Why do place-based policies have limited effects on unemployment rates? A tale with new and more traditional explanations.*

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Abstract

This paper looks for the reasons why substantial payroll tax cuts in *Zones Franches Urbaines* (ZFUs) only have a limited impact on unemployment rates in the long run. Unemployment is in our model a genuine problem because of search-matching frictions that are amplified by wage rigidities, but also because some explicit heterogeneities lead to non-trivial acceptance decisions once a vacant job and an applicant have met. A cut in payroll taxation obviously lowers the cost of labor. Improving firms' profitability favors vacancy creation in the ZFU. This cut also makes entrepreneurs less choosy when they select applicants but this effect varies according to the importance of a mismatch in "productive traits" in production (akin to a "skill mismatch" problem). As is more usual in the literature, the incentive to create jobs in the ZFU is also limited by congestion costs. Having developed and exploited analytically as far as possible the theoretical framework, we turn to a numerical exercise. A baseline calibration of the model allows to generate an impact of payroll tax cuts on equilibrium unemployment rates that is compatible with the econometric evidence for France. Doubling the impact of mismatch on firms' output leads to complex adjustments which all together lower the beneficial effects of tax cuts on unemployment rate.

1 Introduction

Place-based policies are usually policies targeting some deprived area within a country. Contrary to policies where a a subpopulation with specific individual characteristics is eligible, these policies target heterogeneous agents located within a given area. These

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policies may be of very different kinds, from payroll tax exemptions to infrastructure investment. The amount of money spent is sometimes huge, while the evidence on the effectiveness of place-based policies is mixed. This paper explores the reasons of this lack of clear success, with a focus on unemployment rates.

In France, 41 enterprise zones, called *Zones franches urbaines* (ZFUs for short) were settled in 1997. Eligible firms could benefit from several tax exemptions. In 2000, the total tax exemptions amounted to around 360 millions euros, according to a French report (DIV, 2001), among which 63% was devoted to reductions in payroll taxes. However, despite the amount spent, the evidence provided by Gobillon et al. (2012) suggests that the policy has reduced unemployment duration by 3% only in the targeted area and its immediate surroundings. Other studies, focusing among others on employment, found however higher effects (see e.g. Mayer et al., 2016, that finds that employment increases by 24% in the ZFU area).

Besides the disparities in unemployment across space, unemployment rates are also very different across skills. Because the policy in France tries to help areas where the population is not-well educated, we chose to focus on the low-skill segment. People in deprived areas are often younger and less educated than the population (Thélot, 2006). Furthermore, as tax reductions were only implemented up to a wage equal to 140% of the minimum wage, the policy has more impacted low-skilled workers. In 2004, 70% of the employed workers under the policy had a professional high-school degree or lower (CAP-BEP or lower).

This paper looks for the reasons why substantial payroll tax cuts in ZFUs only have a limited impact on unemployment rates in the long run. For this purpose, we do not rely on standard, yet too extreme, arguments such as a perfectly mobile workforce or a totally inelastic supply of commercial buildings and housing. Instead we model a city divided in a subsidized area and a non-subsidized one. Both areas are confronted with congestion costs in the matching process and along the spatial dimension (an upward sloping supply of commercial buildings, roads and whatnot). Entrepreneurs decide freely where to open vacant jobs and workers commute at some cost. There is a single labor market for low-skilled workers at the level of the city, but the matching effectiveness of job-seekers can be heterogeneous. In the French context, wages are rigid. We realistically assume that both jobs and low-skilled workers have heterogeneous "productive traits". We also introduce an heterogeneity in the value of time in unemployment. Unemployment is in our model a genuine problem because of search-matching frictions that are amplified by wage rigidities, but also because the above-mentioned explicit heterogeneities lead to non-trivial acceptance decisions once a vacant job and an applicant have met. A cut in payroll taxation obviously lowers the cost of labor. Improving firms' profitability favors vacancy creation in the ZFU. This cut also makes entrepreneurs less choosy when they select applicants but this effect varies according to the importance of a mismatch in "productive traits" in production (akin to a "skill mismatch" problem). As is more usual in the literature, the incentive to create jobs in the the ZFU is also limited by congestion costs. Furthermore, differences, if any, in the matching effectiveness influence the extent to which job-seekers in a given area can benefit from the rise in vacancies at the city level. Having developed and exploited analytically as far as possible the theoretical framework, we turn to a numerical exercise. A baseline calibration of the model allows to generate an impact of payroll tax cuts on equilibrium unemployment rates that is compatible with the econometric evidence for France. Doubling the impact of mismatch on firms' output, leads to complex adjustments which all together lower the beneficial effects of tax cuts on both unemployment rates.

The theoretical literature on place-based policies can be organized in two groups. Some papers focus on the rationale for place-based policies. Some others provide models compatible with empirical facts. Our paper belongs to the second category.

According to Neumark and Simpson (2015), the theoretical justifications for place-based policies utilize arguments related to six domains: agglomeration economies, knowledge spillovers, industry localization, spacial mismatch, network effects and equity motivations.

In a short paper, Kline (2010) builds a spatial equilibrium model with perfect competition on both the good and labor markets. Firms are perfectly mobile but workers face idiosyncratic preferences for the region (see also Lutgen and Van der Linden, 2015). Because of these preferences and perfect competition, a tax subsidy induces a deadweight loss, except when agents are perfectly immobile. When adding agglomeration economies in the production function, the author finds that the equilibrium is not unique. In this case, a subsidy may help a region to go from one equilibrium to the other, by inducing workers to move to this region. Kline and Moretti (2013) provide a rationale for hiring subsidies. They show that when hiring costs are too high compared to their efficient level, firms post too few vacancies and hiring subsidies may restore the efficiency.

Kline and Moretti (2014b) wrote a theoretical essay on the different winners and losers of place-based policies when markets are perfect, as in Kline (2010). Then, they extend their work to different market imperfections, e.g. agglomeration economies and local public goods. However, as they mentioned, "economists do not have enough information to reliably suggest strategies that can raise aggregate welfare via agglomeration forces". They also point out the importance of pre-existing distortionary policies, in which case place-based policies act as an instrument to correct the distortions.

On the other hand, (at least) two papers try to assess the effectiveness of policies in the US. First, Busso et al. (2013) assess the impact of the empowerment zones program in the US. Building a theoretical framework, the authors are able to compute a deadweight loss based on several elasticities. They then estimate them to conclude that this loss was really modest for this particular program, allowing the subsidies to be transferred successfully to the population settled in the zone. The impact of another policy is much more limited. Kline and Moretti (2014a) first estimate the impact of the Tennessey Valley Authority on employment and wages in different sectors. In a second part of their paper, they construct a model to evaluate the impact of the policy on total welfare. Finding that agglomeration elasticities are not very different across counties, they conclude that the program indirect effect (i.e. an increase in national output) is minimal. However, none of these papers put a particular emphasis on unemployment.

This paper is organized as follows. Section 2 describes the French policy implemented

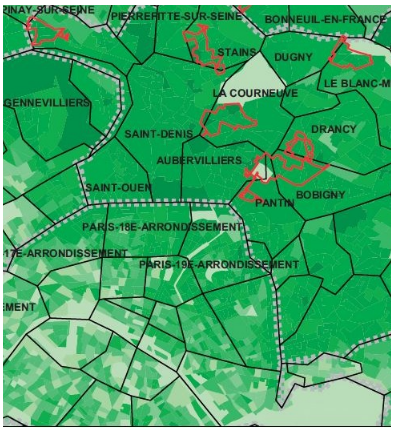

Figure 1: Pacte de relance pour la ville (Mayer et al., 2016)

from 1997 onwards and some empirical findings of its impact. The theoretical framework is developed in Section 3 and its properties in Section 4. Section 5 explains the numerical exercise we implemented. Finally, Section 6 concludes.

2 The French case

2.1 Description of the policy

In France, the "Plan de relance pour la ville" was created in 1996. Deprived areas were selected, among which the most ones were designated as "Zones Franches Urbaines". The borders of the zones were set by law. It is worth mentioning that the borders of the ZFU are different from the administrative borders. A ZFU can be either a part of a municipality or parts of different municipalities, as described by Figure 1. For instance, the ZFU in La Courneuve is almost on the territory of a single municipality only, while another ZFU covers parts of three different municipalities: Pantin, Bobigny and Drancy. Therefore, if one wants to consider what happens in a municipality, one has to build a model of a city with 2 parts: one which is covered by the tax reductions (described in the next paragraph) and one which is not. On average, a ZFU covers around 10% of the area of its municipality(ies).[1]

A full description of the advantages the policy offers can be found in Appendix 2 of Mayer et al. (2016) and in Appendix B of Briant et al. (2015). We only here briefly describe the main features that we will take into account in our model. Firms that settle in the zones were offered some tax reductions, among which a total exemption of payroll taxes which represents 48% of the total cost of the policy in 1999 (DIV, 2001).[2] A first

[1] To give the reader a rough idea about the size of the area, the surface of the municipality of La Courneuve is $7.52km^2$ while the ZFU' surface is $1.25km^2$ only.

[2] The other benefits allowed were full release on corporate income tax (or tax on corporate profits), on (local) business tax, on property tax on buildings and on health contribution for artisans and shopkeepers.

wave of 41 zones were created in 1997. It was then extended in 2004 to another 44 zones. We chose to deal with this second wave, because of data availability. To benefit from the policy, there are limits on the number of employees (50) and on the turnover, but also a rule on the local workforce. Newly created firms had to employ at least 33% of the workforce in the nearby area (the ZFU extended to other deprived areas of the city) when they employ at least 3 workers. For firms created before 2002, they could benefit from the tax exemptions if they employed 20% of their workforce locally.

2.2 Empirical findings

The only study focusing on the effect of place-based policies on unemployment is carried out by Gobillon et al. (2012). In their analysis of the impact of the first wave of ZFUs in the Paris region, they assess the impact of the policy on unemployment duration for workers localized in a given municipality. They find that unemployment duration has decreased by 3% due to the policy. This effect appears to last only in the short run (up to 3 years).

The effect at the municipality level may hide some mechanisms playing at a more disaggregated level. Among the literature, Mayer et al. (2016) use a novel strategy to analyze the impact of the introduction of ZFUs on firm location, employment and wages. They focus on the introduction of new ZFUs in 2004. Contrary to the other studies that choose as control group other zones that were not designated as ZFU, they use the non-ZFU part of the municipality as control group. This choice is made as they notice that the number of firms at the municipality level has not been affected, so that they can focus on within municipality relocation and compare the ZFU part of the city with the non-ZFU part. The effects they find on employment are important: the policy increases employment in targeted zones by 24 %. Rathelot and Sillard (2008) also study the impact of the policy on the new selected zones in 2004. Using however another way of creating the counterfactual (namely the zones that were not selected), they get similar conclusions (an increase by 18% of the stock of employed workers in the targeted area). They also point out the firm relocation process which could have taken place and its potential impact on the neighborhood.

3 The theoretical framework

Our aim is not to study the rationale for creating ZFUs or more generally Enterprise Zones (on this see e.g. Kline and Moretti, 2014, or Neumark and Simpson, 2015). We instead intend to provide an analytical framework that rationalizes the weak effects of ZFUs summarized in Section 2.2.

A full description can be found in Mayer et al. (2016), Appendix 2 and in Briant et al. (2015), Appendix B

3.1 Basic modeling choices

As explained earlier, a ZFU is typically a relatively small area inside a municipality or crossing the borders of a few municipalities. Therefore, our unit of observation is a municipality (or a few number of municipalities), henceforth called the "city", and is made of two parts: the ZFU itself (designated by index Z) and the rest of the city where firms are ineligible to the policy (and designated by index R). Assuming that the matching process between job-seekers and vacant jobs is segmented (i.e. specific to each part of the city) makes little sense. We henceforth assume that vacant jobs opened in any part of the city can be matched with job-seekers living in both parts. However, we will later open the possibility that the "matching effectiveness" of job-seekers is heterogeneous within the city.

We are interested in particular in the unemployment rate in the targeted area (u_Z) and, because of spillovers effects, in the unemployment rate u_R in the non-targeted area. We are specifically focusing on the low-skilled subpopulation since only workers paid at or close to the minimum wage were eligible to payroll tax cuts in ZFUs.[3] An originality of our framework is that heterogeneity is *two-sided* in the sense that both low-skilled workers and jobs have specific productive attributes. In some ways that we explain later, our framework allows for skill mismatch problems within the city. Therefore, unemployment is in our model a genuine problem because of search-matching frictions but also because explicit heterogeneities lead to non-trivial acceptance decisions once a vacant job and a job-seeker have met. Two-sided heterogeneity is notoriously difficult to handle in the presence of search-matching frictions because the sorting process is much more complex than in a frictionless Walrasian economy (Shimer and Smith, 2000; Shimer, 2005). For tractability, Gautier et al. (2006) have advocated the use of a circular representation of two-sided heterogeneity (a horizontal instead of a vertical differentiation as in Shimer's work). We follow their approach.[4]

As far as workers' mobility is concerned, one should distinguish inter-city migration from intra-city migration and intra-city commuting. Since the two parts of the city are close, we take costly commuting between them into account. However, we assume that the presence of a ZFU does not induce a relocation of the workforce. On the one hand gross migration flows between cities appear to be relatively small in France (Detang-Dessendre et al., 2016). So, we think that the causal impact of ZFUs on these flows can be neglected. As a city is relatively small, intra-city migration induced by the policy should on the other hand also be a minor phenomenon. It is well-known that workers' residential mobility can undermine the effects of place-based policies on local unemployment. Ignoring those migration flows actually forces us to find more original channels of explanations to the weak effect of ZFUs on local unemployment rates.

Another easy explanation is ruled out. We do not assume that the local supply of land (or buildings) for productive purposes is inelastic. We assume instead that the

[3]Dealing with possible substitution effects between skill groups is left for further research.

[4]While some observable workers' and firms' characteristics can be hierarchically ordered, the same is less obvious in the case of a circle. This limitation is recognized since long (see e.g. Gautier et al., p. 120, 2006).

cost of renting a production unit and, possibly, other operating costs are increasing and convex in the number of firms located in the area (respectively Z and R).

Since we are interested in lasting effects, if any, of place-based policies, we conduct our analysis in a steady-state of a dynamic framework (developed in continuous time). All agents discount the future at a common rate r. All firms produce an homogeneous good, which is taken as the *numeraire*. In the two parts of city resides a given workforce of low-skilled (risk neutral and infinitely lived) agents. Considering only such a subpopulation, we do not introduce knowledge spillover effects. Put another way, we do not assume an improvement in learning when the population of employees is denser in an area. Given the small size of the geographic areas under consideration, we do not think that agglomeration forces can appear within a part of the city (and not in the rest).[5] Such forces could however be important at a broader geographic level. As such a level is not the focus of this analysis, our framework ignores agglomeration forces altogether.

3.2 The matching process

The matching process is random and occurs at the city level. Put differently, firms do not open job vacancies that are restricted to job-seekers located in a specific part of the city. Consequently, if there is an increase in the aggregate number of vacancies at the city level, the unemployment exit rates of job-seekers in both parts will increase. It is however possible that the matching effectiveness of job-seekers vary according to their area of residence. The instantaneous number of meetings is given by the function

$$M(V, \mu_Z U_Z + \mu_R U_R)$$

where U_k represents the number of unemployed in zone i, μ_k their (exogenous) matching effectiveness and V the number of vacancies posted at the city level. So, if $\mu_Z < \mu_R$ the whole pool of job-seekers in the ZFU takes part less effectively to the matching process.[6] We assume constant returns to scale.[7] Let tightness in the city, θ, be defined as

$$\theta \equiv \frac{V}{\mu_Z U_Z + \mu_R U_R}. \tag{1}$$

[5]There is by the way no evidence of agglomeration forces at such a disaggregate geographical level.

[6]There is no empirical evidence of this difference. However, Briant et al. (2015) mention that unemployed workers in the ZFUs remain in their house on average 0.8 day more per week than their counterparts in non-ZFU zones. They conclude that it would therefore be surprising that these job-seekers find a partner with the same effectiveness as their non-ZFU counterparts. An alternative explanation for $\mu_Z < \mu_R$ could be a prejudice among employers against jobless people living in the ZFU or less effective public employment services in this area.

[7]Gautier et al. (2006) and Gautier and Zenou (2010) assume a quadratic contact technology. This means that returns to scale are increasing and the contact rate is independent of the number of participants on both sides of the market. So doing, they want to "avoid congestion effects between rocket engineers and hamburger flippers" (Gautier et al., 2006, p. 123). As we focus on a the segment of low-skilled workers and jobs, we instead think that congestion effects in the matching process are highly plausible.

The rate $m(\theta)$ at which a vacant job meets an applicant is

$$\frac{M(V, \mu_Z U_Z + \mu_R U_R)}{V} = M(1, \frac{\mu_Z U_Z + \mu_R U_R}{V}) \equiv m(\theta) \text{ with } m'(\theta) < 0. \quad (2)$$

The rate at which a job-seeker living in part k meets a vacant position is $\mu_k \, p(\theta)$, where

$$p(\theta) \equiv M(\frac{V}{\mu_Z U_Z + \mu_R U_R}, 1) \text{ with } p'(\theta) > 0. \quad (3)$$

Finally, V_i denotes the number of vacancies posted in part i of the city, with $V_Z + V_R = V$. The match ends at an exogenous Poisson rate q.

3.3 The workers

A low-skilled workforce of exogenous size N_k resides in each part k of the city ($k \in \{Z, R\}$; $N = N_Z + N_R$). Among them, U_k agents are currently unemployed while E_k are employed. Our framework features hand-to-mouth agents. To improve our understanding of the hiring process, these low-skilled workers are heterogeneous along two dimensions. First, they have an *observable* trait ("productivity" or "skill") x. As is standardly done,[8] we assume that x is uniformly distributed among the workforce around a circle of radius $1/2\pi$, so that its circumference is equal to 1. The distribution of x within the workforce is *the same* in the two parts of the city. Let $u_k(x)$ be the number of unemployed of type x living in region k.[9] Second, the value of time in unemployment is heterogeneous as well. This feature will matter for the acceptance decision of a job offer. More specifically, an unemployed of type j living in part k of the city gets some flow utility

$$B_{kj} = b + \varepsilon_{kj}, \quad (4)$$

where b stands for some common value (say, an unemployment allowance) and ε_{kj} is an idiosyncratic value of time (in monetary units). ε_{kj} is assumed to be uniformly distributed over an interval $[0; e_k]$.[10] So, in addition to the above-mentioned area-specific matching effectiveness, μ_k, we add here the possibility a location-specific labor supply heterogeneity (via e_k). Note that ε_{kj} and x are independently distributed.

Employed workers are assumed to earn the exogenous minimum wage $w > b$ in France.[11] Consequently, the wage is the same across the city. We believe this is not

[8] This assumption or a similar one can be found in e.g.: Marimon and Zilibotti (1999); Hamilton et al. (2000); Gautier et al. (2006, 2010); Gautier and Zenou (2010).

[9] With $\int_0^1 u_k(x)dx = U_k$ defined above.

[10] To account for "work-lovers", one could extend the framework to the case of a (moderate) negative lower bound of the support.

[11] As eligibility to payroll tax reductions in ZFUs requires a wage no greater than 1.4 times the minimum wage and because we focus our analysis on the low-skilled population, we think that this assumption is relevant. France is a country where the incidence of the minimum wage is relatively large. On average, 13% of all employees earn the minimum wage in France (Source: `http://www.wageindicator.org/main/salary/minimum-wage/france/minimum-wages-faq#header12`). The incidence of the minimum wage in the low-skill segment of ZFUs is unknown but obviously much larger.

too strong an assumption as Mayer et al. (2016) found no effect of the policy on wage differentials between the two parts of the city for low-skilled workers. Employed people are assumed to work full-time and the disutility of work is normalized to zero.

Being employed in i when living in k implies some commuting costs c_{ik}. We assume that commuting within the part of the city one lives in is less costly than commuting to the other part:

$$c_{ZZ} < c_{ZR} \text{ and } c_{RR} < c_{RZ} \tag{5}$$

Furthermore, the cost of commuting inside an area is bounded from above:

$$\max\{c_{ZZ}, c_{RR}\} < w - b \tag{6}$$

This will guarantee that a least some workers accept to work in the area in which they live (avoiding degenerated equilibria, where everybody is unemployed). Furthermore, we take the view that only employed workers do commute.[12]

3.4 The firms

The number of jobs in each geographical area is determined by profit maximization. As it is often the case in the search-matching literature, labor is the only input that explicitly determines the output level. Production occurs under constant returns to scale. Formally, a firm is made of a single job.[13] Therefore, the number of firms, M_i, in each part i of the city and the number of workers employed in that part are equal. As occupied positions can be destroyed, vacancy creation captures both a relocation of destroyed jobs between areas and net job creation. When a job is vacant, the firm is actively engaged in the hiring process. Due to matching frictions, this takes time and it has a cost κ_i per unit of time and per vacant position. This exogenous unit recruitment cost can differ according to the part i of the city where the job is located.[14]

When opening a vacancy, an entrepreneur chooses where to locate in the city. The tax relief in ZFUs is supposed to affect this location decision. Within each part, the entrepreneur has also to decide which position y to occupy along the circle of circumference one (y and the workers' characteristics x are assumed to be measured in the same units and can be observed at no cost). Vacancies face no barrier to entry, so that in equilibrium the marginal value of opening an additional vacancy is zero in each area. Let $v_i(y)$ be the number of vacancies of type y located in equilibrium in i.

[12] As explained e.g. in Zenou (2009), the framework can easily be extended to the case where the unemployed commute a non-negligible amount of time, yet less than the employed people.

[13] Tax cuts in ZFUs are conditional on occupying at least a fifth of employees locally. This rule was extended to 33% in 2004 for the new hirings, but with an extension of the area of workers' dwellings. In a one-job-one-firm setting, we cannot verify this condition at the individual level, but in the simulations we check this condition for the pool of firms located in the ZFU.

[14] As Pissarides (1985) writes, this cost κ_i "is assumed to be a flow in order to simplify the exposition; it represents the fixed cost of machines that has to be borne regardless of whether jobs are filled or not, and any other labor-recruitment costs that the firm may have" (pp 679-680). Since vacancies are accessible to job seekers living in both areas, the parameter κ_i can however not capture that the cost of recruiting a worker can vary with her location of residence.

If a vacancy of type y located in i matches with a worker of type x living in k, their productivity varies first with x and y. Following Subsection 3.1, the impact of this two-sided heterogeneity on the level of output is for tractability reasons captured by the "distance" between x and y. This distance lies in $[0, 1/2]$ and measures the degree of "*skill mismatch*". So, the output is the highest (and normalized to 1) when this distance is nil and it decreases with its magnitude. We follow Gautier et al. (2006) by assuming a simple quadratic form:

$$f_{ik}(x, y) = 1 - \frac{\gamma_{ik}}{2}(x - y)^2, \text{ where } \gamma_{ik} > 0. \quad (7)$$

The lower the value of the parameter γ the closer two different workers' types, say x and x', are substitutes for a firm located at y. Put another way, the higher γ, the more a given intensity of skill mismatch lowers the output level. Second, the output of a given pair (x, y) in (7) is also allowed to differ with i and k. It this was not the case, nothing would distinguish the accessible output levels in both areas. Some hierarchical ranking of the two areas in terms of the production process can however be useful to understand why a part of the city is more depressed than the other before ZFUs are introduced. It is well possible that beyond the spectrum of the x values, which is the same within the labor force of each part of the city, there is some "fixed attribute" in each place of residence i that scales the mismatch effect $(x - y)^2$. An example could be a concentration of migrants with a poorer knowledge of the official language used inside the firms. An area-specific sectoral specialization could explain an heterogeneity in production processes. The latter could lead to another relationship between the levels of mismatch and of output according to the index of the location of jobs k. Allowing for an interaction between i and k is then a generalization that can be dealt with at no additional modeling cost. Hence, the fully general notation γ_{ik} is adopted. Intuitively, the value of this parameter will affect the selectivity in the hiring process and eventually the level of unemployment rates.

A firm located in part i of the city pays the minimum wage w to the worker and payroll taxes $\tau_i w$ where the payroll tax rate τ_i is specific to the location of jobs. This allows to deal with the cut in those taxes on jobs in the ZFU ($i = Z$).

In order to produce, each firm occupies a unit of homogeneous office or commercial building for which it pays a rent. We do not assume an inelastic supply of such buildings. Nevertheless, as the number of firms grow in the area, we expect rents to increase. Congestion effects could appear for other reasons as well: the number of *local* intermediate suppliers could be hard to adjust, road congestions in the area could affect the cost of delivering goods, and the like. All factors causing costly congestion for firms will be encapsulated in an area-specific cost per production unit $C_i(M_i)$, function of the total number M_i of firms operating in area i. We assume $C_i(0) = 0$, $C'(\cdot) > 0$ and $C''(\cdot) \geq 0$.

Ex-post profits are taxed at a rate $t_i \in [0, 1)$. These profits $\pi_{ik}(x, y)$ are made by a firm of type y located in i occupying a worker of type x living in k. The net ex-post profit made on a $\{i, k, x, y\}$ match is therefore:

$$\begin{aligned}\pi_{ik}(x,y) \equiv & \quad (1-t_i)\left[f_{ik}(x,y) - w(1+\tau_i) - C_i(M_i)\right] \\ = & \quad (1-t_i)\left[1 - \frac{\gamma_{ik}}{2}(x-y)^2 - w(1+\tau_i) - C_i(M_i)\right] \qquad (8)\end{aligned}$$

In each geographical area $i \in \{R, Z\}$, we assume that

$$1 - w(1+\tau_i) - C_i(0) > 0. \qquad (9)$$

Otherwise, even in the absence of mismatch, the very first job in an area would not be profitable.

3.5 Tax reductions in the Z zone

The policy corresponds to a decrease in τ_Z and t_Z while τ_R and t_R remain constant. However, we mainly focus on payroll taxes since there is evidence that 75% of the small firms were already not paying any corporate income tax (Givord et al., 2015).

4 The properties of the model

Under the assumptions that the value of the pair (x, y) affects neither the separation rate q nor the cost of opening a vacant position κ_i, Appendix A shows that a uniform density function of vacant jobs, $v_i(y)$, located in each part i of the city and a uniform density function of unemployed, $u_k(x)$, living in each part k are compatible with a steady-state equilibrium under free-entry of vacant jobs.[15] Consequently, the following exposition of the properties of the model assumes uniform distributions.

4.1 The workers

A worker endowed with skill x and type j (recall (4)), who lives in region k, has a lifetime discounted utility level $\mathcal{E}_{ikj}(x)$ if she is currently employed in part i of the city and $\mathcal{U}_{kj}(x)$ if she is currently unemployed. These lifetime values are the solutions to the following Bellman equations:

$$r\mathcal{E}_{ikj}(x) = w - c_{ik} + q(\mathcal{U}_{kj}(x) - \mathcal{E}_{ikj}(x)) \qquad (10)$$

$$r\mathcal{U}_{kj}(x) = b + \varepsilon_{kj} + \mu_k p(\theta) \sum_{i\in\{R,Z\}} \frac{V_i}{V} \int_0^1 \left(\max\left\{\mathcal{E}_{ikj}(x) - \mathcal{U}_{kj}(x), 0\right\}\right) B_{ik}(y|x)dy \qquad (11)$$

[15]Under the same assumptions (in a one location setting), Marimon and Zilibotti (1999) have shown that if the skill level of the unemployed population is uniformly distributed, so is the distribution of vacancies in a steady-state equilibrium. Gautier et al. (2006) generalize the proof to the case where the distribution of the unemployed population is endogenously distributed. These proofs are provided under the assumption of Nash bargaining. They need to be reconsidered in the case of exogenous wages because the acceptance decisions of a partner introduce some complexity. Finally, note that when the distributions are uniform, the framework presents similarities with the "stochastic job matching" model of Pissarides (1985).

When employed in part i, workers with skills x living in area k get paid w to which a commuting cost c_{ik} is deducted. At rate q, the match ends, which yields a utility loss $\mathcal{U}_{kj} - \mathcal{E}_{ikj}$. Being paid the minimum wage, the lifetime value in employment does not depend on the type y of the employer. An unemployed person of type j living in k has a flow value defined in (4). At rate $\mu_k p(\theta)$, this job-seeker meets a vacant position. The latter is located in part i of the city with probability $\frac{V_i}{V}$, where $V = V_Z + V_R$ is the aggregate number of vacancies in the city. Conditional on meeting a vacant position in i, an expectation is taken over the set of possible values of y. $B_{ik}(y|x)$ is a dummy equal to 1 when an entrepreneur with a vacancy of type y accepts to form a match with a job-seeker of type x, and zero otherwise (given their respective locations i and k). If $B_{ik}(y|x) = 1$, a match is formed if and only if the worker benefits from a utility gain $\mathcal{E}_{ikj} - \mathcal{U}_{kj} > 0$.

4.2 The firms

The inter-temporal profit made on a filled position $\mathcal{J}_{ik}(x,y)$ and the inter-temporal value of vacancy open in part i of the city, $\mathcal{V}_i(y)$, solve the following Bellman equations:

$$r\mathcal{J}_{ik}(x,y) = \pi_{ik}(x,y) - q\,\mathcal{J}_{ik}(x,y) \tag{12}$$

$$r\mathcal{V}_i(y) = -\kappa_i + m(\theta) \sum_{\in\{R,Z\}} \left(\frac{\mu_k U_k}{\mu_1 U_1 + \mu_2 U_2} \int_0^1 \max\left\{\mathcal{J}_{ik}(x,y) - \mathcal{V}_i(y), 0\right\} A_{ik}(x|y)dx \right) \tag{13}$$

When a job is filled, a firm makes an instantaneous profit π_{ik}(x,y), defined by (8). At rate q, this vacancy can be destroyed, hence the loss of the value $\mathcal{J}_{ik}(x,y)$. When a position is vacant, an entrepreneur bears a flow cost κ_i. At some rate $m(\theta)$, the firm meets a job-seeker. This worker lives in region k with probability $\mu_k U_k/[\mu_Z U_Z + \mu_R U_R]$. Conditional on meeting someone located in k, an expectation is taken with respect to the type x of the worker. $A_{ik}(x|y)$ is a dummy equal to 1 when the job-seeker of type x accepts to form a match with the vacancy of type y (given their respective locations k and i). A match is formed if the inter-temporal value of a filled vacancy is high enough ($\mathcal{J}_{ik}(x,y) - \mathcal{V}_i(y) > 0$). As vacancies can freely enter each part of the city, we restrict our analysis to an equilibrium under free-entry. Henceforth, the property $V_i(y) = 0$ holds for all y's in both areas $i \in \{Z, R\}$.

4.3 The firms' and workers' acceptance decisions

An entrepreneur y located in i accepts a given worker k if this yields a positive profit. The acceptance decisions of entrepreneurs (i.e. $B_{ik}(y|x)$) verify the following proposition:

Proposition 1. *For each i and k in $\{R, Z\}$, under Assumption* (9)*, there exist threshold values*

$$\Delta_{ik} \equiv \min\left\{ \sqrt{\frac{2}{\gamma_{ik}}(1 - w(1+\tau_i) - C_i(M_i))}, \frac{1}{2} \right\} \tag{14}$$

such that an entrepreneur with a vacancy of type y located in i

- *accepts to match with all job-seekers of type x located in k if $x - \Delta_{ik} \leq y \leq x + \Delta_{ik}$ - i.e. $B_{ik}(y|x) = 1$ - and*
- *refuses to form a match otherwise - i.e. $B_{ik}(y|x) = 0$.*

This is easily shown. For, a firm accepts to form a match when it is profitable to do so, i.e. when $\mathcal{J}_{ik}(x, y) - \mathcal{V}_i(y) = \pi_{ik}(x, y)/(r + q) \geq 0$ by (12). So, for any i, k and y, we have to look for x^* such that $\pi_{ik}(x^*, y) = 0$:

$$0 = (1 - t_i)(1 - \frac{\gamma_{ik}}{2}(x^* - y)^2 - w(1 + \tau_i) - C_i(M_i)) \text{ or}$$
$$x^* = y \pm \sqrt{\frac{2}{\gamma_{ik}}(1 - w(1 + \tau_i) - C_i(M_i))}$$

Because x is distributed between 0 and 1, we need to impose that the square root is lower than 1/2, which leads to (14). Everything else equal, a smaller parameter γ_{ik} reduces the role of mismatch and hence increases the range of acceptable applicants. Notice that a cut in the payroll tax τ_i increases this range as well (at given M_i).

Consequence 1. *From* (14)*, the range of job-seekers living in k and accepted by a firm located in i is independent of its type of job y. The length of this range is always $2\Delta_{ik} \in [0, 1]$. It measures the probability of acceptance of an applicant.*

We now turn to the worker's point of view. Because the acceptance rate of entrepreneurs is independent of x, so are the workers' value functions. Formally, $\mathcal{U}_{kj}(x) = \mathcal{U}_{kj}$ and hence $\mathcal{E}_{ikj}(x) = \mathcal{E}_{ikj}$. A job-seeker of type j living in part k will accept to form a match with a firm located in i if she is better off than when unemployed, i.e. when, by (10),

$$\mathcal{E}_{ikj} - \mathcal{U}_{kj} = \frac{w - c_{ik} - r\mathcal{U}_{kj}}{r + q} > 0 \tag{15}$$

Plugging this expression in (11), the lifetime value of a job-seeker living in area k solves:

$$\begin{aligned} r\mathcal{U}_{kj} = b + \varepsilon_{kj} + \mu_k p(\theta) \Bigg[& \frac{V_Z}{V} 2\Delta_{Zk} \max\left\{\frac{w - c_{Zk} - r\mathcal{U}_{kZ}}{r + q}, 0\right\} \\ & + \frac{V_R}{V} 2\Delta_{Rk} \max\left\{\frac{w - c_{Rk} - r\mathcal{U}_{kR}}{r + q}, 0\right\}\Bigg] \end{aligned} \tag{16}$$

Under Assumptions (5) and (6), the following proposition characterizes the acceptance decisions of the unemployed:

Proposition 2. *There exist four threshold values (two in each part k of the city) $\underline{e}_k$ and $\overline{e}_k$ such that a job-seeker of type j located in k:*

- *Rejects an offer and remains unemployed if her idiosyncratic value of time $\varepsilon_{kj} > \overline{e}_k$,*
- *Only accepts a position in part k of the city if $\underline{e}_k < \varepsilon_{kj} \leq \overline{e}_k$,*
- *Accepts a job offer in whole the city otherwise.*

These thresholds are defined by:

$$\overline{e}_k \equiv \min\{w - b - c_{kk}, e_k\}, \quad \textit{where } e_k \textit{ is the upper-bound of the support of } \varepsilon_{kj}, \tag{17}$$

$$\underline{e}_k \equiv \max\left\{w - b - c_{ik} - \mu_k p(\theta)\frac{V_k}{V}2\Delta_{kk}(c_{ik} - c_{kk}), 0\right\} \textit{ with } i \neq k \tag{18}$$

The proof is provided in the appendix. The intuition is the following. Assume an interior solution, so that the max- and min-operators do not play a role. For simplicity, let us focus on the population living in part $k = Z$ of the city. They value their time when unemployed at ε_{Zj}, which is distributed between 0 and e_Z. Someone with a very high ε_{Zj} refuses any offer because she values her time so much. The importance of this voluntary unemployment phenomenon depends on the net flow value of working in one's area of residence: $\overline{e}_Z \equiv w - b - c_{ZZ}$. Job-seekers with a value of time somewhat below this threshold only accept a job offer in their area of residence. Let's now assume a worker that is indifferent between working in the other part or remaining unemployed (waiting to get a job offer from a firm located in part Z). We notice that a higher net benefit from working in R $(w - b - c_{RZ})$ implies that a worker should value more her time to refuse to work in R. The lower the probability to get a position in Z or the smaller the difference in commuting time $c_{RZ} - c_{ZZ}$, the more utility it brings to work in part R and so the more a worker should value her time to refuse a job offer in R (the threshold $\underline{e}_k$ shrinks).

Consequence 2. *The worker's acceptance decision is independent of x and y. Let α_{ik} denote the probability that a job-seeker living in area k accepts an offer to work in area i, conditional on having met a firm settled in this area. From Proposition 2 these probabilities are:*

$$\alpha_{ZZ} = \frac{\overline{e}_Z}{e_Z} \qquad \alpha_{RR} = \frac{\overline{e}_R}{e_R} \qquad \alpha_{RZ} = \frac{\underline{e}_Z}{e_Z} \qquad \alpha_{ZR} = \frac{\underline{e}_R}{e_R} \tag{19}$$

where e_k is the upper-bound of the support of the idiosyncratic value of time ε_{kj}.

4.4 Vacancy creation under free-entry

After combining Consequences 1 and 2 with (13), the labor demand side of the model is summarized by the following equalities under free-entry (in each area i):

$$\frac{\kappa_i}{m(\theta)} = \sum_{k\in\{R,Z\}}\left((1-t_i)\frac{\alpha_{ik}\mu_k U_k}{\mu_Z U_Z + \mu_R U_R}\int_{y-\Delta_{ik}}^{y+\Delta_{ik}}\frac{1 - \frac{\gamma_{ik}}{2}(x-y)^2 - w(1+\tau_i) - C_i(M_i)}{r+q}dx\right) \tag{20}$$

After some simplifications, one gets:

$$\frac{\kappa_i}{m(\theta)} = \frac{1-t_i}{r+q}\sum_{k\in\{R,Z\}}\frac{\mu_k U_k}{\mu_Z U_Z + \mu_R U_R}\alpha_{ik}\left[2\Delta_{ik}\left(1 - w(1+\tau_i) - C_i(M_i)\right) - \int_{y-\Delta_{ik}}^{y+\Delta_{ik}}\frac{\gamma_{ik}}{2}(x-y)^2 dx\right] \tag{21}$$

Equation (21) implies that the expected cost of opening a vacancy (on the LHS) should be equal to the expected return from doing so (on the RHS). The RHS is made of three terms (after the sum operator), the first one multiplying the 2 others. This first term measures the probability that the job-seeker a firm has met comes from part k of the city and accepts the match. The second term quantifies the maximum expected profit the firm could get conditional on meeting someone from part k who accepts to form a match. The last term (i.e. the second line of Equation (21)) corresponds to the expected loss due to skill mismatch, conditional on meeting someone from part k who accepts to form a match. Solving the integral, the free-entry condition of vacancies (21) becomes:

$$\begin{aligned} \frac{\kappa_i(r+q)}{(1-t_i)m(\theta)} = \quad & \alpha_{iZ}\frac{\mu_Z U_Z}{\mu_Z U_Z + \mu_R U_R} 2\Delta_{iZ}(1 - \frac{\gamma_{iZ}}{6}\Delta_{iZ}^2 - w(1+\tau_i) - C_i(M_i)) \\ & + \alpha_{iR}\frac{\mu_R U_R}{\mu_Z U_Z + \mu_R U_R} 2\Delta_{iR}(1 - \frac{\gamma_{iR}}{6}\Delta_{iR}^2 - w(1+\tau_i) - C_i(M_i)) \end{aligned} \tag{22}$$

4.5 The flow equations

Remember that this analysis is carried out in a steady-state. Therefore, the number of workers living in k and entering unemployment (the separation rate times the number of employed workers living in k wherever they work) should be equal to the number of workers living in k and finding a job. The latter number is equal to the stock of unemployed in part k, U_k, which is multiplied by the rate at which they meet a firm $\mu_k p(\theta)$ and an overall acceptation rate. Indeed, workers accept the match with a firm in i at rate α_{ik} while the entrepreneurs in i accepts the match with probability $2\Delta_{ik}$ (the share V_i/V expressing the probability of meeting a vacancy in area i). Then, the flow equations for employment writes:

$$qE_k = \mu_k p(\theta) U_k \sum_{i\in\{R,Z\}} \alpha_{ik}\, 2\Delta_{ik}\, \frac{V_i}{V}. \tag{23}$$

Since $U_k + E_k = N_k$, the unemployment rate in each part k of the city, $u_k = U_k/N_k$, is:

$$u_k = \frac{q}{q + \mu_k p(\theta)\sum_{i\in\{R,Z\}}\left[\alpha_{ik} 2\Delta_{ik}\frac{V_i}{V}\right]} \tag{24}$$

At given tightness θ in the city, the unemployment rate in area k is rising if the matching effectiveness of job-seekers living in this area, μ_k, the acceptance probabilities by these workers or the acceptance probabilities of applicants by employers shrink.

The number of destroyed jobs in each part i of the city (M_i times the destruction rate) has to be equal to the number of newly employed workers in this part (wherever they live). The latter is given by the number of vacancies open in this area, V_i, multiplied by the meeting rate $m(\theta)$ and an overall acceptation probability. For, an entrepreneur accepts to match with a job-seeker coming from k with probability $2\Delta_{ik}$ while this worker living in k (whose relevant share is $\frac{\mu_k U_k}{\mu_Z U_Z + \mu_R U_R}$) accepts to trade with probability α_{ik}.

This leads to the following equality between flows:

$$qM_i = m(\theta)V_i \sum_{k\in\{R,Z\}} \left[\alpha_{ik} 2\Delta_{ik} \frac{\mu_k U_k}{\mu_Z U_Z + \mu_R U_R}\right] \tag{25}$$

4.6 Steady-state equilibrium

Definition 1. *An equilibrium is a vector* $\{(\alpha_{ik}, \overline{e}_k, \underline{e}_k, u_k, M_i, V_i, \Delta_{ik})_{i,k\in\{1,2\}}$ *and* $\theta\}$ *verifying their definitions and, for* i *and* $k \in \{1,2\}$*,* (14),(17)*,* (18)*,* (19)*,* (22)*,* (24)*,* (25)*. Tightness* θ *verifies its definition:*

$$\theta = (V_Z + V_R)/(\mu_Z u_Z N_Z + \mu_R u_R N_R) \tag{26}$$

The model is not recursive. All the variables, except the unemployment rates, are determined simultaneously. Then, given the other variables, the unemployment rates are determined.

We have not checked whether the steady-state equilibrium is efficient. However, because wages are exogenously set at the city level, search-matching externalities have no reason to be internalized by the economic agents.

5 Numerical Exercise

More analytical properties being out of scope, we turn to a numerical exercise. The calibration is as far as possible based on the evidence available about ZFUs and the surrounding areas before the introduction of the place-based policy. Next, we quantify the impact of cutting payroll taxes in the ZFU. We then turn to a deeper analysis of the consequences of the skill mismatch problem. More precisely, a sensitivity analysis looks first at the consequences of changing the effect of any discrepancy between the worker's type, x, and the firm's one, y, on firms' output. Next, we analyze how this change influences the impact of the payroll tax cut in the ZFU.

5.1 Baseline calibration

We have collected data about unemployment rates from the French institution for the "Politique de la Ville"[16] which gives the rates for the year 1999, for the ZFU and for the municipality (or the group of municipalities). We want to assess the effect of the policy in an average city, so that we take the average of the available unemployment rates. These averages are respectively $u_Z = 26\%$ and $u_R = 15\%$. As the database also provides the level of the total population, but not the one of the labor force, in the two parts of the city, we make the assumption that the labor force is split between these two areas as the total population. We normalize the workforce population in the city to 1.

[16] `http://sig.ville.gouv.fr/atlas/ZFU/`

As is standardly done, we assume a Cobb-Douglas matching function, $h(\mu_z U_Z + \mu_R U_R)^{0.5}\ (V_Z + V_R)^{0.5}$, with $h = 0.32$[17]. Mayer et al. (2016) provides an estimate of the ratio of firms located in the ZFU (over the number of firms in the municipality) of 15%. This allows us to parametrize the ratio of search effectiveness μ_Z/μ_R and the two costs of opening a vacancy.

The other parameters are set using national accounts or the literature, when possible. First, we use national accounts to set the wage in proportion of the highest level of output (namely, 1). We obtain $w = 0.40$. We compute the replacement ratio a worker can get when she earns the minimum wage. In 2016, it corresponds to around 58%[18]. Therefore, we set $b = 0.23$. The unit of time being the month, we set the interest rate r is set to 0.004 and the separation rate q to 0.02 (average rate found by Bucher, 2010, who studies the low-skilled labor market in France in the years 90s).

We do not have reliable information about congestion costs (not even about rents) at the right geographical level. So, we set the congestion costs to 0.42. In the absence of other information, we assume that this cost is, before the introduction of the ZFU policy, equal in the two areas. Assuming a linear functional form $C_i(M_i) = s_i M_i$ we set $s_R = 0.6$ and $s_Z = 3.45$.[19] We furthermore assume that a worker of type x living in k who is matched with a firm y produces the same output $1 - \frac{\gamma_k(x-y)^2}{2}$ wherever the job is located. To the best of our knowledge, there is no literature estimating the acceptance decisions by firms. Acceptance rates are therefore arbitrarily set to respectively 80% when meeting a worker from R and 70% when meeting a worker living in Z, we deduct $\gamma_Z = 0.80$ and $\gamma_R = 0.61$. We develop below a sensitivity analysis to measure the consequences of lower acceptance rates.

About commuting costs there is no evidence either. Setting the cost of commuting to 10% of the difference (w-b) within the area a worker lives in and to 20% otherwise and assuming an upper-bound of the support of the idiosyncratic value of time ε_{kj} respectively equal to $(w - b)$ in R and to $1.015 * (w - b)$ in Z, we reach an average acceptance rate by job-seekers of 0.86, which is in the range of values found by Eckstein and van den Berg (2007) in their survey of the empirical job-search literature. We are therefore confident that our assumptions about commuting costs are making sense.

Table 1 summarizes the values of the parameters. With this baseline parameterization, the endogenous variables are provided in column 1 of Table 2.

5.2 Impacts of the payroll tax cut in the ZFU

We simulate a cut in the payroll tax rate, from 30% to 0%, in the ZFU (area Z).[20] Overall, the impact on unemployment rates is limited: Both unemployment rates decline

[17]See Bucher (2010) and Bentolila et al. (2012) who also take the value 0.5 for the exponents in France.

[18]See e.g. http://www.juritravail.com/Actualite/rmi-rma/Id/111631.

[19]Because the ratio of the number of firms located in Z is set to 15%, so is the ratio of s_i.

[20]As mentioned earlier, the reduction should only affect firms employing 20% locally (or 33 % in a bigger zone for the firms created after 2004). We check that this is indeed the case by computing the share of workers employed in ZFUs who live in this zone. In our baseline calibration, this ratio reaches almost 30% with and without payroll taxes.

(from 26 to 23% in the ZFU and from 15 to 13% in the surrounding area). The new steady-state equilibrium values are provided in column 2 of Table 2.

We first focus on the direct impact of this reduction in area Z. Recall that vacancies can freely enter the market. Hence, forward-looking entrepreneurs adjust the number of vacancies instantaneously to the new environment. On the contrary, the unemployment levels adjust sluggishly because of matching frictions. Since payroll taxes disappear in the ZFU area, firms' profits (given by Equation (8)) rise. Furthermore, entrepreneurs accept more workers (see Equation (14)). So, firms open more vacancies in the ZFU and the number of firms located in area Z goes up. This leads to a rise in the congestion costs, which mitigates the direct favorable effects described earlier. This induced impact echoes complains of entrepreneurs who in a survey said that they faced a lack of real-estate opportunities in ZFUs (Givord et al., 2013). The rise in the number of vacancies reduces the rate at which vacancies in the ZFU find applicants. Under free-entry of vacancies, Condition (22) holds and in the presence of tax cuts, the number of vacancies and, hence, equilibrium tightness are higher in the ZFU.

This increase in tightness affects the rest of the city (area R) as well. Because the expected cost of opening a vacancy rises but the payroll tax rate remains unchanged, vacancy creation shrinks, less firms are present and the expected profit rises as well via diminishing congestion costs. This reduction also yields a higher acceptance rate for firms located in R (see Equation (14)).

It is worth noticing that the acceptance probability of job-seekers remains almost the same (see Equations (17), (18) and (19)). For, the acceptance decision in the worker's area of residence is not affected by a change in tightness. Second, the worker's acceptance decision out of her area of residence is slightly modified. However, as the difference in commuting costs between working in and out her area of residence is small, the change in tightness has almost no impact.

Our model does not endogeneize the decision to end a match. So, entrepreneurs are not allowed to close businesses in area R to relocate it in area Z in order to benefit from tax exemptions. However, through vacancy creation of jobs (characterized by an exogenous destruction rate), simulation results show that the number of firms decreases in the non-treated area R, while it increases in the treated area Z. The relocation process that was described in the empirical part thus also takes place in our numerical exercise.

Overall, employment and, because of our one-firm-one-job setting, the number of firms rise in the city, by about 1%. Unemployment slightly decreases, going from 26.1% to 23.8% in the ZFU part of city and from 15% to 13.7% in the rest of city. Compared to what was found in the literature which looks at the impact on the average (un)employment level, we get slightly bigger impacts in both areas. However, as we focus on the low-skill segment of the population which has been the main target of the policy, we consider that our simulated impacts are compatible with the conclusions of the available econometric literature. This suggests that our theoretical framework is able to account for the long run impact of the French place-based policy on the low-skilled unemployment rates.

5.3 Increasing the rate of output loss due to mismatch γ_k

Due to the lack of information about the entrepreneurs' probabilities of acceptance of applicants, we assigned relatively high values to them in the baseline calibration (and, hence, relatively low values to parameters γ_Z and γ_R). This part of the calibration is now subject to a sensitivity analysis. In this subsection, we assume that these parameters are 100% higher than in Table 1. So γ_Z is now set to 1.6 and γ_R to 1.2. We then simulate the impact of such a change on the steady-state equilibrium when tax cuts are not introduced. To see this, compare columns 1 and 3 of Table 2. Overall, unemployment rates are much higher than in the baseline scenario: 30% instead of 26 in the ZFU and 17% instead of 15 in the rest of the city in 1999. As we would like to see the pure effect of doubling γ_Z and γ_R, all other parameters keep their values in Table 1, despite the too high equilibrium unemployment rates obtained in 1999.

Because the increased rate of output loss due to mismatch implies a lower firm's output for a given match, the firm accepts a smaller range of workers and, hence, the acceptance rates are lower (see Equation(14)). This also yields a lower expected profit for entrepreneurs, which implies a lower level of tightness when the free-entry conditions hold (see Equation (22)). The effect on profits is however mitigated by lower congestion costs, due to a diminished number of firms. A lower tightness and entrepreneurs who are more choosy yield higher unemployment rates in both parts of the city.

5.4 The impact of the tax cut when skill mismatch matters more

This subsection compares the adjustments induced by the same tax cut as in Subsection 5.2 when the parameters γ_k are low (the baseline of this subsection) and when they are doubled. The aim is to check whether a tax cut affects unemployment rates less when the skill mismatch problem affects output more and to understand why it is so. Columns 2 and 4 of Table 2 provide information in levels. We refer below to the variation in percentage, given in columns 1 and 2 of Table 3.

When skill mismatch matters more (higher γ_k), the cut in payroll taxes has a lower impact on entrepreneurs' acceptance probability. This yields a lower variation in expected profit, and therefore, in the expected cost of opening a vacancy (see the free-entry conditions (22)). As a result, the variation in tightness is smaller when skill mismatch affects output more.

The rise in the number of firms in area Z and the decline in R are then *more* important. Using Equation (25)), the effect can be explained by the lower variations in both the matching rate of a vacancy $m(\theta)$ and the acceptance rate for firms Δ. These effects dominate the lower variation in vacancies V, so that the number of firms in each part the city and therefore the congestion costs vary more with a bigger degree of mismatch. However, as one would expect, the variation in the total number of firms is smaller (the bigger decline in the level of M_R dominating the bigger rise in M_Z). The relative change in the number of employed workers in the city is therefore also smaller. Because of the smaller variations in tightness and entrepreneurs' acceptance rate, the decline in unemployment rates is smaller as well.

6 Conclusion

This paper looks for the reasons why substantial payroll tax cuts in ZFUs only have a limited impact on unemployment rates in the long run. For this purpose, we have not relied on standard, yet too extreme, arguments such as a perfectly mobile workforce or a totally inelastic supply of commercial buildings and housing. Instead we modeled a city divided in a subsidized area and a non-subsidized one. Both areas were confronted with congestion costs in the matching process and along the spatial dimension (an upward sloping supply of commercial buildings, roads and whatnot). In the French context, wages are rigid. We realistically assumed that both jobs and low-skilled workers have heterogeneous "productive traits". We also introduce an heterogeneity in the value of time in unemployment. Unemployment is in our model a genuine problem because of search-matching frictions that are amplified by wage rigidities, but also because the above-mentioned explicit heterogeneities lead to non-trivial acceptance decisions once a vacant job and an applicant have met. A cut in payroll taxation obviously lowers the cost of labor. Improving firms' profitability favors vacancy creation in the ZFU. This cut also makes entrepreneurs less choosy when they select applicants but this effect varies according to the importance of a mismatch in "productive traits" in production (akin to a "skill mismatch" problem). As is more usual in the literature, the incentive to create jobs in the the ZFU is also limited by congestion costs. Furthermore, differences, if any, in the matching effectiveness influence the extent to which job-seekers in a given area can benefit from the rise in vacancies at the city level. Having developed and exploited analytically as far as possible the theoretical framework, we turn to a numerical exercise. A baseline calibration of the model allowed to generate an impact of payroll tax cuts on equilibrium unemployment rates that is compatible with the econometric evidence for France. Doubling the impact of mismatch on firms' output, leads to complex adjustments which all together lower the beneficial effects of tax cuts on both unemployment rates.

The paper could be improved in several ways. On the one hand, we have not studied the efficiency of the equilibrium. We could try to assess whether first the equilibrium is efficient. Then, we could try to analyze under which conditions the policy could be welfare improving but also reach the level of taxes/transfers needed to maximize net output in the city.

On the other hand, we have focused on the low-skill segment. A way to improve the model could be to add another skill segment, to study the interactions of skills and the mismatch associated.

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A The general model

With an exogenous wage and under the assumption that job separation rates q are the same for all (x, y) pairs, the value of holding a job is not a function of y but well possibly of x:

$$r\mathcal{E}_{ikj}(x) = w - c_{ik} + q(\mathcal{U}_{kj}(x) - \mathcal{E}_{ikj}(x)) \tag{27}$$

$$r\mathcal{U}_{kj}(x) = b + \varepsilon_{kj} + \mu_k p(\theta) \sum_i \frac{V_i}{V_Z + V_R} \int_0^1 \left(\max\left\{\mathcal{E}_{ikj}(x) - \mathcal{U}_{kj}(x), 0\right\}\right) B_{ik}(y|x) v_i(y) dy \tag{28}$$

$$r\mathcal{U}_{kj}(x) = b + \varepsilon_{kj} + \mu_k p(\theta) \sum_i \frac{V_i}{V_Z + V_R} \int_0^1 \left(\max\left\{\frac{w - c_{ik} - r\mathcal{U}_{kj}(x)}{r+q}, 0\right\}\right) B_{ik}(y|x) v_i(y) dy \tag{29}$$

Under free-entry, we have

$$\mathcal{J}_{ik}(x,y) = \frac{\pi_{ik}(x,y)}{r+q} = \frac{(1-t_i)\left[1 - \frac{\gamma_{ik}}{2}(x-y)^2 - w(1+\tau_i) - C_i(M_i)\right]}{r+q} \tag{30}$$

which is positive for all $\mid x - y \mid$ in $[0; \Delta_{ik}]$ with

$$\Delta_{ik} = \min\left\{\sqrt{\frac{2}{\gamma_{ik}}(1 - w(1+\tau_i) - C_i(M_i))}, \frac{1}{2}\right\} \tag{31}$$

Thus, $B_{ik}(y|x) = 1$ iff $y \in [x - \Delta_{ik}; x + \Delta_{ik}]$ and 0 otherwise. Then, (11) can be rewritten:

$$\begin{aligned} r\mathcal{U}_{kj}(x) &= b + \varepsilon_{kj} + \mu_k p(\theta) \sum_i \frac{V_i}{V_Z + V_R} \int_{x-\Delta_{ik}}^{x+\Delta_{ik}} \left(\max\left\{\frac{w - c_{ik} - r\mathcal{U}_{kj}(x)}{r+q}, 0\right\}\right) v_i(y) dy \\ &= b + \varepsilon_{kj} + \mu_k p(\theta) \sum_i \frac{V_i}{V_Z + V_R} \left(\max\left\{\frac{w - c_{ik} - r\mathcal{U}_{kj}(x)}{r+q}, 0\right\}\right) \Phi(x, \Delta_{ik}) \quad (32) \end{aligned}$$

where

$$\Phi(x, \Delta_{ik}) \equiv \int_{x-\Delta_{ik}}^{x+\Delta_{ik}} v_i(y) dy. \tag{33}$$

If the density $v(\cdot)$ happens to be symmetric around x, Φ would only depend on Δ_{ik}.

Turning to the free-entry condition, we have:

$$\frac{\kappa_i}{m(\theta)} = \sum_k \left(\frac{\mu_k U_k}{\sum_{\ell \in \{R,Z\}} \mu_\ell U_\ell} \int_0^1 \max\left\{\frac{\pi_{ik}(x,y)}{r+q}, 0\right\} A_{ik}(x|y) u_k(x) dx\right) \tag{34}$$

where $A_{ik}(x|y)$ is the probability that a type x agrees to match with a type y firm, i.e. the probability that

$$\frac{w - c_{ik} - r\mathcal{U}_{kj}(x)}{r+q} \geq 0.$$

It should be noticed that this condition is not affected by the value of y. So, we can write $A_{ik}(x)$. Let us look more closely at the probability $A_{ik}(x)$. Consider the example where the region of residence $k = Z$. Then, we have $c_{ZZ} < c_{RZ}$. So, necessarily for a given type j, we can have three cases as a function of the magnitude of $r\mathcal{U}_{Zj}(x)$:

1. $w - c_{RZ} - r\mathcal{U}_{Zj}(x) < w - c_{ZZ} - r\mathcal{U}_{Zj}(x) < 0$

$$\Rightarrow r\mathcal{U}_{Zj}(x) = r\mathcal{U}_{Zj} = b + \varepsilon_{Zj}, \tag{35}$$

2. $w - c_{RZ} - r\mathcal{U}_{Zj}(x) < 0 \leq w - c_{ZZ} - r\mathcal{U}_{Zj}(x)$

$$\Rightarrow r\mathcal{U}_{Zj}(x) = b + \varepsilon_{Zj} + \frac{\mu_Z p(\theta)}{r+q}\frac{V_Z}{V_Z+V_R}\left(w - c_{ZZ} - r\mathcal{U}_{Zj}(x)\right)\Phi\left(x, \Delta_{ZZ}\right) \tag{36}$$

3. $0 \leq w - c_{RZ} - r\mathcal{U}_{Zj}(x) < w - c_{ZZ} - r\mathcal{U}_{Zj}(x)$

$$\Rightarrow r\mathcal{U}_{Zj}(x) = b + \varepsilon_{Zj} + \frac{\mu_Z p(\theta)}{r+q}\frac{V_Z}{V_Z+V_R}\left(w - c_{ZZ} - r\mathcal{U}_{Zj}(x)\right)\Phi\left(x, \Delta_{ZZ}\right) \tag{37}$$

$$+\frac{\mu_Z p(\theta)}{r+q}\frac{V_R}{V_Z+V_R}\left(w - c_{RZ} - r\mathcal{U}_{Zj}(x)\right)\Phi\left(x, \Delta_{RZ}\right) \tag{38}$$

To find the thresholds,

- We first equate (35) and (36). This leads to the following boundary:

$$\overline{e}_Z(x) = \overline{e}_Z = w - b - c_{ZZ} \tag{39}$$

  independent of x and assumed to be in $[0, e_Z]$. For any region of residence k, $\overline{e}_k(x) = \overline{e}_k = w - b - c_{kk}$.

- Next, we look at someone who is indifferent between accepting or not an offer in the other region. For this person, we get:

$$\underline{e}_Z(x) = \overline{e}_Z - (c_{RZ} - c_{ZZ})\left[1 + \mu_Z p(\theta)\frac{V_Z}{V_Z+V_R}\Phi\left(x, \Delta_{ZZ}\right)\right] \tag{40}$$

  assumed to be nonnegative. For any region of residence k,

$$\underline{e}_k(x) = \overline{e}_k - (c_{(-k)k} - c_{kk})\left[1 + \mu_k p(\theta)\frac{V_k}{V_R+V_Z}\Phi\left(x, \Delta_{kk}\right)\right] > \overline{e}_k$$

The last definition can also be written (18).

Concerning $A_{ik}(x)$, we have:

- The probability that people living in k accept an offer in region $i = k$ is

$$A_{kk}(x) = A_{kk} = P[e \leq \overline{e}_k] = \frac{\overline{e}_k}{e_k} \tag{41}$$

- The probability that people living in k accept an offer in region $i \neq k$ is

$$A_{ik}(x) = P[e \leq \underline{e}_k] = \frac{\underline{e}_k(x)}{e_k} \tag{42}$$

Going back to the free-entry, under the assumption that the cost of opening a vacancy is not y-specific, the LHS is independent of y, we need to have that the RHS is also independent of y. We can rewrite (13) as

$$\frac{\kappa_i}{m(\theta)} = \sum_k \left(\frac{\mu_k U_k}{\sum \mu_\ell U_\ell} \int_{y-\Delta_{ik}}^{y+\Delta_{ik}} \frac{\pi_{ik}(x,y)}{r+q} A_{ik}(x) u_k(x) dx \right) \tag{43}$$

$$= \frac{(1-t_i)\left[1 - w(1+\tau_i) - C_i(M_i)\right]}{r+q} \sum_{k=\{R,Z\}} \left(\frac{\mu_k U_k}{\sum_{\ell=\{R,Z\}} \mu_\ell U_\ell} \int_{y-\Delta_{ik}}^{y+\Delta_{ik}} A_{ik}(x) u_k(x) dx \right)$$

$$-\frac{(1-t_i)}{r+q} \sum_{k=\{R,Z\}} \left(\frac{\mu_k U_k}{\sum_{\ell=\{R,Z\}} \mu_\ell U_\ell} \frac{\gamma_{ik}}{2} \int_{y-\Delta_{ik}}^{y+\Delta_{ik}} (x-y)^2 A_{ik}(x) u_k(x) dx \right) \tag{44}$$

Let $\varphi_k = \frac{\mu_k U_k}{\sum_{\ell=\{R,Z\}} \mu_\ell U_\ell}$. The derivative of (44) with respect to y should be zero. This derivative is the sum of the following terms (ignoring $\frac{(1-t_i)}{r+q}$ in front of everything):

$$\left[1 - w(1+\tau_i) - C_i(M_i)\right] \left[\varphi_i \frac{\overline{e}_i}{e_i} \left[u_i(x)\right]_{x=y-\Delta_{ii}}^{x=y+\Delta_{ii}} + \varphi_{-i} \left[\frac{\underline{e}_{-i}(x)}{e_{-i}} u_{-i}(x) \right]_{x=y-\Delta_{i(-i)}}^{x=y+\Delta_{i(-i)}} \right]$$

$$- \left[\varphi_i \frac{\gamma_{ii} \overline{e}_i}{2e_i} \left[(x-y)^2 u_i(x)\right]_{x=y-\Delta_{ii}}^{x=y+\Delta_{ii}} + \varphi_{-i} \left[\frac{\gamma_{i(-i)} \underline{e}_{-i}(x)}{2e_{-i}} (x-y)^2 u_{-i}(x) \right]_{x=y-\Delta_{i(-i)}}^{x=y+\Delta_{i(-i)}} \right]$$

$$+ \left[\varphi_i \frac{\overline{e}_i}{e_i} \gamma_{ii} \int_{y-\Delta_{ii}}^{y+\Delta_{ii}} (x-y) u_i(x) dx + \varphi_{-i} \gamma_{i(-i)} \int_{y-\Delta_{i(-i)}}^{y+\Delta_{i(-i)}} (x-y) \frac{\underline{e}_{-i}(x)}{e_{-i}} u_{-i}(x) dx \right] \tag{45}$$

We would like now to see whether the last sum is zero under the following **sufficient** conditions: $u_k(x) = 1$ (unemployed are uniformly distributed : $\int_0^1 u_k(x)dx = 1$ then) and $v(y) = 1$ (same). Then, $\Phi(x, \Delta_{ik}) = 2\Delta_{ik}$. Thus, $A_{ik}(x)$ is independent of x whether i and k are the same or not. Therefore, (45) becomes

$$\left[1 - w(1+\tau_i) - C_i(M_i)\right] \left[\varphi_i \frac{\overline{e}_i}{e_i} 0 + \varphi_{-i} \frac{\underline{e}_{-i}}{e_{-i}} 0 \right]$$

$$- \left[\varphi_i \frac{\gamma_{ii} \overline{e}_i}{2e_i} (\Delta_{ii}^2 - (-\Delta_{ii})^2) + \varphi_{-i} \frac{\gamma_{i(-i)} \underline{e}_{-i}}{2e_{-i}} (\Delta_{i(-i)}^2 - (-\Delta_{i(-i)}^2)) \right]$$

$$+ \left[\varphi_i \frac{\overline{e}_i}{e_i} \gamma_{ii} \left[\frac{(x-y)^2}{2} \right]_{y-\Delta_{ii}}^{y+\Delta_{ii}} + \varphi_{-i} \gamma_{i(-i)} \frac{\underline{e}_{-i}}{e_{-i}} \left[\frac{(x-y)^2}{2} \right]_{y-\Delta_{i(-i)}}^{y+\Delta_{i(-i)}} \right] = 0 \tag{46}$$

B Calibration

Table 1 the values of the parameters used to get the baseline results of the simulation. The endogenous variables in the baseline are provided in column 1 of Table 2.

parameters	values
μ_Z	0.62
μ_R	1
h	0.31
γ_{ZZ}	0.8
γ_{RZ}	0.8
γ_{RR}	0.61
γ_{ZR}	0.61
w	0.40
τ_Z	0.3
τ_R	0.3
t_Z	0
t_R	0
r	0.004
q	0.02
κ_Z	0.51
κ_R	0.55
e_R	0.17
e_Z	0.17
b	0.23
s_Z	0.45
s_R	0.61
N_Z	0.27
N_R	0.73
N	1

Table 1: Parameter values

C Simulation results

variables	$\tau_Z = 0.3$ γ low	$\tau_Z = 0$ γ low	$\tau_Z = 0.3$ γ high	$\tau_Z = 0$ γ high
V_R	0.0345	0.0375	0.0431	0.0462
V_Z	0.0065	0.0091	0.0081	0.0113
V	0.041	0.0466	0.0512	0.0574
θ	0.2672	0.3548	0.289	0.3685
p	0.1602	0.1846	0.1667	0.1882
m	0.5997	0.5204	0.5767	0.5107
U_R	0.1091	0.0931	0.1268	0.1111
U_Z	0.0714	0.0617	0.0813	0.0721
M_R	0.6965	0.6886	0.6732	0.6644
M_Z	0.1229	0.1566	0.1188	0.1524
$M_Z + M_R$	0.8194	0.8452	0.792	0.8168
α_{RZ}	0.7969	0.7964	0.7971	0.7967
α_{ZR}	0.7892	0.7875	0.791	0.7899
average α	0.8623	0.86	0.8629	0.8606
α_{RR}	0.9	0.9	0.9	0.9
α_{ZZ}	0.8978	0.8978	0.8978	0.8978
Δ_{RR}	0.4	0.4195	0.3215	0.3349
Δ_{ZZ}	0.35	0.3671	0.2813	0.293
Δ_{RZ}	0.35	0.367	0.2813	0.293
Δ_{ZR}	0.4	0.4196	0.3215	0.3349
u_R	0.1502	0.1282	0.1745	0.153
u_Z	0.261	0.2255	0.297	0.2634
$C_R(M_R)$	0.425	0.4201	0.4107	0.4054
$C_Z(M_Z)$	0.425	0.5416	0.4108	0.5268

Table 2: Simulation results

In Table 3, the first column describes the percentage variation of the steady-state with the baseline value of the degrees of mismatch. The second column stands for the percentage variation from its steady-state equilibrium (column 3 of Table 2) when the degrees of mismatch are doubled.

variables	γ low	γ high
V_R	8.71%	7.07%
V_Z	40.20%	39.17%
V	13.70%	12.16%
θ	32.79%	27.50%
p	15.23%	12.92%
m	-13.22%	-11.44%
U_R	-14.68%	-12.33%
U_Z	-13.62%	-11.30%
M_R	-1.14%	-1.30%
M_Z	27.42%	28.26%
$M_Z + M_R$	3.14%	3.13%
α_{RZ}	-0.07%	-0.05%
α_{ZR}	-0.21%	-0.14%
average α	-0.27%	-0.26%
α_{RR}	0.00%	0.00%
α_{ZZ}	0.00%	0.00%
Δ_{RR}	4.87%	4.16%
Δ_{ZZ}	4.89%	4.17%
Δ_{RZ}	4.87%	4.16%
Δ_{ZR}	4.89%	4.17%
u_R	-14.68%	-12.33%
u_Z	-13.62%	-11.30%
$C_R(M_R)$	-1.14%	-1.30%
$C_Z(M_Z)$	27.42%	28.26%

Table 3: Simulation results: Variation following a shock on taxes