,T}(R) + C^{o,D} \tag{3}$$

3.3.2 Renting firm

The relocation costs of the renting firm C^r are only made of dead-weight costs, then:

$$C^r = C^{r,D} = \delta_r \tag{4}$$

The parameter δ_r captures the same costs as δ_o. Because of presumably higher search costs for owning firm, we can reasonably assume that $\delta_r \leq \delta_o$.

3.4 End of periods

In period 2, the firm disappears and the project is liquidated. The liquidation value corresponds to the after-tax proceeds of real-estate assets sales, when applicable, at date 2.

3.5 Employment and size of the premises

The firm makes a decision on employment in period 0 and 1 and on relocation in period 1 in order to maximize the discounted value of the flows. We first study the optimal employment level conditional on the size of the premises.

3.5.1 Employment level

There is no friction in the labor market. The number of employees chosen by the firm in period 0 and 1 cancels the first derivative of Π with respect to L. We therefore have:

$$\alpha \theta_t L_t^{\alpha-1} = w + \frac{1}{R_t} P' \left(\frac{L_t}{R_t} \right) \tag{5}$$

Proposition 1 *Equation 5 has a unique solution $L(R)$ for each value of R which is increasing in R.*

Proof. See appendix C.2 ∎

As a corollary, a firm relocating its activities in larger (resp. smaller) premises employs more (resp. less) workers in period 1 than a static firm, other things held constant.

3.5.2 Size of the premises after relocation

We study the optimal firm's behaviour in two steps. First, we consider the size of the premises in which the firm settles if it decides to relocate. Second, we compare the discounted value of the flows of profit with and without relocation.

Let us consider the size of the premises when the firm relocates in period 1. The firm makes a decision on the number of workers and the size of the premises to maximize its profit in period 1 while taking into account the relocation costs; that is to say $\Pi - C$. In this notation, C indicates the applicable cost function depending on the firm's tenure status. As explained before, when the elasticity of the function P' is sufficiently high with respect to α, Π is strictly concave and this maximization problem admits a unique solution (L, R) in period 1 (see Appendix C.1). We know that L and R satisfy equation (5) and:

$$\frac{L}{R^2} P'\left(\frac{L}{R}\right) = (\frac{1}{\beta} p_1 - \tilde{p}_2) + C' \tag{6}$$

where $C' = p_1 \gamma + \beta \tau \max\{\tilde{p}_2 - p_1, 0\}$ for an owning firm and $C' = 0$ for a renting firm.

3.6 Relocation decision

We now turn to the choice of the firm to relocate or to remain in the same premises. The firm compares the expected flows induced by the two options and relocates if the following condition is verified:

$$\Pi(L, R) - C(R) > \Pi(\hat{L}, R_0) \tag{7}$$

where $\hat{L} = L(R_0)$ in period 1.

Notice that when the firm relocates, the size of the premises in which it settles is affected by the marginal relocation costs which are strictly positive for the owning firm. As a result, the vector (L, R) maximizing $\Pi - C$ differs from the vector maximizing Π that we denote (L^*, R^*). We can think of (L^*, R^*) as the employment level and the optimal size of the premises absent marginal relocation costs.

We can decompose the difference $\Pi(L, R) - \Pi(\hat{L}, R_0)$ as follows:

$$\Pi(L, R) - \Pi(\hat{L}, R_0) = \{\Pi(L^*, R^*) - \Pi(\hat{L}, R_0)\} + \{\Pi(L, R) - \Pi(L^*, R^*)\} \tag{8}$$

The first term is always positive by definition of (L^*, R^*) and corresponds to the gains that would be induced by a relocation in absence of moving costs. The second term is non-positive and corresponds to the losses induced by the frictions on real-estate transactions captured by τ and γ. Those frictions entail an increase in the real-estate prices that impair the demand for real-estate. Notice that this second term is equal to zero if $\tau = 0$ and $\gamma = 0$ or for renting firms.

Proposition 2 *When R^* is close to R_0, the difference between $\Pi(L^*, R^*)$ and $\Pi(\hat{L}, R_0)$ can be written:*

$$\Pi(L^*, R^*) - \Pi(\hat{L}, R_0) \approx \kappa(R^* - R_0)^2 \tag{9}$$

where $\kappa > 0$ is a function of (L^*, R^*).

Proof. See Appendix C.3 ■

Using the same arguments, we can show that:

$$\Pi(L, R) - \Pi(L^*, R^*) \approx -\kappa(R^* - R)^2 \tag{10}$$

From equation (5) and (6), we know that R satisfies the following equation:

$$\alpha\theta L(R)^\alpha - wL(R) = (\frac{1}{\beta}p_1 - \tilde{p}_2 + C^{'})R \tag{11}$$

While R^* satisfies:

$$\alpha\theta L(R^*)^\alpha - wL(R^*) = (\frac{1}{\beta}p_1 - \tilde{p}_2)R^* \tag{12}$$

Taking first order Taylor developments of the function L in equations (11) and (12), we show in Appendix C.4 that, locally around R^*, the difference between R^* and R can be written:

$$R^* - R \approx \frac{C'}{2\kappa} \tag{13}$$

We use this result, once again locally around R^*, to write:

$$C(R) = C_f + C^{'}R \approx C_f + C^{'}\frac{2\kappa R^* - C^{'}}{2\kappa} \tag{14}$$

where C_f corresponds the components of the relocation costs that do not depend on the size of the premises in which the firm relocates. That is to say for the owning firm: $C_f = \tau \max\{p_1 - p_0, 0\}R_0 + \delta_o$; and for the renting firm: $C_f = \delta_r$.

Eventually, when R_0 and R are close to R^*, from equation (9), (10), (13) and (14), we obtain that a firm relocates if the following condition is verified:

$$(R^* - R_0)^2 \geq \frac{C_f}{\kappa} + \frac{C^{'}}{4\kappa^2}(4\kappa R^* - C^{'}) \tag{15}$$

And, from equation (13), we know that $4\kappa R^* - C^{'} > 0$.

Proposition 3 *A firm relocates if and only if the difference between the size of the premises maximizing its profit function R^* and the size of the current premises R_0 is large enough to compensate the relocation costs.*

From the condition (15), we deduce that a firm moves if the following condition is verified:

$$|R^* - R_0| \geq \sqrt{\frac{C_f}{\kappa} + \frac{C'}{4\kappa^2}(4\kappa R^* - C')} \tag{16}$$

This relocating condition differs for a renting firm and for an owning firm but is always weaker for the former. Hence, there exist values of $R^* - R_0$ for which the renting firm moves but the owning firms does not. More specifically, since the left-hand side variable does not depend on moving frictions, we can easily look at the effect of an increase in the moving costs, either captured by τ or by γ.

Proposition 4 *The non-moving interval of the owning firm widens with the value of τ and γ, the parameters governing the frictions on real-estate transactions. The size of the premises in which a relocating firm settles diminishes with τ and γ.*

Proof. See Appendix C.5 ∎

Since the right-hand side of inequality (15) is not a linear function of R^* (recall that κ is a function of R^*), this condition is not symmetric in R_0. Hence the following proposition:

Proposition 5 *The RHS in the inequality (15) is increasing in R^*. As a result, the difference between the size of the premises maximizing the profit and the size of the occupied premises required to trigger relocation is larger in absolute value when the firm is growing than when the firms is declining.*

Proof. See Appendix C.6. ∎

The critical distance between R^* and R_0 triggering relocation is always higher for the owning firm than for the renting firm and this distance is higher when R^* is larger than R_0 (growing firm) than when R^* is lower than R_0 (declining firm). Locally around R_0, a first order approximation of the change in employment of relocating firms can be written as a linear function of $R^* - R_0$. Hence, the value of the thresholds triggering relocation has a direct effect on the size of the adjustment of the number of workers when the firm relocates.

Proposition 3 echoes 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.[13] More closely related to our result, L. 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. In our model we consider profit-maximizing firms and corporate real-estate. Peculiarities of the adjustment of real-estate assets generate additional interesting properties with respect to the interactions between relocation and employment at the firm level.

Finally, we put the emphasise on the fact that the rule derived for relocation decisions is only valid locally, that is to say when R^* and R_0 are close, which notably means that the time span of what we call "a period" should not be too long so that the difference between the values of *theta* in periods 0 and 1 is not too large.

3.7 Productivity change, relocation and employment

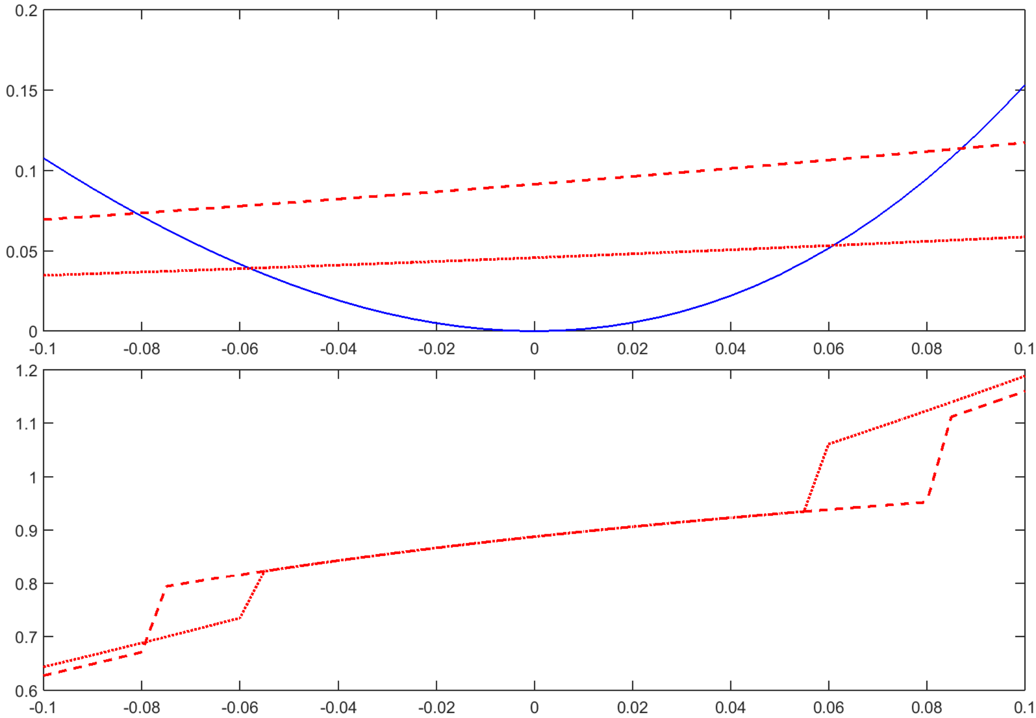
In this model, if the size of the premises initially endowed maximizes the profit in period 0, the deviation of R^* from R_0 is caused by either a change in the productivity level in period 1 or a change in real-estate prices.

Because the model does not allow a tractable study of the effect of either θ nor real-estate prices, we present a numerical example to illustrate the impact of a productivity change on the relocation decision and on employment dynamics. To do so, we specify the functional form of the function P as well as parameters' value in order to simulate the model. In what follows, we take $P\left(\frac{L}{R}\right) = \mu\left(\frac{L}{R}\right)^{\nu}$ with $\mu > 0$ and $\nu \geq 2$. Parameters' value are discussed in Appendix C.7.

We consider the case where the endowed premises maximize the profit in period 0. We study how a change in productivity in period 1, expressed in percentage deviation from productivity in period 0, affects the relocation decision and the employment level. The results are presented in Figure 3. In the top panel, looking at the curve representing the LHS of the inequality (15) (the solid line), we see that productivity changes have direct effects on the optimal size of the premises. We also see that the cost associated to relocation entails intervals of productivity changes within which the firm does not relocate. The size of those intervals depends on the tenure status. We observe in the bottom panel that, when the productivity change is within this interval of inaction, the firm adjusts its number of employees very smoothly because of the congestion effects but, when the productivity change

[13] See Bertola and Caballero, 1990 for a survey on discontinuous adjustment control policy and Grossman and Laroque, 1990 model of consumer durable purchase for a example of such a range of inaction.

Figure 3: Changes in productivity, relocation and employment



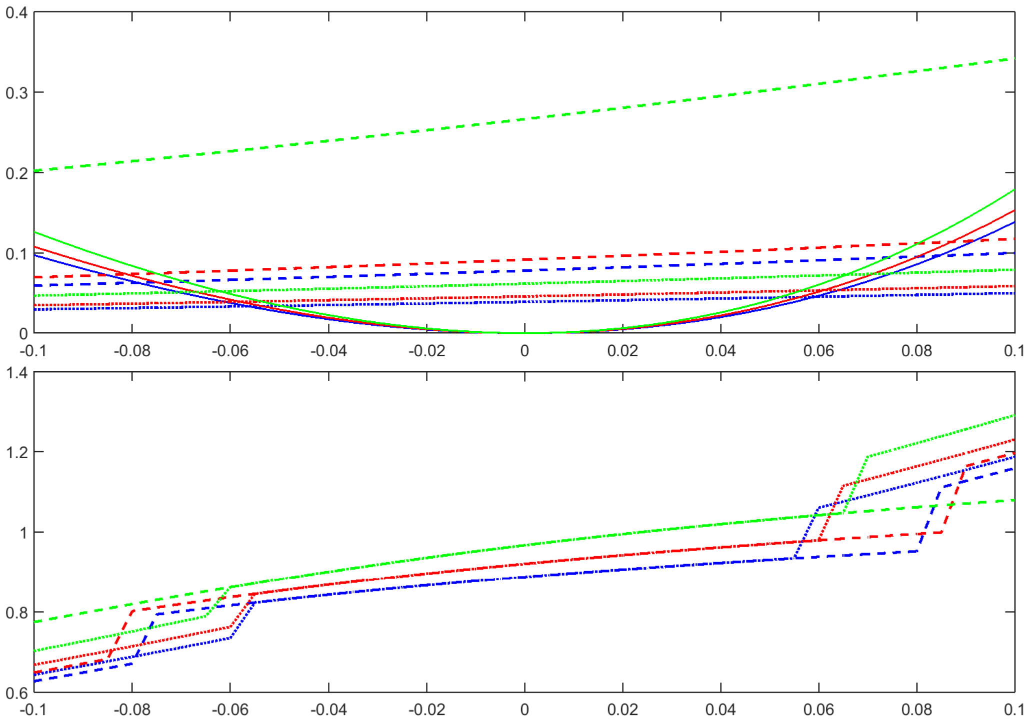
Notes: In the top panel, we plot the LHS (solid line) and the RHS of the inequality (15) against the productivity change in period 1 in percentage deviation from its level in period 0. The dashed line corresponds to the RHS for the owning firm and the dotted line corresponds to the LHS for the renting firm. In the bottom, we plot the employment level in period 1 against the productivity change. The dashed line corresponds to the employment level of the owning firm and the dotted line corresponds to to the employment level of the dotting firm. Parameters' value are presented and discussed in Appendix C.7.

is large enough to trigger relocation, the firm fully adjusts employment. This mechanism generates discontinuities in employment's reaction to productivity shocks.

We do the same exercise considering three scenarios for expected real-estate price dynamics.[14] In addition to the scenario where prices are expected to be the same in period 2 as in period 1 (presented above), we study the case where prices are expected to decrease by 10% and the case where prices are expected to increase by 10%. We assume that those expectations are formed based on the observed price dynamics between period 0 and period 1. Results are presented in Figure 4. It is interesting to notice that the interval of inaction of the owning firm markedly widens in case of price increase because of capital the tax on capital gains.

[14]The dynamics of real-estate prices are taken as exogenous in those simulations. It could be an insightful exercise to introduce endogenous reactions of anticipated prices to firms' demand for real-estate units in this model.

Figure 4: Changes in productivity, relocation and employment - Three scenarios for anticipated real-estate prices



Notes: In the top panel, we plot the LHS (solid lines) and the RHS of the inequality (15) against the productivity change in period 1 in percentage deviation from its level in period 0. The dashed lines correspond to the RHS for the owning firm and the dotted lines correspond to the LHS for the renting firm. In the bottom, we plot the employment level in period 1 against the productivity change. The dashed lines correspond to the employment level of the owning firm and the dotted lines correspond to to the employment level of the renting firm. Red lines are for the case where prices are expected to be the same in period 2 as in period 1, blue lines for the case where prices are expected to decrease by 10% and green lines for the case where prices are expected to increase by 10%. Parameters' value are presented and discussed in Appendix C.7.

4 Reduced-form evidence

In this section, we use our firm-level dataset to test the predictions of the model. In particular, we show that firms that relocate experience a higher growth rate in their workforce (in absolute value) and that moves and workforce adjustment are contemporaneous. We find evidence of an asymmetric impact of relocation on the number of employees between growing and declining firms. We also show that the moving costs and notably the latent capital gain is negatively correlated with the occurrence of a move. We then explore the direct effect of those adjustment costs on employment dynamics. Finally, we run some robustness checks.

4.1 Effect of a local relocation on employment dynamics

Our first set of regressions explores the links between relocation and the employment growth rate. Results are presented in Table 2. We first consider five cross-section analyses aiming at confirming the predictions of our model regarding the relationship between relocation and employment growth:

(i) From the corollary of proposition 1, we deduce that, among growing (resp. declining) firms, the ones that relocate are characterised by higher (resp. lower) employment growth rates than the ones that do not.

(ii) From proposition 5, we deduce that the employment growth gap between relocating and non-relocating firms should be larger for growing firms than for declining firms.

First, we run different specification of a simple equation for employment growth. Specifically, for the firm i, the average employment growth over the observed period (or, alternatively, the absolute value of this average) is given by:

$$\Delta Emp_i = \beta_1 Move_i + X_i' \beta_2 + \epsilon_i \tag{17}$$

where $Move_i$ is a binary variable that takes the value 1 if the firm has moved (locally) during the observed period and 0 otherwise and X_i is a vector of firm's characteristics in initial year of observation. Shocks ϵ_i are clustered at the *département* level.

First, we run an OLS regression of equation (17) using the absolute value of the average employment growth over the observed time period as the dependent variable. We add the following controls: the age of the firm in the first year of observation, the size of the firm as measured by the net value of its assets and its profitability as measured by its $EBIT$ (Earning Before Interest and Tax) margin. We also add *département*, sector and first year of observation fixed effects. Corresponding results can be found in column 1 of Table 2. As expected, the occurrence of a local move is positively correlated with the absolute value of employment growth. Our model predicts varying effects of the move on employment growth depending on the dynamic of the firm (i). We estimate equation (17) on a restricted sample consisting of firms characterized by an overall positive (*resp.* negative) employment growth over the observed period; results are presented in column 2 (*resp.* in column 3). To give more insight of the response of various quantile of employment growth to a move, we run quantile regressions. Figure 5 graphs the quantile regression estimates of the coefficient associated with $move_i$ for each decile of employment growth. For 0.1 (*resp.* 0.8) quantile regression models, all the estimated are presented in column 4 (*resp.* in column 5).[15] We find that the effect of a local move is positively (*resp.* negatively) associated with employment growth for firms that experienced an overall positive (*resp.* negative) growth rate of the workforce. These results indicate that "relocating growing" firms are characterized by a yearly employment growth rate which is in average 1.3 percentage point higher than their static peers whereas "relocating declining" firms are characterized by a yearly employment growth rate in average 0.8 percentage point lower than their static peers. The OLS estimates provide evidence of an asymmetric effects of relocations (ii). Nevertheless, as it can be observed in Figure 5, more conclusive evidence of such an asymmetric effect is obtained with the estimation results of quantile regression models.

Next, we take advantage of the time dimension of our sample and run panel regressions to validate that the timing of the interaction between employment growth and relocation is consistent with our model. We run different specification of an equation for employment growth in year t. For the firm i, in year t, the employment growth over the observed period is given by:

$$\Delta Emp_{i,t} = \beta_1 Move_{i,t} + X'_{i,t}\beta_2 + \iota_i + \delta_t + \epsilon_{it} \tag{18}$$

where $Move_{i,t}$ is a dummy variable indicating the occurrence of a relocation in year t, $X_{i,t}$ is a vector of firm's characteristics and ι_i is a firm fixed-effect that captures the effect of time-invariant unobserved characteristics of the firm. Shocks $\epsilon_{i,t}$ are clustered at the *département*$\times$year level.

Estimation results of equation (18) can be found in columns 6 and 7 of Table 2, the composition of the sample in column 6 (*resp.* 7) is the same as in column 2 (*resp.* 3). From these regressions, we see that firms characterized by an increase in their number of employees over the observed period experience a statistically significant increase in the size of their workforce contemporaneously with the move. The contemporaneous effect of the relocation on firms declining over the observed period is not statistically significant. In columns 8 and 9, we look at the effect of a relocation for different time lags from 0 to 3. With this specification, we obtain a statistically significant negative effect of the move on

[15] We put the emphasize on these two quantiles because they correspond to two distinctive expected links between employment growth and the propensity to move as seen in Figure 1

declining firm. We also find that the relocation has a persistent effect in time, although decreasing, for growing firms while we do not observe such persistence for declining firms. These findings suggest plausible asymmetries between positive and negative change in the workforce.

Table 2: The effect of a move on employment dynamics

	Cross-Section					Panel-Regression			
	|Emp|	Low growth	High growth	0.1 quant	0.8 quant	Low growth	High growth	Low growth	High growth
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**	**(9)**
Move	0.014***	-0.0083***	0.013***	-0.0035***	0.024***	0.0013	0.051***	-0.016***	0.044***
	(0.00073)	(0.0009)	(0.001)	(0.0008)	(0.0008)	(0.0051)	(0.0081)	(0.004)	(0.0075)
Move (t-1)								-0.0051	0.038***
								(0.0034)	(0.0079)
Move (t-2)								0.0057*	0.0098*
								(0.0033)	(0.0059)
Move (t-3)								0.0026	-0.00069
								(0.0033)	(0.0039)
Age	-0.003***	0.00066***	-0.0056***	-0.0039***	-0.0064***	-0.069***	-0.024***	-0.027***	-0.031***
	(0.00022)	(0.00021)	(0.00032)	(0.00016)	(0.00012)	(0.0021)	(0.0025)	(0.0016)	(0.0028)
Size	-0.0011	0.0074***	-0.0048***	-0.014	0.0022*	-0.085***	-0.11***	-0.057***	-0.09***
	(0.00089)	(0.0018)	(0.0017)	(0.0093)	(0.0013)	(0.025)	(0.035)	(0.012)	(0.024)
Profit.	-0.0057***	0.011***	-0.00067	0.044***	0.025***	0.15***	0.052***	0.15***	0.059***
	(0.0017)	(0.0021)	(0.0028)	(0.0026)	(0.0017)	(0.006)	(0.008)	(0.0065)	(0.0089)
Nb year of obs.	-0.0051***	0.0063***	-0.0061***	0.0065***	-0.0029***				
	(0.00011)	(0.00012)	(0.00019)	(0.000058)	(0.000044)				
Fixed effects:									
Firm	No	No	No	No	No	Yes	Yes	Yes	Yes
Year	Yes	Yes	Yes	No	No	Yes	Yes	Yes	Yes
Sector	Yes	Yes	Yes	No	No	No	No	No	No
Département	Yes	Yes	Yes	No	No	No	No	No	No
Nb of obs.	144,028	56,130	69,172	144,028	144,028	566,166	749,433	395,034	538,704
R^2	0.11	0.23	0.17	-	-	0.13	0.12	0.14	0.14

Notes: $***pvalue < 0.01$. $**pvalue < 0.05$. $*pvalue < 0.10$.
Robust standard errors in brackets.

Notes: The table presents estimates of employment growth on a local relocation. The dependent variable is the employment growth (averaged over the period 1994-2013) for columns 1 to 5, taken in absolute value in column (1). Columns 1 to 5 are in cross-section while columns 6 to 9 are in panel over the period 1994-2013. Column 1 consider all firms, columns 2, 6 and 8 (*resp.* 3, 7 and 9) consider only firms with average negative employment growth (*resp.* positive employment growth). Columns 4 and 5 are quantile regressions using quantiles 0.1 and 0.8, respectively. Variable description is given in Table A3. With the exception of columns 4 and 5, coefficient are obtained using an OLS estimator.

4.2 Effects of the frictions on employment dynamics

Next, we seek to identify the effect of relocation costs on mobility and on employment dynamics. A key determinant of the moving cost is the tenure status. As explained previously, owners face legal and fiscal costs associated with relocation that renters do not pay. We can also observe varying moving costs among the owners, notably because of the tax on capital gains. Indeed, the base for this tax is determined by the interaction between the acquisition date and the dynamic of local prices since this acquisition (see appendix A for more detail). We exploit these varying adjustment costs to analyse their effects on firms' relocation and employment behaviour.

We proceed in two steps. In the first step, we run various cross-section regressions to show that higher moving 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's i decision to relocate:

$$Move_i = \beta_1 Tenure_i + X_i' \beta_2 + \epsilon_i \tag{19}$$

where $Tenure_i$ is is a dummy equal to 1 if the firm reports real-estate holdings in initial year of observation.

Restricting our sample to owning firms, we alternatively run:

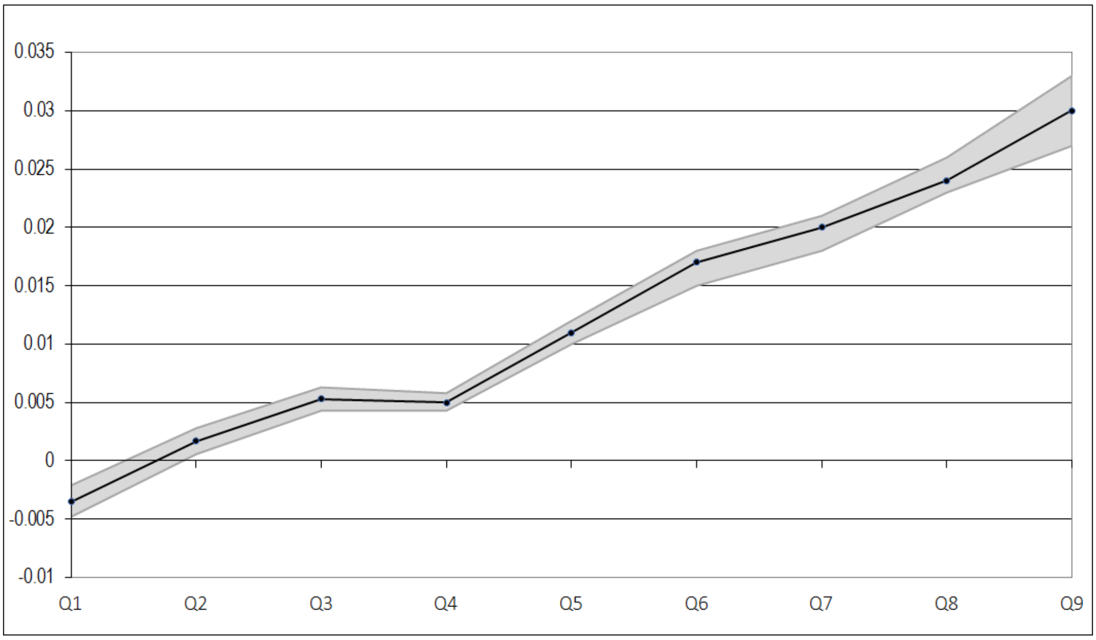
$$Move_i = \beta_1 Tax_i + X_i' \beta_2 + \epsilon_i \tag{20}$$

where Tax_i is the share 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 the initial year of observation.[16]

The estimation results can be found in Table 3: columns 1 to 4 correspond to estimates of (19). We control for the length of the observation period in the four regressions. In column 2 to 4, we add a large set of fixed effects: *département*, sector and first year of observation in column 2; we also add overall employment growth deciles in column 3. In column 4, we also control for the size, the age and the profitability of the firm. The results establish unambiguously that owning its premises is associated with a lower propensity to relocate. The coefficient obtained from the first column indicates that, without any control for other characteristics, being owner is associated with a decrease in the propensity to relocate by 9.2 percentage points. Once the effects of *département*, sector and initial year are taken into account, the estimates of the coefficient associated with the tenure status are broadly unaltered by the introduction of the other controls. Column 4 indicates that the owners' propensity to move is 4.4 percentage points lower then the renters' one. This result

[16] The choice of this regressor is discussed below. Notice that, in the model, this corresponds to $\tau \frac{\max\{p_1 - p_0, 0\}}{p_1}$.

Figure 5: Effect of relocation on employment growth on various quantiles of the dependent variable



Notes: This graph plots the coefficients on the dummy indicating local move during the observed period from a cross-section quantile regression with employment growth as a dependent variable. 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 (grey area). Regression also includes our usual control variables: Age, Profit, Size (all taken in the first year of observation) and the number of years the firm appears in the database. Confidence intervals at the 95% level have been estimated with a variance-covariance matrix built with 40 bootstrap replications.

is clearly in line with the prediction of the model.

Nevertheless, the choice of the tenure status is not exogenous and probably depends on unobservable growth prospects. We understand from Figure 3 that, if the distributions of change in productivity differ between the owning and the renting firms, a reverse causality issue prevents us from associating a difference in the propensity to relocate to higher relocation costs. We try to tackle this issue by restricting our analysis to real-estate owners in order to focus on the heterogeneity in relocating costs resulting from the tax on capital gains that has to be paid upon moving.

The estimation results of equation (20) are reported in columns 5 to 8 of Table 3. In those columns, the main coefficient of interest is the one associated with the share of the proceeds from the real-estate asset sales that would be paid under the heading of the tax on capital gains. This share results from a marginal tax rate, identical across firms, and a tax base, the capital gains on real-estate assets, that varies across firms and across time. The variability of the tax base across firms and across time results from varying acquisition dates and varying dynamics of local prices since the acquisition. Another exploitable feature of this tax scheme is that the tax base is reduced by 10 percentage point per year after a holding period of 5 years. This decreasing tax base is taken into account in our computation of the variable Tax; details on the construction of this variable are provided in Appendix A. Column 5 presents estimation results of equation (20) when we only control for the length of the observation period. In column 6, we introduce a set of fixed-effects and control variables. In column 7, we control for all the standalone determinants of the level of tax on capital gains, notably introducing fixed-effects for the acquisition years of real-estate assets as well as controls for the initial volume of real-estate assets. The estimates of the coefficient associated with the tax on capital gains are statistically significant at the 1% level across the three specifications. We find that an increase by 10 percentage points in the tax on capital gains lowers by 2.3 percentage point the propensity to move.

One may be concerned that the level of the tax on latent 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. Nevertheless, 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.[17] 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 tax on the propensity to move is an upper bound. This point is supported by the fact that the negative effect of the tax sharpens when we introduce additional controls for firms' characteristics.

We can exploit an additional source of heterogeneity resulting from the feature of the

[17]Notice that we obtain similar results as in column 7 of Table 3 when we estimate the same equation on sample restricted to growing firms.

tax on capital gains to assess the effect the relocation costs on the propensity to move. Because the tax base shrinks when the length of the ownership period increases, we expect that the longer this holding period in initial year of observation, the lower the effects of the latent capital gain on the propensity to relocate. This is what we test in column 8. Interestingly, the effects of the level of the tax on the propensity to move depend on the age of the real-estate holding in the initial year of observation. The strongest effect is found when the real-estate assets have been held for less than 5 years; the effect is almost halved when the holding period of the assets is between 5 and 10 years and it becomes statistically insignificant when the the holding period is between 10 and 15 years.

All these results show that moving costs dampen the firms' propensity to move. By highlighting the role of the tax on capital gains, they provide empirical evidence to support for Proposition 4. They also echo those of the existing literature that emphasized the "lock-in" effect of the tax on capital gains (see for example S. Yitzhaki, 1979; Feldstein, Slemrod, and Shlomo Yitzhaki, 1980 or Kanemoto, 1996).

Table 3: Adjustment costs and relocation behaviours

	Owners vs renters				Tax on capital gains			
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**
RE Owner	-0.092***	-0.05***	-0.051***	-0.044***				
	(0.0033)	(0.0023)	(0.0026)	(0.0027)				
Tax on capital gains					-0.13***	-0.18***	-0.23***	
					(0.027)	(0.031)	(0.04)	
RE age(0y-5y)×Tax on capital gains								-0.4***
								(0.073)
RE age(5y-10y)×Tax on capital gains								-0.22***
								(0.039)
RE age(10y-15y)×Tax on capital gains								-0.13
								(0.081)
Age				-0.01***		-0.0071***	-0.0047***	-0.0046***
				(0.00084)		(0.00095)	(0.001)	(0.001)
Size				0.0045		0.002	0.0021	0.0021
				(0.0059)		(0.01)	(0.01)	(0.01)
Profit				0.022***		0.012	0.016	0.016
				(0.0084)		(0.011)	(0.011)	(0.011)
Nb year of obs.	0.0091***	0.01***	0.012***	0.012***	0.0063***	0.0086***	0.0086***	0.0086***
	(0.00055)	(0.00046)	(0.00056)	(0.00058)	(0.00037)	(0.00046)	(0.00045)	(0.00045)
Volume RE							-0.00089**	-0.00088**
							(0.00036)	(0.00035)
Fixed effects:								
Emp. growth decile	No	No	Yes	Yes	No	Yes	Yes	Yes
Acq. year of RE assets	No	No	No	No	No	No	Yes	Yes
Year	No	Yes	Yes	Yes	No	Yes	Yes	Yes
Sector	No	Yes	Yes	Yes	No	Yes	Yes	Yes
Département	No	Yes	Yes	Yes	No	Yes	Yes	Yes
Nb of obs.	151,583	151,583	119,028	113,646	56,603	44,682	43,952	43,952
R^2	0.031	0.074	0.095	0.096	0.017	0.069	0.068	0.069

Notes: $***pvalue < 0.01$. $**pvalue < 0.05$. $*pvalue < 0.10$.
Robust standard errors in brackets.

Notes: The table presents estimates of local relocation on variables indicating the level of the relocation costs. The dependent variable is a dummy equal to one if the firm has moved over the period 1994-2013. All columns show regressions in cross-section at the firm-level. Columns 1 to 4 include a dummy equal to one if the firm owns its real-estate. Columns 5 to 9 include the tax on latent capital gains as a regressor. Variable description is given in Table A3. Coefficient are obtained using an OLS estimator.

We now turn to our second step where we explore the direct effect of the relocation costs on employment dynamics. We understand from section 3.7 and notably from Figure 3 that the relocation costs have a causal impact on the employment growth of firms characterized by productivity change around the bounds of the interval of inaction (impact on the decision to relocate or not) and outside this interval (impact of the size of the new premises). The relationship between relocation costs and employment growth is hence expected to differ across the distribution of productivity change.

As in Table 2, we run cross-section OLS and quantile regressions where the dependent variable is the average employment growth over the observed time period. As in Table 3, we focus on the two distinct sources of heterogeneity with regard to relocation costs. Specifically, we estimate the following equation:

$$\Delta Emp_i = \beta_1 Tenure_i + X_i' \beta_2 + \epsilon_i \tag{21}$$

And, restricting our sample to owning firms, we estimate:

$$\Delta Emp_i = \beta_1 Tax_i + X_i' \beta_2 + \epsilon_i \tag{22}$$

The results can be found in Table 4. Columns 1 to 3 report estimates of equation (21). In column 1, the dependent variable is the absolute value of the average employment growth. We add controls for initial age, size and profit and fixed-effects for *département*, sector and first year of observation. We find that owning real-estate is, on average, associated with a yearly growth rate 0.4 percentage point lower, in absolute value, as compared to a real-estate renter. As in Table 2, we explore heterogeneous effects on growing and declining firms by restricting our sample to firms characterized by a growing (*resp.* declining) number of employees in column 2 (*resp.* 3). For growing firms, we find that holding real-estate assets is associated with a mean employment growth lower by 0.8 percentage point as compared to renting firms. For declining firm, the estimate is positive but non-significant. As previously noted, owning and renting firms may differ in many other respects that relocation costs. In order to focus on a more exogenous source of variation for relocation costs across firms, we restrict our sample to real-estate owners and we exploit the heterogeneity entailed by the tax on latent capital gains. From columns 4 to 6 of Table 4, we report estimates of equation (22). In column 4, the dependent variable is the absolute value of the mean employment growth rate over the observation period; in addition to the controls introduced in column 1 to 3, we add controls for the initial age and the volume of real-estate assets. The sign of the estimate associated with the level of the tax is positive, although imprecisely estimated. This imprecise estimate may result from the fact that the theoretical impact of relocation costs on employment growth differs across the distribution of productivity change. In order to investigate those potential heterogeneous effects of the relocation costs on the employment growth we run various quantile regressions. As in column 4 and 5 in Table 2, we present in columns 5 and 6 quantile regressions corresponding to quantiles 0.1 and 0.8. We report the estimates of the coefficients associated with the level of the tax, as well as their 95% confidence interval, for quantiles 0.10, 0.20, 0.30, 0.40, 0.50, 0.60, 0.70, 0.80 and 0.90 in Figure 6. In those regressions, we control for the initial age and volume of real-estate assets and we add *département* fixed-effects. We obtain estimated values for the coefficients on tax that decrease with the employment growth quantiles: higher costs slightly dampen the employment fall of declining firms whereas they hinder the employment growth of growing firms. Those costs have no clear effect on the employment growth of the median firm. We find that a decrease by 10 percentage points of the tax increases by 0.6 percentage point the quantile 0.9 of the yearly employment growth rate distribution of owning firms. This result suggests sizable macroeconomic impact of relocation costs. Without considering the effect of legal fees which have been proved to have similar effect as the tax on capital gains in the theoretical section, we deduce from the mean value of the tax on capital gains[18] that, absent these relocation costs, the quantile 0.9 of the yearly employment growth rate of owning firms would be 0.3 percentage point higher, that is to say would increase by 4%.[19]

4.3 Robustness

In this subsection we present complementary analysis aiming at assessing the robustness of our main results. Relocation is an event that can be triggered by external factors. To limit these external effects, this study has focused on local relocation, defined as relocation characterised by a distance of less than 15km between the *commune* of departure and the *commune* of settlement. That way, we seek to give as much weight as possible to internal factors, notably to the constraint of size that has been extensively discussed. Yet, it is plausible that some short-distance moves are triggered by external factors and that those external factors simultaneously also affect employment. We consider alternatively two external factors that could both trigger relocation and affect the employment dynamics: the place-based programs and notably the French program known as the *Zones Franches Urbaines* (hereafter *ZFU*)[20] and the role of the agglomeration effects.

4.3.1 The place-based programs

The displacement effect of publicly funded place-based programs has been documented in recent contributions (Givord, R. Rathelot, and P. Sillard, 2013; Mayer, Mayneris, and Py, 2015 for the French *ZFUs* and Overman and Einio, 2012 for the Local Enterprise Growth

[18]The mean value of the latent tax on capital gains for owning firms located in the upper decile in term of employment growth is equal to 5.5%

[19]In our sample, this upper decile corresponds to a stock of approximately 100,000 jobs. Hence these relocation costs could have deterred the creation of 300 jobs per year.

[20]Being located within the limits of a *ZFU* allows a company to be totally exempt from business and corporate taxes, as well as social security contributions. The implementation of the *ZFU* program occurred in three rounds, respectively in 1997, 2004 and 2006.

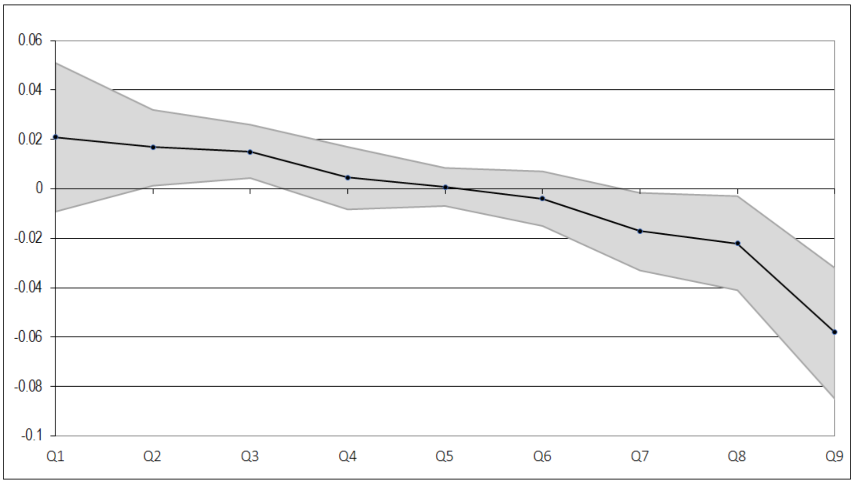
Table 4: Adjustment costs and employment dynamics

	Owners vs renters			Tax on capital gains		
	|Emp|	Low growth	High growth	|Emp|	0.1 quant	0.8 quant
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
RE owner	-0.0039***	0.0012	-0.008***			
	(.00059)	(.00076)	(.00087)			
Tax on capital gains				-0.0042	0.021*	-0.022**
				(.0082)	(.012)	(.011)
Age	-0.0029***	0.00065***	-0.0052***	-0.0012***	-0.0026***	-0.003***
	(.00022)	(.0002)	(.00033)	(.0002)	(.00035)	(.00017)
Size	-0.00093	0.0073***	-0.0046***	0.00007	-0.0009	0.005**
	(.00088)	(.0018)	(.0017)	(.00097)	(.0068)	(.0025)
Profit	-0.0054***	0.011***	-0.00041	-0.0064**	0.052***	0.033***
	(.0017)	(.0021)	(.0028)	(.0029)	(.0043)	(.0033)
Nb year of obs.	-0.0049***	0.0062***	-0.0059***	-0.0041***	0.0058***	-0.0018***
	(.00011)	(.00012)	(.00019)	(.000098)	(.000096)	(.000067)
Volume RE				-1.2e-06	-0.00089***	-0.000036
				(.000071)	(.00034)	(.00012)
Age RE				-0.00025***	-0.00017*	-0.00093***
				(.000071)	(.000098)	(.000059)
Fixed effects:						
Year	Yes	Yes	Yes	Yes	No	No
Sector	Yes	Yes	Yes	Yes	No	No
Département	Yes	Yes	Yes	Yes	Yes	Yes
Nb of obs.	144,028	56,130	69,172	54,198	54,198	54,198
R^2	0.11	0.23	0.17	0.11		

Notes: $***pvalue < 0.01$. $**pvalue < 0.05$. $*pvalue < 0.10$.
Robust standard errors in brackets.

Notes: The table presents estimates of employment growth on variables indicating the level of the relocation costs. The dependent variable is the average yearly employment growth over the observed period. All regressions are in cross-section at the firm-level. Columns 1 to 3 use a dummy equal to one if the firms owns its real-estate. Column 1 use the absolute value of the average employment growth as a dependent variable and include all firms, column 2 and 3 consider only growing and declining firms, respectively. Columns 4 to 6 include the tax on capital gain as a regressor and focus on real-estate owning firms. Column 4 use the absolute value of the average employment growth as a dependent variable whereas column 5 and 6 are quantile regressions for quantiles 0.1 and 0.8, respectively. Variable description is given in Table A3. With the exception of columns 5 and 6, coefficient are obtained using an *OLS* estimator.

Figure 6: Effect of relocation costs on employment growth on various quantiles of the dependent variable



Notes: This graph plots the coefficients on the tax of capital gain from a cross section quantile regression with the employment growth as a dependent variable. We plot the coefficient obtained for each of the quantile: 0.10, 0.20, 0.30, 0.40, 0.50, 0.60, 0.70, 0.80 and 0.90 along with the 95% confidence interval (grey area). Regression also includes our usual control variables: Age, Profit, Size (all taken in the first year of observation) as well as département fixed effects. Confidence intervals at the 95% level have been estimated with a variance-covariance matrix built with 40 bootstrap replications.

Initiative in the UK). 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 move 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 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 *communes* located less than 15km away from a ZFU.[21] In so doing, we discard all the moves that could be related to the documented displacement effect of $ZFUs$. We report in columns 1 to 4 of Table 6 the main analyses presented in Table 2 and 3 with this

[21] 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.

restricted sample. We find no difference compared to our baseline results.[22]

4.3.2 The agglomeration effects

The alternative mechanism affecting the observed relationship between local moves and the employment dynamics relates to agglomeration effects. As documented by Delgado, Porter, and Stern, 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.

We show that this effect cannot drive our results by conducting two types of analysis. First, we compare the characteristics between the *commune* of departure and the *commune* of settlement for growing moving firms and declining moving firms. The above explained mechanism would predict that growing firms relocate to bigger or denser cities, or to cities where the industry in which firms operate are more developed. Conversely, declining firms would relocate to smaller cities with fewer competition. This is at odds with the data presented in Table 5. We conduct a Student test on the equality of the mean between "relocating declining" and "relocating growing" firms for four local characteristics: population, density, local sectoral concentration index and local sectoral size. Concentration is measured by the Herfindahl index and sectoral size is the sum of total sales in this same sector. Both are calculated each year at the sector (2-digit)$\times$*commune* level. We observe that both growing and declining firms relocate, in average, to smaller and less dense *commune* where the level of concentration in the industry as well as its overall size are smaller. This corroborates the results on the urban sprawling, documented in the Paris area (*Île-de-France*) by Delisle and Laine, 1998.[23] The differences between growing and declining firms are small and not statistically significant. Second, we run cross-section *OLS* regressions where we control for the initial level of the four local characteristics which are studied in Table 5. Results are reported in columns 5 to 8 in Table 6. Introducing those controls leaves our results unaltered.

[22]There exist other differences in the level of local taxes that can also alter location choices (Devereux and Griffith, 2003; Roland. Rathelot and Patrick. Sillard, 2008 and Gilles. Duranton, Laurent Gobillon, and Overman, 2011). Unfortunately, we do not have access to precise information on the local indirect taxes at the level of the *commune* over the observation period that would allow us to take them into account.

[23]In fact, those results are altered when we exclude the *Île-de-France* (Paris area) to compute those statistics and the differences in population and density are much lower in that case.

Table 5: Statistics on changes in local characteristics following a move - Growing firms and declining firms

	Mean		Difference
	Declining firms	Growing firms	
Population	-55.9	-42.4	-12.4*
			(7.5)
Density	-0.80	-0.71	-0.89
			(0.56)
Herfindahl index	0.019	0.016	0.032
			(48.0)
Local sectoral size	-34	-23	-10
			(8)
Nb of obs.	9,082	12,670	-

Notes: This table shows the mean changes in some local characteristics following a move. 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. The statistics reported correspond the difference between the value observed in the *commune* of settlement in the year of the move and the value observed in the *commune* of departure prior to the move. Population is in thousands inhabitants in 1990 at the *commune* level. Density, at the *commune* level, in thousands inhabitants per square kilometer. The Herfindahl index is computed at the 2-digit sector×*commune*×year level. Finally, the local sectoral size is the sum of the sales at the 2-digit sector×*commune*×year level. The Period of observation: 1994-2013. Source: INSEE and FiBEn, see section A for more detail about the data.

Table 6: Robustness checks

	Place-based programs				Agglomeration economies			
	Low growth	High growth	Move	Move	Low growth	High growth	Move	Move
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**
Move	-0.0082***	0.014***			-0.0082***	0.013***		
	(.0015)	(.0017)			(.0009)	(.001)		
RE owner			-0.035***				-0.042***	
			(.0029)				(.0026)	
Tax on capital gains				-0.16***				-0.22***
				(.046)				(.04)
Population					-1.9e-06	-0.000018***	0.000055**	0.000071**
					(4.6e-06)	(5.1e-06)	(.000024)	(.000029)
Density					-0.00017	0.0007***	0.0077***	0.012***
					(.00017)	(.00021)	(.001)	(.0022)
Herfindahl index					0.0013	0.00096	0.01**	0.013**
					(.0011)	(.0015)	(.0042)	(.0059)
Sectoral size					-8.8e-07	3.7e-06***	-0.000011*	6.8e-06
					(9.3e-07)	(1.1e-06)	(5.8e-06)	(8.9e-06)
Fixed effects:								
Emp. growth decile	No	No	Yes	Yes	No	No	Yes	Yes
Acq. year of RE assets	No	No	No	Yes	No	No	No	Yes
Year	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Sector	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Département	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Nb of obs.	31,325	39,560	64,575	29,358	56,130	69,172	113,646	43,952
R^2	0.23	0.17	0.054	0.045	0.23	0.17	0.099	0.073

Notes: $***pvalue < 0.01$. $**pvalue < 0.05$. $*pvalue < 0.10$.
Robust standard errors in brackets.

Notes: The table presents robustness checks aiming at assessing the role of external factors on the interaction between relocation and growth. The dependent variable is the employment growth (averaged over the observed period) for columns 1 and 2 / 5 and 6; the equations estimated are identical to those reported in column 2 and 3 of Table 2. In columns 3 and 4 / 7 and 8, the dependent variable is a dummy indicating the occurrence of a relocation; the equations estimated are identical to those reported in column 4 and 7 of Table 3. In columns 1 to 4, the sample is restricted to *commune* which are located farther than 15km away from a ZFU. In columns 5 to 8, control variables for local characteristics in year of observation are introduced. Variable description is given in Table A3. Coefficient are obtained using an OLS estimator.

5 Conclusion

Using a large sample of French firms in all business sectors over a large period, this paper investigates interactions between local relocations and employment dynamics.

First, we build a partial equilibrium model in which a representative firm makes decisions on relocation and employment level considering the dynamics of its productivity and the relocation costs. The model predicts that a relocation is associated with a concomitant adjustment of employment level. The magnitude of those adjustment may differ whether the firm is growing or slackening, we refer to this mechanism as the asymmetric effect of the relocation: the relocation of a growing is typically associated with larger change in the workforce. This asymmetry suggests more stringent constraints for firms with growth potential. Our model also predicts that moving costs, as captured by the tax on capital gain, other fiscal costs associated to real-estate transactions or direct search costs and moving expenses, reduce the propensity to relocate, and constrain the employment growth.

Second, we confront these predictions with a large dataset on French firms over the period 1994-2013. The results presented in the theoretical model are confirmed, namely that moving is associated with significant adjustment in workforce, notably in the last deciles of the employment growth distribution. Empirical results also suggest that the level of the relocation costs reduces the propensity to move, and constrains jobs creation of the dynamic firms.

We believe that this paper provides an example of frictions that prevent efficient allocation of resources in an economy. The identified frictions have marked effects on the individual behaviour of the firms and could have sizable effects on aggregate productivity and production. The nature of these frictions suggests some policy implications, notably with respect to the taxation and the legal fees affecting corporate real-estate transactions. Proper quantitative evaluations of aggregate impact and policy reforms probably require consideration of general equilibrium effects. Our results hence indicate avenues left for further research.

References

[1] John Asker, Allan Collard-Wexler, and Jan De Loecker. “Dynamic Inputs and Resource (Mis)Allocation”. In: *Journal of Political Economy* 122.5 (2014), pp. 1013–1063 (cit. on p. 3).

[2] Giuseppe Bertola and Ricardo Caballero. “Kinked adjustment costs and aggregate dynamics”. In: *NBER Macroeconomics Annual 1990, Volume 5*. MIT Press, 1990, pp. 237–296 (cit. on p. 17).

[3] Michael Carlos Best and Henrik Jacobsen Kleven. “Housing market responses to transaction taxes: Evidence from notches and stimulus in the UK”. Mimeo, London School of Economics. 2013 (cit. on p. 4).

[4] Aleid E. Brouwer, Ilaria Mariotti, and Jos N. van Ommeren. “The firm relocation decision: An empirical investigation”. In: *The Annals of Regional Science* 38.2 (June 2004), pp. 335–347 (cit. on p. 2).

[5] Thomas Chaney, David Sraer, and David Thesmar. “Real Estate Collateral and Labor Demand”. Mimeo, Toulouse School of Economics. 2013 (cit. on p. 46).

[6] Pierre-Philippe Combes et al. “The productivity advantages of large cities: Distinguishing agglomeration from firm selection”. In: *Econometrica* 80.6 (2012), pp. 2543–2594 (cit. on p. 34).

[7] Benjamin Dachis, Gilles Duranton, and Matthew Turner. “The effects of land transfer taxes on real estate markets: evidence from a natural experiment in Toronto”. In: *Journal of Economic Geography* 12.2 (2012), pp. 327–354 (cit. on p. 4).

[8] Mercedes Delgado, Michael E. Porter, and Scott Stern. “Clusters, convergence, and economic performance”. In: *Research Policy* 43.10 (2014), pp. 1785–1799 (cit. on p. 34).

[9] Jean-Pierre Delisle and Frédéric Laine. “Les transferts d’établissements contribuent au desserrement urbain”. In: *Économie et Statistique* 311.1 (1998), pp. 91–106 (cit. on pp. 5, 34).

[10] Michael P. Devereux and Rachel Griffith. “Evaluating tax policy for location decisions”. In: *International Tax and Public Finance* 10.2 (2003), pp. 107–126 (cit. on p. 34).

[11] Thomas J. Dohmen. “Housing, mobility and unemployment”. In: *Regional Science and Urban Economics* 35.3 (2005), pp. 305–325 (cit. on p. 2).

[12] Gilles. Duranton, Laurent Gobillon, and Henry G. Overman. “Assessing the effects of local taxation using microgeographic data”. In: *The economic journal* 121.555 (2011), pp. 1017–1046 (cit. on p. 34).

[13] Gilles Duranton et al. "The misallocation of land and other factors of production in India". Mar. 2015 (cit. on p. 4).

[14] R. Färe and L. Svensson. "Congestion of production factors". In: *Econometrica: Journal of the Econometric Society* (1980), pp. 1745–1753 (cit. on p. 11).

[15] Martin Feldstein, Joel Slemrod, and Shlomo Yitzhaki. "The Effects of Taxation on the Selling of Corporate Stock and the Realization of Capital Gains". In: *The Quarterly Journal of Economics* 94.4 (1980), pp. 777–791 (cit. on p. 28).

[16] Denis Fougère and Mathilde Poulhes. "The Effect of Housing on Portfolio Choice: A Reappraisal Using French Data". In: *CEPR Discussion Paper* 9213 (2012) (cit. on p. 41).

[17] Jacques Friggit. "Le prix des logements sur longue période". In: *Informations sociales* 155.5 (2009), pp. 26–33 (cit. on p. 42).

[18] P. Givord, R. Rathelot, and P. Sillard. "Place-based tax exemptions and displacement effects: An evaluation of the Zones Franches Urbaines program". In: *Regional Science and Urban Economics* 43.1 (2013), pp. 151–163 (cit. on p. 31).

[19] L. Gobillon and D. Le Blanc. "L'impact des contraintes d'emprunt sur la mobilité résidentielle et les choix entre location et propriété". In: *Annales d'Économie et de Statistique* (2004), pp. 15–45 (cit. on p. 17).

[20] S. Grossman and G. Laroque. "Asset Pricing and Optimal Portfolio Choice in the Presence of Illiquid Durable Consumption Goods". In: *Econometrica* 58.1 (1990), pp. 25–51 (cit. on p. 17).

[21] C. Hilber and T. Lyytikäinen. "Housing transfer taxes and household mobility: Distortion on the housing or labour market?" Government Institute for Economic Research VATT Working Papers 47/2013. 2013 (cit. on p. 4).

[22] C. Hsieh and P. Klenow. "Misallocation and Manufacturing TFP in China and India". In: *The Quarterly Journal of Economics* (2009), pp. 1403–1448 (cit. on p. 3).

[23] Y. Kanemoto. "On the "Lock-In" Effects of Capital Gains Taxation". In: *Journal of Urban Economics* 40.3 (1996), pp. 303–315 (cit. on p. 28).

[24] J. Knoben, L. Oerlemans, and R. Rutten. "The effects of spatial mobility on the performance of firms". In: *Economic Geography* 84.2 (2008), pp. 157–183 (cit. on p. 5).

[25] T. Mayer, F. Mayneris, and L. Py. "The impact of Urban Enterprise Zones on establishment location decisions and labor market outcomes: evidence from France". In: *Journal of Economic Geography* (2015), lbv035 (cit. on p. 31).

[26] G. Olley and A. Pakes. "The Dynamics of productivity in the telecommunication equipment industry". In: *Econometrica* 64.6 (1996), pp. 1263–1297 (cit. on p. 3).

[27] Henry G. Overman and Elias Einio. “The Effects of Spatially Targeted Enterprise Initiatives: Evidence from UK LEGI”. ERSA conference papers No. 12p164. 2012 (cit. on p. 31).

[28] P. Pellenbarg, L. Van Wissen, and J. Van Dijk. *Firm relocation: state of the art and research prospects*. University of Groningen, Research Institute SOM, 2002 (cit. on p. 2).

[29] C. Pen and P. Pellenbarg. “Firm migration and central government policy; An overview”. In: *Paper from the Regional Science Association conference, Groningen*. 1998 (cit. on p. 5).

[30] Roland. Rathelot and Patrick. Sillard. “The importance of local corporate taxes in business location decisions: Evidence from French micro data”. In: *The Economic Journal* 118.527 (2008), pp. 499–514 (cit. on p. 34).

[31] Roger W. Schmenner. “Choosing New Industrial Capacity: On-Site Expansion, Branching, and Relocation”. In: *The Quarterly Journal of Economics* 95.1 (1980), pp. 103–119 (cit. on p. 2).

[32] J. Weltevreden et al. “Firm relocation and regional employment development in the Netherlands (1999-2006)”. In: *European Regional Science Association* (2007) (cit. on pp. 3, 5).

[33] S. Yitzhaki. “An empirical test of the lock-in-effect of the capital gains tax”. In: *The Review of Economics and Statistics* (1979), pp. 626–629 (cit. on p. 28).

A Data description

A.1 Data sources

We use French firm-level data merged with real-estate prices at the *département* level.[24]

A.1.1 firm-level information

We exploit a large French firm-level database constructed by the Banque de France: FiBEn. It 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 also exclude from our sample firms 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 moves.[25] 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.[26] The median length of the observation period is 9.75 years.

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[27] 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.[28] 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 *département* in 2013. Apartment per square meter prices at the *département* level are collected by the *Chambre des Notaires*.

[24] 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, we excluded departments 12 (Aveyron), 46 (Lot) and 53 (Mayenne).

[25] Note that keeping those sectors in the database has on the results

[26] 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.

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

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

They correspond to the average price per square meter of all apartment transactions registered in a given year.[29] 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 *département* located in the Paris area (*Île-de-France*) and the national housing price index (available from 1936 onwards) for the other *département*. We report the trend 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 behaviour thanks to the reported location of headquarters. FiBEn provides, at annual frequencies, the *commune* [30] 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 moves 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 find that, over an average observation period of 10 years, around 20% of the firms relocate their activities in another municipality. Among those moving firms, 17.5% move once and 2.4% move twice and the rest move more than twice. Overall, we observe more than 35,000 relocations.

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 identify as single-establishment turn to multi-establishment structures. When compared to the 15.3% of firms moving 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

[29] 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.

[30] French equivalent for municipality

Table A1: French *Départements* in 2013

Département name	*Département* code	Population	*Département* name	*Département* code	Population
Ain	01	634 173	Lozère	48	76 204
Aisne	02	538 743	Maine-et-Loire	49	809 505
Allier	03	343 680	Manche	50	500 019
Alpes-de-Haute-Provence	04	162 924	Marne	51	572 968
Hautes-Alpes	05	140 706	Haute-Marne	52	179 638
Alpes-Maritimes	06	1 081 821	Mayenne	53	307 831
Ardèche	07	323 543	Meurthe-et-Moselle	54	729 664
Ardennes	08	278 970	Meuse	55	190 550
Ariège	09	153 011	Morbihan	56	747 458
Aube	10	308 085	Moselle	57	1 047 013
Aude	11	370 056	Nièvre	58	212 111
Aveyron	12	278 062	Nord	59	2 607 174
Bouches-du-Rhône	13	2 007 684	Oise	60	822 858
Calvados	14	693 277	Orne	61	286 256
Cantal	15	146 299	Pas-de-Calais	62	1 466 483
Charente	16	354 586	Puy-de-Dôme	63	646 537
Charente-Maritime	17	639 596	Pyrénées-Atlantiques	64	670 434
Cher	18	311 768	Hautes-Pyrénées	65	228 304
Corrèze	19	238 713	Pyrénées-Orientales	66	472 033
Corse-du-Sud	2A	152 720	Bas-Rhin	67	1 118 009
Haute-Corse	2B	174 178	Haut-Rhin	68	763 716
Côte-d'Or	21	533 023	Rhône	69	1 816 373
Côtes-d'Armor	22	599 438	Haute-Saône	70	238 181
Creuse	23	119 381	Saône-et-Loire	71	555 840
Dordogne	24	418 219	Sarthe	72	572 135
Doubs	25	536 474	Savoie	73	429 253
Drôme	26	501 154	Haute-Savoie	74	791 094
Eure	27	599 518	Paris	75	2 218 536
Eure-et-Loir	28	435 171	Seine-Maritime	76	1 255 587
Finistère	29	907 423	Seine-et-Marne	77	1 391 429
Gard	30	748 509	Yvelines	78	1 424 411
Haute-Garonne	31	1 335 366	Deux-Sèvres	79	372 586
Gers	32	191 639	Somme	80	571 595
Gironde	33	1 542 964	Tarn	81	386 004
Hérault	34	1 123 990	Tarn-et-Garonne	82	255 666
Ille-et-Vilaine	35	1 039 983	Var	83	1 041 681
Indre	36	225 590	Vaucluse	84	554 619
Indre-et-Loire	37	606 164	Vendée	85	667 970
Isère	38	1 253 614	Vienne	86	433 682
Jura	39	259 455	Haute-Vienne	87	375 363
Landes	40	405 213	Vosges	88	371 792
Loir-et-Cher	41	332 775	Yonne	89	340 884
Loire	42	761 357	Territoire de Belfort	90	145 074
Haute-Loire	43	227 509	Essonne	91	1 279 864
Loire-Atlantique	44	1 358 627	Hauts-de-Seine	92	1 603 379
Loiret	45	670 906	Seine-Saint-Denis	93	1 573 959
Lot	46	173 021	Val-de-Marne	94	1 372 018
Lot-et-Garonne	47	334 106	Val-d'Oise	95	1 210 318

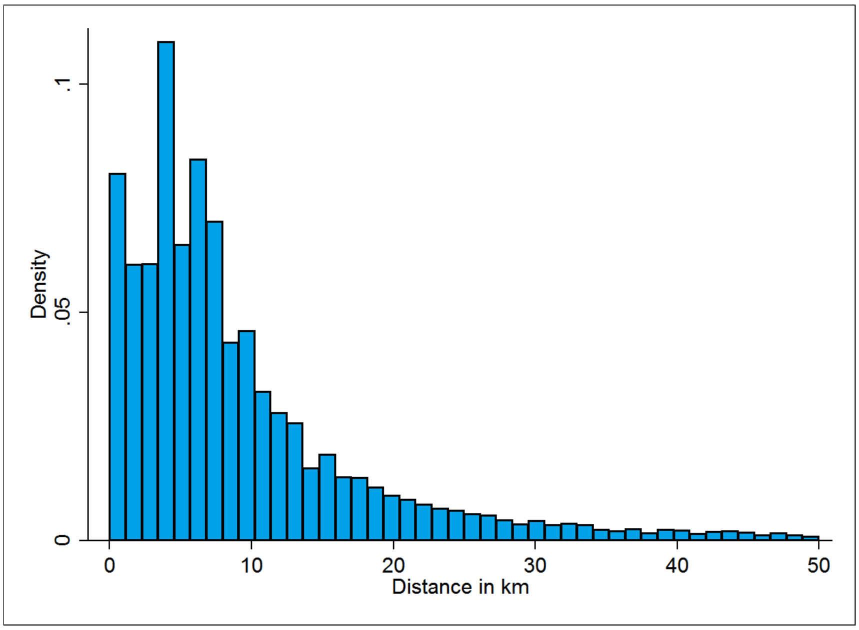
Notes: List of French *département* in 2013 and population. The codes presented in this table are consistent from 1994 to 2013. Source: INSEE.

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

Département	(1)	(2)	(3)	(4)	*Département*	(1)	(2)	(3)	(4)
1	1 101	0.76	1.89	1.19%	50	637	0.77	1.51	1.09%
2	657	0.83	1.36	0.87%	51	1 044	1.15	1.93	0.96%
3	399	0.43	1.05	1.13%	52	275	0.7	1.1	0.51%
4	183	0.81	1.87	1.03%	54	801	0.73	1.62	1.60%
5	217	0.71	2.15	0.77%	55	209	0.48	1.13	0.75%
6	1 452	1.96	3.75	1.31%	56	1 020	1.15	2.08	1.01%
7	426	0.68	1.4	1.06%	57	1 068	0.8	1.59	1.41%
8	431	0.57	1.13	1.14%	58	243	0.47	0.95	0.86%
9	196	0.97	1.72	0.86%	59	3 185	1.08	2.39	1.79%
10	532	0.49	1.28	1.20%	60	1 006	1.45	2.35	1.50%
11	396	0.93	2.11	0.49%	61	404	0.47	1	0.94%
13	2 932	1.07	2.54	1.43%	62	1 625	1.25	2.02	1.33%
14	888	1.66	2.37	1.59%	63	954	0.6	1.68	1.18%
15	199	0.52	1.3	0.68%	64	1 127	0.99	2.36	1.32%
16	535	0.42	1.02	1.07%	65	272	0.62	1.54	1.10%
17	827	1.7	2.97	0.83%	66	559	0.91	2	0.97%
18	438	0.72	1.26	0.87%	67	1 831	1.25	2.15	1.36%
19	331	0.52	1.18	0.68%	68	1 236	0.59	1.52	1.28%
21	846	0.97	2	1.45%	69	3 396	1.74	2.77	2.51%
22	905	0.92	1.6	0.93%	70	357	0.5	1.03	0.73%
23	139	0.47	0.94	0.42%	71	987	0.73	1.14	0.95%
24	601	0.64	1.35	1.03%	72	687	0.66	1.39	1.05%
25	892	0.77	1.64	1.14%	73	894	1.36	2.61	1.50%
26	1 015	0.63	1.46	1.05%	74	1 571	1.38	3.26	1.44%
27	716	0.9	1.67	1.27%	75	4 990	2.89	8.14	3.40%
28	625	1.11	2.01	1.09%	76	1 672	0.98	1.93	1.71%
29	1 191	0.45	1.37	0.85%	77	2 005	1.16	2.69	1.56%
30	853	0.88	1.92	1.08%	78	1 746	1.65	3.78	2.12%
31	1 830	1.04	2.39	1.60%	79	591	0.6	1.19	0.90%
32	261	0.51	1.44	0.25%	80	672	1.02	2.08	0.86%
33	2 032	0.81	2.6	1.78%	81	656	0.81	1.45	0.70%
34	1 212	1.5	2.75	1.52%	82	344	0.51	1.39	0.48%
35	1 593	1.32	2.28	1.14%	83	1 123	1.3	3.08	1.34%
36	305	0.47	1.06	0.75%	84	882	0.92	1.91	0.93%
37	902	0.97	2.02	1.65%	85	1 240	1.35	2.33	0.68%
38	2 230	1.24	2.16	1.45%	86	640	1.18	1.59	0.98%
39	541	0.54	1.33	0.69%	87	515	0.71	1.22	0.86%
40	473	1.01	2.3	0.79%	88	629	0.57	1.11	0.77%
41	513	0.7	1.47	0.70%	89	486	0.86	1.4	0.96%
42	1 511	0.66	1.14	1.17%	90	169	0.67	1.21	1.53%
43	401	0.41	1.12	0.82%	91	1 819	1.28	2.69	2.30%
44	1 738	1.13	2.52	1.32%	92	2 511	2.27	5.26	3.51%
45	925	1.05	1.8	1.16%	93	1 943	1.48	3.2	2.71%
47	528	0.4	1.15	1.00%	94	1 888	1.87	4.19	2.47%
48	110	0.68	1.49	0.37%	95	1 330	1.17	2.76	2.08%
49	1 400	0.96	1.7	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 moves 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: FiBEn.

is below 7.5km for 50% of the moves; it is below 16km for 75 percent of the moving 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 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]

[31] The accounting standard for the length of the amortization period depends on the nature of the buildings.

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 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

We retain an average length of 25 years following Chaney, Sraer, and Thesmar, 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.
RE owner	Dummy variable equal to one if the firm reports real-estate assets in its balance-sheet.
Move	Dummy variable equal to one if the firm have relocated its activities over the observed 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.
Profit	EBIT margin (i.e., EBIT to Sales ratio).
Age of RE	Average age, in years, of real-estate assets held by the firm.
Tax on cap. gains	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 RE	Numbers of square meters normalised the net value of the balance sheet.
Population	Population of the current *commune* in thousands inhabitants
Density	Population of the current *commune* in thousands inhabitants per square kilometer.
Herfindahl index	Sum of the square of the market share, in % of all firms in a give 2-digit sector and in the *commune* during the year.
Sectoral size	Sum of the sales at the 2-digit sector $\times$ *commune* $\times$ year level in constant million of euros of 2010.

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.

B Additional figures

Figure B1: Propensity to move at different percentiles of employment growth - within *Île-de-France* (Paris area)

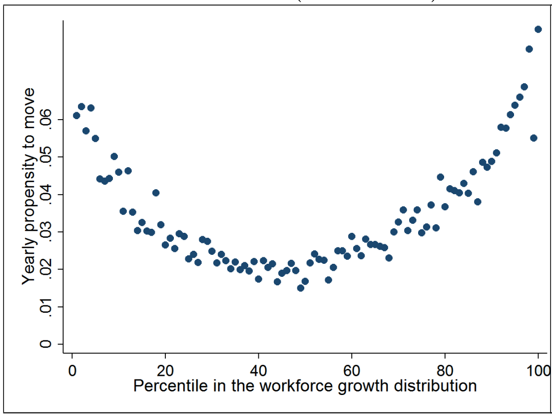
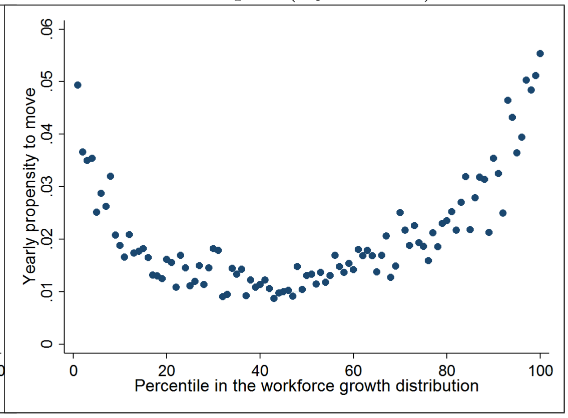


Figure B2: Propensity to move at different percentiles of employment growth - within *Rhône-Alpes* (Lyon area)



Notes: This Figure plots the propensity to move (y-axis) against the percentile in the employment growth distribution (x-axis). Employment growth is taken as an average over the observation period. Observed propensities to move are calculated in each percentile as the number of move observed divided by the number of firm×year observations. Period of observation: 1994-2013. Right-hand side figure only includes observations from Lyon Area (Region *Rhone-Alpes*, D'epartements 01, 07, 26, 38, 42, 69, 73, 74) while left-hand side figure only includes observations from Paris Area (Region *Ile de France*, D'epartements 75, 77, 78, 91, 92 ,93 ,94 ,95). Source: FiBEn.

Figure B3: Propensity to move at different percentiles of employment growth - (Marseille area)

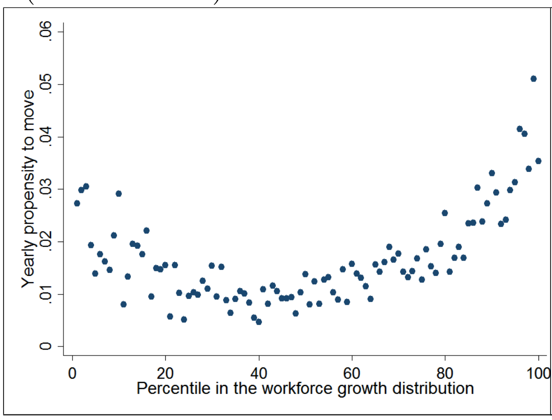
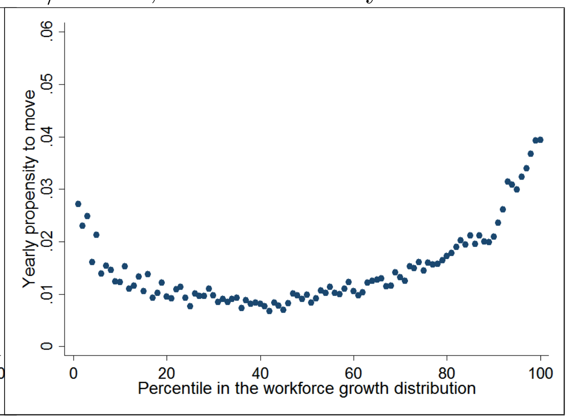


Figure B4: Propensity to move at different percentiles of employment growth - w/o Paris, Marseille and Lyon areas



Notes: This Figure plots the propensity to move (y-axis) against the percentile in the employment growth distribution (x-axis). Employment growth is taken as an average over the observation period. Observed propensities to move are calculated in each percentile as the number of move observed divided by the number of firm×year observations. Period of observation: 1994-2013. Right-hand side figure excludes all observations from Paris, Lyon and Marseille areas while left-hand side figure only includes observations from Marseille Area (Region *Provence-Alpes-Cote-d'Azur*, D'epartements 04, 05, 06, 13, 83, 84) Source: FiBEn.

Figure B5: Propensity to move at different percentiles of employment growth - service industries

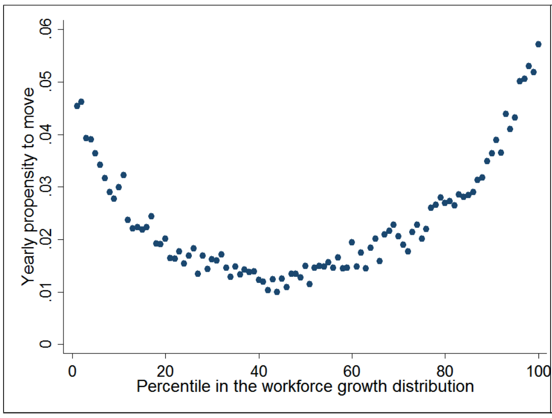
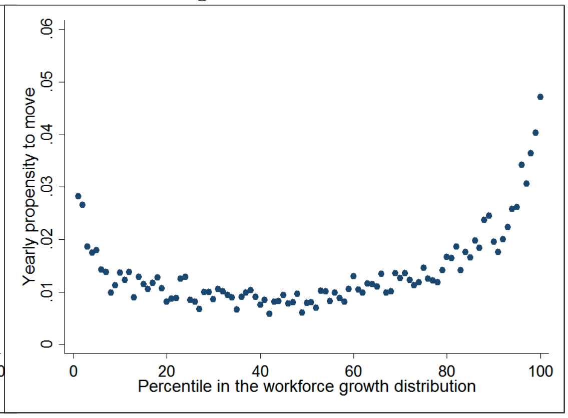


Figure B6: Propensity to move at different percentiles of employment growth - manufacturing industries.



Notes: This Figure plots the propensity to move (y-axis) against the percentile in the employment growth distribution (x-axis). Employment growth is taken as an average over the observation period. Observed propensities to move are calculated in each percentile as the number of move observed divided by the number of firm×year observations. Period of observation: 1994-2013. Right-hand side figure only includes observations from manufacturing industry while left-hand side figure only includes observations from the service industry. Source: FiBEn.

C Proof of propositions

C.1 Concavity of profit function

The function Π is concave when the elasticity of the function P' is greater to $\frac{2\alpha-1}{1-\alpha}$.
Proof.

We first show that $\Pi_{11}(L,R)\Pi_{22}(L,R) > \Pi_{12}(L,R)^2$

We have:

$$\begin{aligned} \Pi_{11}(L,R)\Pi_{22}(L,R) &= \tfrac{2\alpha(1-\alpha)\theta L^{\alpha-1}}{R^3}P'\left(\tfrac{L}{R}\right) + \tfrac{2L}{R^5}P'\left(\tfrac{L}{R}\right)P''\left(\tfrac{L}{R}\right) \\ &+ \tfrac{\alpha(1-\alpha)\theta L^{\alpha}}{R^4}P''\left(\tfrac{L}{R}\right) + \tfrac{L^2}{R^6}P''\left(\tfrac{L}{R}\right)^2 \end{aligned} \tag{23}$$

And:

$$\Pi_{12}(L,R)^2 = \frac{2L}{R^5}P'\left(\frac{L}{R}\right)P''\left(\frac{L}{R}\right) + \frac{L^2}{R^6}P''\left(\frac{L}{R}\right)^2 + \frac{1}{R^4}P'\left(\frac{L}{R}\right)^2 \tag{24}$$

Hence:

$$\begin{aligned} \Pi_{11}(L,R)\Pi_{22}(L,R) - \Pi_{12}(L,R)^2 &= \alpha(1-\alpha)\theta L^{\alpha-1}\left[\tfrac{2}{R^3}P'\left(\tfrac{L}{R}\right) + \tfrac{L}{R^4}P''\left(\tfrac{L}{R}\right)\right] \\ &- \tfrac{1}{R^4}P'\left(\tfrac{L}{R}\right)^2 \\ &= \tfrac{2(1-\alpha)w}{R^3}P'\left(\tfrac{L}{R}\right) + \tfrac{(1-\alpha)wL}{R^4}P''\left(\tfrac{L}{R}\right) \\ &+ \tfrac{1-2\alpha}{R^4}P'\left(\tfrac{L}{R}\right)^2 + \\ &\tfrac{(1-\alpha)L}{R^5}P'\left(\tfrac{L}{R}\right)P''\left(\tfrac{L}{R}\right) \end{aligned} \tag{25}$$

We deduce a sufficient condition on the elasticity of function P so that $\Pi_{11}(L,R)\Pi_{22}(L,R) > \Pi_{12}(L,R)^2$:

$$\frac{P''\left(\frac{L}{R}\right)\frac{L}{R}}{P'\left(\frac{L}{R}\right)} \geq \frac{2\alpha-1}{1-\alpha} \tag{26}$$

Notice that, when $\alpha = \frac{2}{3}$, every function $P(x) = \mu x^{\nu}$ with $\nu \geq 2$ satisfies this condition.

■

C.2 Proof of proposition 1

Proof. Equation 5 can be written as $\Pi_1(L(R),R) = 0$ for any $R > 0$, where Π_1 denotes the derivative of Π with respect to its first variable.

- **Existence of a unique solution**: P being convex, P' is increasing and therefore Π_1 is decreasing in L and diverges to infinity as L goes to 0. When $L > \left(\frac{\alpha\theta}{w}\right)^{\frac{1}{1-\alpha}}$, Π_1 is negative since P is increasing. Since Π_1 is continuous in L, this ensures that equation 5 has a unique solution denoted $L(R)$.

- **This solution is increasing in** R: The derivative of Π_1 with respect to R is then equal to 0 for any $R > 0$. Using the chain rule, we have: $\frac{\partial \Pi_1}{\partial R} = \Pi_{11}(L(R), R)L'(R) + \Pi_{12}(L(R), R) = 0$ and:

$$\begin{cases} \Pi_{11}(L(R), R) = & -\alpha(1-\alpha)\theta L(R)^{\alpha-2} - \frac{1}{R^2}P''\left(\frac{L(R)}{R}\right) \\ \Pi_{12}(L(R), R) = & \frac{1}{R^2}P'\left(\frac{L(R)}{R}\right) + \frac{L(R)}{R^3}P''\left(\frac{L(R)}{R}\right) \end{cases}$$

Since P is both increasing and convex, both $\Pi_{12}(L(R), R) > 0$ and $\Pi_{11}(L(R), R) < 0$ and we conclude that $L'(R) > 0$.

■

C.3 Proof of proposition 2

Proof. When R^* is close to R_0, we can apply a Taylor decomposition of Π around (L^*, R^*):

$$\Pi(\hat{L}, R_0) = \Pi(L^*, R^*) + \vec{x}^T \vec{\nabla}\Pi(L^*, R^*) + \frac{1}{2}\vec{x}^T \vec{\nabla}^2\Pi(L^*, R^*)\vec{x} + o(\vec{x}^T\vec{x}) \tag{27}$$

with:

$$\vec{x} = \begin{pmatrix} \hat{L} - L^* \\ R_0 - R^* \end{pmatrix} \quad \text{and} \quad \vec{\nabla}\Pi(L^*, R^*) = \begin{pmatrix} \Pi_1(L^*, R^*) \\ \Pi_2(L^*, R^*)) \end{pmatrix} = 0 \tag{28}$$

As (L^*, R^*) maximizes Π and:

$$\vec{\nabla}^2\Pi(L^*, R^*) = \begin{pmatrix} \Pi_{11}(L^*, R^*) & \Pi_{12}(L^*, R^*) \\ \Pi_{21}(L^*, R^*) & \Pi_{22}(L^*, R^*) \end{pmatrix} \tag{29}$$

Hence we obtain:

$$\begin{aligned} \Pi(L^*, R^*) - \Pi(\hat{L}, R_0) \quad &= -\tfrac{1}{2}\{(\hat{L} - L^*)^2\Pi_{11}(L^*, R^*) \\ &+2(R_0 - R^*)(\hat{L} - L^*)\Pi_{12}(L^*, R^*) + (R^* - R_0)^2\Pi_{22}(L^*, R^*)\} \\ &+o\{(R_0 - R^*)^2 + (\hat{L} - L^*)^2\} \end{aligned} \tag{30}$$

A first order Taylor development of the function L around R^* yields:

$$\hat{L} = L^* + (R_0 - R^*)L'(R^*) + o(R_0 - R^*) \tag{31}$$

Plugging into the previous equation gives:

$$\begin{aligned} \Pi(L^*, R^*) - \Pi(\hat{L}, R_0) \quad &= -\tfrac{1}{2}(R_0 - R^*)^2\{L'(R^*)^2\Pi_{11}(L^*, R^*) \\ &+2L'(R^*)\Pi_{12}(L^*, R^*) + \Pi_{22}(L^*, R^*)\} \\ &+o(R_0 - R^*)^2 \end{aligned} \tag{32}$$

And since $L'(R^*) = \dfrac{-\Pi_{12}(L^*, R^*)}{\Pi_{11}(L^*, R^*)}$:

$$\begin{aligned}\Pi(L^*, R^*) - \Pi(\hat{L}, R_0) &= -\tfrac{1}{2}(R^* - R_0)^2 \tfrac{\Pi_{11}(L^*,R^*)\Pi_{22}(L^*,R^*) - \Pi_{12}(L^*,R^*)^2}{\Pi_{11}(L^*,R^*)} \\ &+ o(R^* - R_0)^2\end{aligned} \tag{33}$$

Denoting $\kappa \equiv -\dfrac{1}{2}\dfrac{\Pi_{11}(L^*, R^*)\Pi_{22}(L^*, R^*) - \Pi_{12}(L^*, R^*)^2}{\Pi_{11}(L^*, R^*)}$, we can write:

$$\Pi(L^*, R^*) - \Pi(\hat{L}, R_0) = \kappa(R^* - R_0)^2 + o(R^* - R_0)^2 \tag{34}$$

From the concavity of Π when the elasticity of the function P' is greater to $\frac{2\alpha-1}{1-\alpha}$, we know that $\frac{\Pi_{11}(L^*,R^*)\Pi_{22}(L^*,R^*) - \Pi_{12}(L^*,R^*)^2}{\Pi_{11}(L^*,R^*)} < 0$ and then that $\kappa > 0$. ■

C.4 Approximation of the difference between R and R^*

Proof. Subtracting equation (11) to (12), we obtain:

$$\alpha\theta[L(R^*)^\alpha - L(R)^\alpha] - w[L(R^*) - L(R)] = [(\frac{1}{\beta}p_1 - \tilde{p}_2) + C'](R^* - R) - C'R^* \tag{35}$$

A first order Taylor development of the function L^α around R^* yields:

$$L(R^*)^\alpha - L(R)^\alpha = (R^* - R)\alpha L'(R^*)L(R^*)^{\alpha-1} + o(R^* - R) \tag{36}$$

A first order Taylor development of the function L around R^* yields:

$$L(R^*) - L(R) = (R^* - R)L'(R^*) + o(R^* - R) \tag{37}$$

From equation (35), (36) and (37), we get:

$$(R^* - R)\left(L'(R^*)(\alpha^2\theta L(R^*)^{\alpha-1} - w) - [(\frac{1}{\beta}p_1 - \tilde{p}_2) + C']\right) = -C'R^* + o(R^* - R) \tag{38}$$

But we know from equation (5) that:

$$\alpha^2\theta L(R^*)^{\alpha-1} - w = \alpha\frac{1}{R}P'\left(\frac{L^*}{R^*}\right) + (\alpha - 1)w \tag{39}$$

And from equation (6) that:

$$(\frac{1}{\beta}p_1 - \tilde{p}_2) + C' = \frac{L}{R^2}P'\left(\frac{L^*}{R^*}\right) \tag{40}$$

We also know that:

$$L'(R^*) = \frac{-\Pi_{12}(L^*,R^*)}{\Pi_{11}(L^*,R^*)} = \frac{\frac{1}{R^{*2}}P'\left(\frac{L^*}{R^*}\right) + \frac{L^*}{R^{*3}}P''\left(\frac{L^*}{R^*}\right)}{\frac{(1-\alpha)}{L^*R^*}P'\left(\frac{L^*}{R^*}\right) + \frac{(1-\alpha)w}{L^*} + \frac{1}{R^{*2}}P''\left(\frac{L^*}{R^*}\right)} \tag{41}$$

From equation (38), (39), (40) et (41), we obtain:

$$\begin{aligned} &L'(R^*)(\alpha^2\theta L(R^*)^{\alpha-1} - w) - [(\tfrac{1}{\beta}p_1 - \tilde{p}_2) + C'] = \\ &\frac{\left(\frac{2(\alpha-1)w}{R^{*2}}P'\left(\frac{L^*}{R^*}\right) + \frac{(\alpha-1)wL^*}{R^{*3}}P''\left(\frac{L^*}{R^*}\right)\frac{2\alpha-1}{R^{*3}}P'\left(\frac{L^*}{R^*}\right)^2 + \frac{(\alpha-1)L^*}{R^{*4}}P'\left(\frac{L^*}{R^*}\right)P''\left(\frac{L^*}{R^*}\right)\right)}{\frac{(1-\alpha)}{L^*R^*}P'\left(\frac{L^*}{R^*}\right) + \frac{(1-\alpha)w}{L^*} + \frac{1}{R^{*2}}P''\left(\frac{L^*}{R^*}\right)} \end{aligned} \tag{42}$$

And we deduce from equation (25) that:

$$\begin{aligned} &L'(R^*)(\alpha^2\theta L(R^*)^{\alpha-1} - w) - [(\tfrac{1}{\beta}p_1 - \tilde{p}_2) + C'] = \\ &R^*\frac{\Pi_{11}(L^*,R^*)\Pi_{22}(L^*,R^*) - \Pi_{12}(L^*,R^*)^2}{\Pi_{11}(L^*,R^*)} = -2R^*\kappa \end{aligned} \tag{43}$$

To conclude that, locally around R^*, the difference between R^* and R can be written:

$$R^* - R = \frac{C'}{2\kappa} \tag{44}$$

■

C.5 Proof of proposition 4

Proof.

We show that the RHS in the inequality (15) is increasing in τ and γ. Let us denote this RHS, $\sqrt{g(R^*)} = \sqrt{\frac{C_f}{\kappa} + \frac{C'}{4\kappa^2}(4\kappa R^* - C')}$ for every value of R^*. As κ and R^* do not depend on τ and γ, and since from equation (13) $2R^*\kappa - C^{'} \geq 0$, we have:

$$\frac{\partial g(R^*)}{\partial \tau} = \frac{\max\{p_1 - p_0, 0\}R_0}{\kappa} + \beta\max\{\tilde{p}_2 - p_1, 0\}\frac{1}{2\kappa^2}(2R^*\kappa - C^{'}) \geq 0 \tag{45}$$

$$\frac{\partial g(R^*)}{\partial \gamma} = \frac{p_1}{2\kappa^2}(2R^*\kappa - C^{'}) \geq 0 \tag{46}$$

Because $C^{'}$ is increasing with τ and γ, we know from equation (13) that the size of the premises in which the relocating firm settles diminishes with τ and γ. ■

C.6 Proof of proposition 5

Proof. If we denote the function g such that $g(R^*) = \frac{C_f}{\kappa} + \frac{C^{'}}{4\kappa^2}(4\kappa R^* - C^{'})$, we have:

$$g^{'}(R^*) = \frac{1}{\kappa^2}\left(C^{'} - \frac{\partial\kappa}{\partial R^*}[\frac{C_f}{\kappa} + \frac{C^{'}}{2\kappa}(2R^*\kappa - C^{'})]\right) \tag{47}$$

We know from equation (13) that $2R^*\kappa - C^{'} > 0$. We show in unreported but available upon request computations that, when the elasticity of the function P' is greater to $\frac{2\alpha-1}{1-\alpha}$, every α from 0.6 to 0.66 (the most acknowledge values for this elasticity) are consistent with $\frac{\partial\kappa}{\partial R^*} < 0$. We conclude that, for those values of α, $g^{'}(R^*) \geq 0$ and the RHS in the inequality (15) is increasing in R^*.

Let's now assume that there exist two solutions R^{*+} and R^{*-} with $R^{*+} > R^{*-}$ to the equation $(R^* - R_0)^2 = \frac{C_f}{\kappa} + \frac{C^{'}}{4\kappa^2}(4\kappa R^* - C^{'})$. We have $R^{*+} - R_0 = \sqrt{g(R^{*+})}$ and $R_0 - R^{*-} = \sqrt{g(R^{*-})}$. From the above-mentioned property of the function g we conclude: $R^{*+} - R_0 > R_0 - R^{*-}$.

■

C.7 Parameter's value in the numerical example

We consider 5-year periods and we retain a discount factor β equal to 0.8 in order to match the semi-annual average 10-year French treasury bond yield between 1994q1 and 2013q4. We set α to the standard value of $\frac{2}{3}$.

The parameters governing the cost of the move are set as follows. We retain a value of 0.004 for the parameter δ_o and 0.002 for δ_r so that a move entails a lump-sum loss equivalent to approximately one week of production for owners and half a week for renters. In France, the legal fees and local taxes associated with a real-estate transaction amount to roughly 5% of the transaction value; we thus set γ to 0.05. Finally, the marginal tax rate on capital gains, τ, is equal to 33%; that is the French corporate income tax rate since 1993.

The real-estate unit price p_0 and the wage are set to match the average ratio of the wages in the non-financial corporations (over 5 years) over the market price of 20 square meter in mainland France; that is 6.5 over the period 1993q1-2013q4.[33] We set the real-estate prices to 0.1 and the wage equals 0.65. The parameters mu and nu in the function P are respectively set to 0.01 and 10 so that, in period 0, the number of square meters per employee is close to 20. The initial endowment in real-estate units is equal to the optimal size of the premises in period 0. The productivity in period 0 is set to 1. Table C4 summarizes the values used in the numerical example.

[33]The data are from the national accounts produced by the INSEE, the national statistics office.

Table C4: Value of parameters used in the numerical example

Parameter	Value	Description
β	0.8	Firms' discount factor
α	$\frac{2}{3}$	Elasticity of production to labor input
μ	0.01	Parameter for function P
ν	10	Parameter for function P
δ_o	0.004	Lump sum cost - owning firm
δ_r	0.002	Lump sum cost - renting firm
γ	0.05	Legal fees and local tax
τ	0.33	Tax rate on capital gain
p_0	0.1	Real-estate price in period 0
w	0.65	Wage
R_0	R_0^*	Endowed real-estate units
θ_0	1	Productivity level in period 0

Notes: R_0^* is set to be equal to R^* in period 0.