Why is Central Paris loosing jobs?

Frederic Gilli
Insee — CERAS-ENPC — Universite Lille 1

April 2003

Abstract

Brueckner *et alii* (1999) have explained urban population through amenities distribution. Based on their model, this paper introduces a productive sector and helps to understand employment suburbanization in a new way.

Considering amenities valorisation, the "people follow jobs" vs. "jobs follow people" case is discussed for Central Business District or high-brawn services firms. If they favour natural amenities, they might leave the historical center. A big constraint against that move is that the firm wants to keep its employees who all live around the center. Despite conventional centripetal forces, they can settle in the suburbs before the households. People may than follow the firm in the suburbs.

JEL Classification: R10 - R12 - R14 - R30 - L89
Key Words: Cities, Location Choice, Suburban Areas, Multipolarization

1 Introduction[1,2]

In March 1999, the French car manufacturer Peugeot SA decided to build its design center in Velizy, located in the greater Paris area, approximately

[1]Adress: Insee Picardie, 1, rue Vincent Auriol 80040 Amiens Cedex. 33.1.44.65.99.13 – frederic.gilli@ensae.org

[2]I greatly thanks Claire Pagès and Georges Verneuil. I also thanks Hubert Jayet and Jean Cavailhès for usefull comments on previous versions of the paper.

15 km south east of Paris. Why choose Velizy ? In the Press kit the corporate management explains that the chosen location offers the best trade-off between several factors, the most important being "the direct proximity to Paris, a center of attraction for artistic creation as well as for industry, and the accessibility of the site". The site is indeed in the 'Golden Triangle' of the car industry since more and more manufacturers or vendors have moved close to this location. But corporate communication emphasises that "while the Design Center is meant to allow an efficient organisation of exchanges, it is at the same time supposed to ensure the utmost serenity to designers and engineers, since it is an essential condition for the inventiveness and the creation sheltered from the murmur of the world". Hence the site is eventually located next to a highway connection and an airport, but between the Meudon forest, the Verrieres forest and the Versailles forest.

The tension underlying the trade-off appears clearly. A high brawn services firm needs to be close to its source (artists, congress, competitors and vendors) but in a protected and quiet place. The firm primarily optimises the employee productivity in a branch where it is highly dependent on the environment. If we use the typology defined by Brueckner et alii (1999), the firm chooses between *modern amenities* whose level depends on the local economic environment and *natural* (or *historical*) *amenities* that depend on the surrounding landscape.

The relationship between the location choice of a firm and the amenities may even be stronger if this firm considers its employees utility. If the latter favour natural amenities, as Brueckner at alii assume it, than a firm may chose to relocate a plant to improve the utility of its employees and then to benefit from it. In 2002 Peugeot relocated as well part of its headquarters from central Paris to Poissy, 30km west: one point worth mentionning about this choice is that the company offered its employees to finance part of the housing for those who would follow the firm and buy a residence in this remote suburb. One major argument was the new vicinity to natural amenities. In this particular case the firm relocates although it does not expect any increase in productivity; it relocates because it has lower costs in the suburbs and it can take advantage of the increase in its employees utility.

Those two specific examples pinpoint the role of amenities in the location choices of the firms, should it be direct or not. Of course they both concern a single company. But this case is not seldom: in the second section, I will deal with the overall evolution of the employment location in Greater Paris. The rise of Secondary Employment Centers (SEC) but also that of the unclustered

suburban jobs is striking over the last 25 years. If Central Paris is still rich, it looses more and more jobs and owns a smaller share of highskilled ones. This result needs a theoretical perspective also provided in that section.

Few model tackle the employment suburbanization in ways that can explain that firms decide to relocate in the suburbs even though people still live in the Center. Section 3 develops a model based on amenities as a generalisation of Brueckner et alii (1999) integrating one productive sector. As in the original model there are two populations, one rich and the other poor. The poor are assumed to work in a sector evenly distributed over the city while the rich work in the Central Business District (CBD). We focus on the choices of the firms located in the CBD in relationhip with the choices of the rich population, knowing that the latter are interactively determined with the constraints imposed on the poor. A firm will integrate as a constraint that all their employees must remain with them, that is to say the utility of the employees in the new location must be at least equal to the utility they enjoyed before the move. We will use a backward resolution - each firm first assesses the choice of their employees to eventually follow the company or to remain in the CBD. Considering the anticipated population pattern, the firm derives the constraints that bind its choice, namely the necessity to keep its employees, and then decides to leave or not.

We show that as long as the firms hardly value the natural amenities we are in a classical framework - the households leave before the firms who can decide to follow them. But as soon as firms are significantly sensitive to the centrifugal forces created by the attraction of a green working environment, then they can be the first to leave the center. Households can then be led to follow the firms if the change of work location drastically modifies their residential trade-offs or they can stay in the center if they still have a greater preference for the center relatively to the poor.

We will study the various possible scenarii in section 4 before concluding in section 5.

2 The rise of suburban employment

Whatever the logics lying behind it, the case of Peugeot is not seldom. Between 1975 and 1999, central Paris has lost more than 15% of its jobs, from

Place	1975		1982		1990		1999		1975-1999	
	People	share	People	share	People	share	People	share	Evolution	(%)
Paris	1 918 060	**36,3%**	1 775 993	33,5%	1 796 378	31,4%	1 600 815	**27,7%**	**-317 245**	**-16,5%**
Inner Ring	1 437 600	27,2%	1 420 356	26,8%	1 514 782	26,5%	1 535 695	26,6%	98 095	6,8%
Empl. Centers	1 032 690	**19,5%**	1 174 172	22,1%	1 355 403	23,7%	1 422 404	**24,6%**	389 714	**37,7%**
Suburbs	900 100	**17,0%**	938 068	17,7%	1 051 876	18,4%	1 222 140	**21,1%**	322 040	**35,8%**
Total G.Paris	5 288 450	100,0%	5 308 589	100,0%	5 718 439	100,0%	5 781 054	100,0%	492 604	9,3%

Figure 1: Evolution of the employment in Greater Paris

1,918,060 down to 1,600,815 jobs (figure 1[3]). Meanwhile the inner ring has grown 6.8%, suburban areas 35.8% and suburban employment clusters 37.7%. Finally the employment distribution in the greater Paris area has completely changed, since Paris 'intra-muros' now represents twice as less as what it used to in the early 1960's. The city now weights 27.7% of all the jobs in the region against 36.3% twenty five years ago. Employment today is almost evenly distributed between the center, the inner ring (26.6%), the suburban clusters (24.6%) and the suburban areas (21.1%). On the one hand, some SEC have grown very fast. Most of the 'New Towns' of the Paris Area and the new Airport area have experienced very high growth rates, from 100% up to 650%. On the other hand one should notice the importance of unclustered employment. Although the suburbanisation of jobs does not automatically translates into the apparition of 'Edge cities' as described by Garreau (1992) in the American context, this movement impacts all occidental cities including those known to be very monocentric such as Paris.

While households massively moved from the centers of occidental cities to their remote suburbs, suburbanisation also impacted employment. Since Mills (1972) a lot of studies have shown this trend of leaving the centers of the cities, and they all wondered whether "jobs follow people" or "people follow jobs" (Steinnes (1982)).

The first scenario belongs to the classical analysis framework - jobs leave the center when the costs of accessing the city center become too high. When the city grows, the average distance to the center increases and the transportation costs tend to increase drastically. A suburban location enables to

[3]Sources : Insee, Recensements. The greater Paris area encompasses the Ile-de-France region and the first ring of clusters around it.

save on real estate and transportation costs. Following the mere action of conventional centripetal and centrifugal forces, it can be profitable for a firm to leave the center despite the advantages it entails (greater chalandise zone, agglomeration externalities) and to locate in the residential suburban area.

The second scenario, where a firm leaves the center to locate in an empty place where there is no jobs nor households, is less often addressed in literature. The natural outcome of centripetal and centrifugal forces being as presented above, it is obvious that one cannot consider a firm locating in a totally virgin place without introducing external effects. Fujita (1985) pinpoints two axes to address that question: competitive models with externalities and non competitive models with scale effects.

In the latter, suburbanisation relates to imperfect competition mechanisms either on the goods market or on the real estate market. On the one hand Fujita et alii (1997) studied the case where it can be profitable for a firm to locate in an empty area as long as it has enough influence on the good market to be assured that its employees and commercial partners will follow. On the other hand, Hendersen and Mitra (1996), following a long tradition of papers, built a model about the real estate market. It assumes the existence of a public or private developer who is able to anticipate the effect of its decisions on the land use pattern. If he believes he can attract enough firms and then enough households, he will build a secondary center where firms will locate primarily.

The first axis put forward by Fujita (1985) encompasses seven versions. Two of them relate specifically to firms. He first suggests to vary the type of externalities affecting the different agents of the economy and then to use models with several economic sectors. As each sector has a different approach to urban space, the needs are different across sectors and location choices are very likely to be different as well.

Usually, a functionnal core-periphery organisation is assumed within the cities. White collar jobs mostly locate around the CBD, whereas blue collar ones are in the suburbs. Indeed, what Duranton and Puga (2002) notice for huge economic regions is even more relevant within a metropolitan area. In 1999, Paris stands for 28% of white collar jobs and for 17% of the blue collar ones. At the same time 11% of the white collars and 31% of the blue ones are located in the remote suburbs. But the dynamics behind this snapshot is that the center is becoming less and less dominant; twenty five years ago, Paris accounted for half of the highskilled jobs of the area. Hence the rise of white collar jobs has been of 45% in Central Paris (130,000 jobs) while it

Types of workers*	Place	1975		1982		1990		1999		Evolution 1975-1999		Evolution of the share (pts
		People	share	People	share	People	share	People	share	Number	%	
Entrepreneurs, shop keeper	Paris	102409	31%	101980	29%	98522	28%	83898	28%	-18511	-18,1%	-3,7pts
	Inner Ring	80989	25%	85444	24%	84161	24%	72941	24%	-8048	-9,9%	-0,8pts
	Empl. Centers	59614	18%	67776	19%	68727	20%	61139	20%	1525	2,6%	1,9pts
	Sub-total	*243012*	*74%*	*255200*	*73%*	*251410*	*72%*	*217978*	*72%*	*-25034*	*-10,3%*	*-2,6pts*
	Suburbs	83294	26%	96728	27%	99265	28%	85402	28%	2108	2,5%	2,6pts
	Total G.Paris	326306	100%	351928	100%	350675	100%	303380	100%	-22926	-7,0%	-
White collars	Paris	289330	49%	357304	46%	417213	40%	420393	36%	131063	45,3%	-12,9pts
	Inner Ring	155910	26%	210680	27%	285631	28%	370946	32%	215036	137,9%	5,4pts
	Empl. Centers	95207	16%	135016	18%	191643	19%	245101	21%	149894	157,4%	4,9pts
	Sub-total	*540447*	*91%*	*703000*	*91%*	*894487*	*86%*	*1036440*	*89%*	*495993*	*91,8%*	*-2,5pts*
	Suburbs	50223	9%	66324	9%	139872	14%	128469	11%	78246	155,8%	2,5pts
	Total G.Paris	590670	100%	769324	100%	1034359	100%	1164909	100%	574239	97,2%	-
Grey collars	Paris	374961	38%	363920	33%	367708	29%	379925	27%	4964	1,3%	-10,6pts
	Inner Ring	299976	30%	325400	30%	326649	26%	401004	28%	101028	33,7%	-1,6pts
	Empl. Centers	193723	19%	250088	23%	274772	22%	372941	26%	179218	92,5%	7,0pts
	Sub-total	*868660*	*87%*	*939408*	*86%*	*969129*	*77%*	*1153870*	*82%*	*285210*	*32,8%*	*-5,2pts*
	Suburbs	128392	13%	159044	14%	285043	23%	255395	18%	127003	98,9%	5,2pts
	Total G.Paris	997052	100%	1098452	100%	1254172	100%	1409265	100%	412213	41,3%	-
Pink collars	Paris	795567	48%	694800	42%	572283	36%	507580	31%	-287987	-36,2%	-16,9pts
	Inner Ring	384934	23%	385384	23%	362148	23%	405642	25%	20708	5,4%	1,6pts
	Empl. Centers	304397	18%	357428	22%	353984	22%	415586	25%	111189	36,5%	7,0pts
	Sub-total	*1484898*	*89%*	*1437612*	*87%*	*1288415*	*80%*	*1328808*	*81%*	*-156090*	*-10,5%*	*-8,3pts*
	Suburbs	177567	11%	207176	13%	315979	20%	310526	19%	132959	74,9%	8,3pts
	Total G.Paris	1662465	100%	1644788	100%	1604394	100%	1639334	100%	-23131	-1,4%	-
Blue collars	Paris	358551	22%	289828	20%	247913	19%	170792	17%	-187759	-52,4%	-5,1pts
	Inner Ring	515784	31%	412624	29%	337815	26%	252790	24%	-262994	-51,0%	-6,7pts
	Empl. Centers	383118	23%	362272	26%	338386	26%	294684	28%	-88434	-23,1%	5,4pts
	Sub-total	*1257453*	*76%*	*1064724*	*75%*	*924114*	*72%*	*718266*	*69%*	*-539187*	*-42,9%*	*-6,4pts*
	Suburbs	399903	24%	354516	25%	364079	28%	316054	31%	-83849	-21,0%	6,4pts
	Total G.Paris	1657356	100%	1419240	100%	1288193	100%	1034320	100%	-623036	-37,6%	-

Figure 2: Geographical setting of the main types of jobs in Greater Paris

has reached 150% in the suburbs and in the SEC (230,000 jobs).

As it appears in Table 2, Central Paris has also lost a huge amount of pink and blue collar jobs. This has partly been studied by Ota and Fujita (1993). In this paper we focus on the specific needs of top services firms or high brawn firms and try to explain why more and more choose not to locate in the Center.

3 The model

Highbrawn services or high technology firms do not belong to those firms whose competitiveness mostly depends on their ability to produce at least costs. Of course production costs are part of the decision making but the survival of the firm even depends on its capacity to innovate. When choosing its location, the firm takes this constraint into account by using productivity based criteria rather than more conventional ones. With the Peugeot-Velizy case, the issue of the commuting costs for employees, which is a traditional centripetal force in urban economics, was not addressed - the location choice was purely industrial. From the strict point of view of the economic modelling that underlies this location choice, we face here a partial equilibrium framework.

It is nevertheless possible to get a general equilibrium framework that integrates households using a different method. As the Peugot-Poissy case shows it, the firm is linked to its employees - they have been trained internally, they are integrated in working teams and often they detain informations that are strategic for the firm competitiveness. Employees can be seen as endowed with a human capital the firm cannot afford to waste. Still in the car industry, Renault, another major actor in the sector, made the same decision as Peugeot to move its technical center to the suburbs of Paris. Asked about the constraints that had prevailed in their location decision, the head of the corporate transportation policy declared that "the high priority goal when creating the Technocentre was not to lose any employee, unless the value of the company would have dropped". Without any market power, a single firm can not forecast if its competitors will relocate or if they will remain in the Center. Thus leaving the Center while its employees and its competitors still locate in here increases the loss of employees probability. So, the firm is led to integrate into its decision not only the transportation costs but also elements of lifestyle and anything that takes part in the employees utility. It

can range from the size of the housing they can afford at a given distance from their work location (as in the classical Alonso-Mills-Muth case) to the whole list of amenities valued by households (as in the framework defined by Brueckner et alii, (1999)).

3.1 The population pattern

The city in which the model is built is linear and is granted exogenous amenities, both *natural* and *historical* that are unevenly distributed in the space. We keep the definition by Brueckner et alii (1999) that "historical amenities are created by monuments, buildings, parcs and other inherited infrastructures that are valued by the current inhabitants of the city" whereas natural amenities are created by the site and the non urban environment it offers[4]. By convention, we will consider that *natural* amenities are increasing with the distance from the center ($a'_n(x) > 0$) and *historical* amenities are decreasing ($a'_h(x) < 0$), their sum being so that overall amenities are higher in the center than in the suburbs ($a'(x) < 0$).

Brueckner et alii(1999) use that typology to show to what extent the relationship between the population pattern and the incomes depend on some idiosyncratic characteristics of a city. That way they demonstrate that if the marginal value of amenities increases faster with income than the consumption of housing, then a high enough level of amenities can by itself determine the equilibrium between living in the center or in the suburbs. Whereas in the classical model (Alonso- Mills- Muth) the rich prefer the suburbs more than the poor do, the introduction of central amenities that the rich value more than the poor do leads to reverse the population pattern of the city. As an illustration they justify by the wealth of the historical landmarks the fact that Central Paris is rich whereas down-town Detroit is poor as are the typical suburban American cities.

Ex-ante the city we consider has a segregated population of rich and poor distributed around the center. To each type of agent corresponds a type of jobs that are spread a certain way in the city. Under some assumptions (see below) the size of the city does not depend on the population pattern.

The rich work in the CBD. We assume the location of the blue collar jobs unchanged, namely in the center of the city. We define t_0 as a rate for the

[4]Obvisouly, at least in Europe, no natural amenity is to be found in its primary form but all bear more or less a human mark. They are *green* amenities rather than *natural*.

transportation costs that is linear with the distance d from the residence to the city center [5]. Hence, the poor have the same budget constraint as in the model of Brueckner et alii (1999). The cost of their consumption of goods e, the price of which is normalized to 1, and of housing pq, cannot be higher than their income y taken net of transportation costs $t_0 x$:

$$e + pq = y - t_0 x.$$

Their utility depends on the consumption of e and q and on the amenities a. To meet a benchmark level u^*, their utility $u(e, q, a)$must verify

$$u^* = \max_q u(y - t_0 x - pq, q, a). \tag{1}$$

The utility of the rich has the same form as in the paper mentioned above. Their transportation costs are a linear function of their commuting distance with coefficient t_1. We just have to replace t_0 with t_1 in the above equation and modify the functional form of $u(.)$ to obtain the condition met by the utility of the rich. If the CBD is in the center (case C), the situation is the one described by the authors, otherwise (case S) the centripetal force of professional travels become an additional centrifugal force. We thus can rephrase the results obtained by the authors while differentiating the two cases.

Case C corresponds exactly to the framework defined by Brueckner et alii (1999). The solution is obtained using the same method. If $\widehat{x}$ is the border between the residential area of the rich and that of the poor, the bid rents offered by both populations at that point must be equal and $p_0(\widehat{x}) = p_1(\widehat{x})$. The population left of the border will be the one who offers the highest bid rent; so the population pattern will depend on the differentials of the bid rent the two populations at $\widehat{x}$. Using equation 1, the differential of the bid rent for the rich when the CBD is in the center is as follows

$$p'^C_1(x) = -\frac{t_1}{q^C_1(x)} + \frac{u(a)}{q^C_1(x)\, u(e)} a'(x),$$

[5] More precisely, we assume that the transportation cost pattern is unchanged, which is more consistent with what is observed: if blue collars tend to live closer to their work location than the white collars do (Glaeser et Kahn (2000)), the marginal transportation cost increase with distance to CBD. For instance in the Greater Paris Area, employers pay for a part of the transportation expenses of their employees and the marginal transportation price is all the higher since one is far from the center.

that is

$$p'^{C}_{1}(x) = -\frac{t_1}{q^C_1(x)} + \frac{v^a\left[y_1 - t_1 x, p^C_1(x), a(x)\right]}{q^C_1(x)} a'(x). \tag{2}$$

In the above equation the ratio $\frac{u^a}{u^e}$ is written $\frac{\partial v}{\partial a}$ where v is the indirect utility function. v^a gives the marginal value of amenities after the optimal adjustment of housing consumption. In the standard model $v^a = 0$. It must be pointed that the optimal housing consumption depends on the budget constraint of households. As a consequence it is sensitive to the location of the CBD in the center or in the suburbs and $q^C_1 \neq q^S_1$. Obviously, the results of Brueckner et alii (1999) on the shape of the bid rents are verified, that is to say when $a' < 0$ the traditional effect is strenghened. When $a' > 0$ discussions are possible and the effect of conventional forces can be overcome if a' is positive and high enough. We can now compare the differential rents. We assume $y_0 < y_1$, $t_0 < t_1$ and $p_0 \neq p^C_1$ but $p_0(\widehat{x}) = p^C_1(\widehat{x})$,

$$\Delta \equiv p'^{C}_{1}(\widehat{x}) - p'_0(\widehat{x}) = \frac{t_0}{q_0(\widehat{x})} - \frac{t_1}{q^C_1(\widehat{x})} + A.a'(x), \tag{3}$$

$A = \frac{v^a\left[y_1 - t_1\widehat{x}, p^C_1(\widehat{x}), a(\widehat{x})\right]}{q^C_1(\widehat{x})} - \frac{v^a\left[y_0 - t_0\widehat{x}, p_0(\widehat{x}), a(\widehat{x})\right]}{q_0(\widehat{x})}$ assumed by the authors to be positive provided a few assumptions that we can keep without hurting the model.

Comparing a benchmark situation to a city having amenities spread more evenly, the authors show that two solutions are possible. Either the traditional result remains i.e the rich are in the suburbs (provided that $\frac{t_0}{q_0} > \frac{t_1}{q_1}$), either the result is new i.e the amenities in the center are so that the rich live in the center since they value the amenities relatively to the the housing surface more than the poor.

In case S, when the CBD is in the suburbs ($\underline{x}_S$), the utility of the rich is written $u\left(y'_1 + t_1 x - p^S_1 q^S_1, q^S_1, a\right)$, with $y'_1 = y_1 - t_1\underline{x}_S$. With the same computation as above we obtain

$$p'^{S}_{1}(x) = \frac{t_1}{q^S_1(x)} + \frac{v^a\left[y'_1 + t_1 x, p^S_1(x), a(x)\right]}{q^S_1(x)} a'(x).$$

When the CBD is in the suburbs, transportation costs, a crucial conventional force, become centrifugal. Under those conditions, the only centripetal force for the households are the amenities and since $u(a(x))' = u^e v^a\left[y'_1 + t_1 x, p^S_1(x), a(x)\right] a'(x)$,

$$p'^{S}_{1}(x) < 0 \Leftrightarrow u(a)' < -u^{e}t_{1}.$$

The marginal change in utility arisen from the amenities must be lower than the drop in utility implied by the increase of transportation costs. Written as a function of $a'(x)$, that constraint means that the level of amenities must decrease faster than the transportation costs relatively to the marginal value of the amenities : $a'(x) < -\frac{t_1}{v^a\left[y'_1+t_1 x, p_1^S(x), a(x)\right]}$.

It is the case if the amenities are very unevenly spread (strong slope) or if they are highly valued (high v^a and low ratio).

The utility of the poor remaining unchanged, the comparison of the differential rents at $\widehat{x}$ is following

$$\Delta \equiv p'^{S}_{1}(\widehat{x}) - p'_{0}(\widehat{x}) = \frac{t_0}{q_0(\widehat{x})} + \frac{t_1}{q_1^S(\widehat{x})} + A.a'(x).$$

The rich will be in the center ($\Delta < 0$) only if the amenities are very unevenly spread (a' negative and high absolute value), that is, if the historical amenities are by far superior to the natural amenities so that amenities overall decrease with the distance from the center. For all other values of a' the rich will be in the suburbs.

The initial configuration corresponds to case C since the CBD is in the center. When dealing with the relocation of a firm, case S will be used to assess the impact of the change on the population pattern in the city and to assess whether the relocation will actually occur or not. Indeed the decisions of the firm partially depend on how the households are supposed to react after their employer has moved to the suburbs.

3.2 The choice of the firm

Here we consider only the high brawn services or high technology firms. All the other jobs, those that are not specific to the CBD, are evenly distributed in the space and not mobile. The CBD is composed of firms that produce exportable goods using merely their L employees. There is no differential exportation costs within the city and the consumption of equipment and real estate is supposed neglectible for our purpose. Production thus just depends on work, whose efficiency is impacted by the distance to other similar firms

(agglomeration externalities caprtured by g_d) and by the working environment g_a.

$$f(a,d,L) = (g_a(x) + g_d(x))\,L.$$

Note that if we assume that g_a and g_d are linear and $g_a(x) = \beta$ and $g_d(x) = \alpha|x - \underline{x}|$, $\underline{x}$ being where the CBD is located, we stand in the linear case decribed by Fujita and Thisse (1997) when all firms are concentrated in one point, here $\underline{x}$ ($\underline{x} \in \{0, \underline{x}_S\}$). In that case, $g'_a = 0$ and the classical results of Fujita and Ogawa (1980) and Imai (1982) stand that only one equilibrium exists and it is either monocentric, mixed or not completely mixed. Introducing amenities prevents mixed equilibriums from occurring as soon as firms and households do not value these amenities the same way.

Every firm then looks for the location that maximizes its profit

$$\pi(x) = r(g_a(x) + g_d(x))\,L - (y_1 - tx)\,L,$$

under the constraint that no employee leaves the firm. To express that constraint implies a set of assumptions on the firms behaviour that impact the decision making process and its outcome. First we assume that all the firms are identical. As a consequence a firm knows that if it is profitable to leave the center on an individual basis, it will be the case for all the other firms. But they cannot coordinate their decisions since they are in an imperfect information context. Two cases can occur :

Case 1 : It is not profitable for the firm to move. Nobody finds incentives to move so the CBD stays where it is.

Case 2 : It is profitable for a particular firm to relocate even though the CBD does not move. The firm moves and so do the CBD.

In all the cases, a firm taken individually is able to anticipate the future location of the CBD. Thus it is able to compute the utility of its employees in the future configuration. Keeping its employees comes down to $u(x, \underline{x}_S) \geq u(x, \underline{x})$.

Given the fact that a firm leaves, the reaction of the households will be considered in the framework S described in the previous section. The differential rent offered by the rich will be p'^S_1. Since a change in the conditions of the rich does not impact the condition of the poor, we know that $p^S_1(\widehat{x}) = p_0(\widehat{x}) = p^C_1(\widehat{x})$ and $q^S_1(\widehat{x}) = q^C_1(\widehat{x})$. We can then write $p'^S_1(\widehat{x})$ as a function of $p^C_1(\widehat{x})$:

$$p'^{S}_{1}(\widehat{x}) = \frac{t_1}{q^{S}_{1}(\widehat{x})} + A.a'(x) = p'^{C}_{1}(\widehat{x}) + 2\frac{t_1}{q^{S}_{1}(\widehat{x})}.$$

with $\frac{t_1}{q_1(\widehat{x})} > 0$, $p'^{S}_{1}(\widehat{x}) > p'^{C}_{1}(\widehat{x})$.

In addition, since the rich are in the center, we know that $p'_0(\widehat{x}) > p'^{C}_{1}(\widehat{x})$. Therefore the question is whether $p'_0(\widehat{x}) > p'^{S}_{1}(\widehat{x}) > p'^{C}_{1}(\widehat{x})$ or $p'^{S}_{1}(\widehat{x}) > p'_0(\widehat{x}) > p'^{C}_{1}(\widehat{x})$. In the former case, the rich stay in the center although the jobs have moved to the suburbs. In the latter they choose to move if the CBD moves to the suburb. In all cases

$$\Delta_C \equiv p'^{C}_{1}(\widehat{x}) - p'_0(\widehat{x}) < p'^{S}_{1}(\widehat{x}) - p'_0(\widehat{x}) \equiv \Delta_S,$$

and the rich stay in the center if $\Delta_S < 0$.

The move of the CBD weakens the power of attraction of the center by reversing the direction of the traditional force - transportation costs. The amenities must be particularly high in the center (a' negative with a high absolute value) to have the households stay in the center when the firms have decided to leave. The constraint upon the firms therefore depends on the distribution of the amenities.

If a' is negative and very high in absolute value, firms anticipate that the employees will stay in the center even though the firm leaves to x_S. The firms must take it into account and pay the employees $y - t_1(\widehat{x} - x - x_S)$ and no longer $y - t_1 x$.

The profits are supposed monotonous with respect to x (which entails that g_a et g_d are linear) hence the firms are led to consider corner solutions at 0 and at x_S which corresponds to the city edge. As conditions of competition remain unchanged, y_1 does not change and firms will relocate if and only if

$$\begin{aligned} \pi(0) &= f(a(0), d(0), L) - (y_1 - t_1 x) L \\ &\leq f(a(x_S), d(x_S), L) - (y_1 - t_1(\widehat{x} - x - x_S)) L = \pi(x_S). \end{aligned} \tag{4}$$

If we assume that q is constant on $[0; \widehat{x}]$ and that employees of a given firm are mixed in the population; then they will be evenly distributed on this interval. One can then state $x \equiv \frac{\widehat{x}}{2}$. Using this equivalence in equation 4 and simplifying by L; we can write the above condition as following:

$$\pi(0) \geq \pi(x_S) \Leftrightarrow g_a(x_S) \geq g_a(0) - g_d(x_S) + t_1 x_S.$$

Since $g_d < 0$ and since we supposed g_a monotonous, the above condition is in contradiction with the original condition that a' is highly negative for the households. In order for the firms to decide to leave, knowing the employees will stay in the center, the way they value the amenities must be different from the way households value them. If the firms value poorly the historical amenities but value highly the natural amenities, the scenario becomes possible. The sensitivity of the firms productivity to amenities can theoretically be applied for natural as well as historical amenities. It seems though that if firms value *historical* amenities for extraordinary events (congress, salons), they do not pursue them on a daily basis whereas it can be the case for *natural* amenities[6]. Therefore it is realistic to make the assumption that firms do not value historical amenities and that $g_a(x) = a_n(x)$. Under that condition, the case just above is possible if natural amenities are unevenly spread (a'_n high and positive). This result is symmetric to the one of Brueckner et alii (1999) where the condition for reversing the population pattern is that the historical amenities are highly valued by households and that a' is high in the negative values.

Proposition 1 *If the households valuation for amenities is strongly decreasing from the center, then no firm will leave the center but those which favour productive exogenous amenities.*

If a' is not strongly negative or even positive, yet low enough to keep the rich households in the center, then the firms can expect that their employees will follow them if they move to the suburbs. Since the firms cannot coordinate their decisions, they assume the CBD won't move. It is only when it is profitable for every single firm to move individually while the others are assumed stable, that all firms will leave and the CBD will relocate. Nevertheless the firms anticipate that their employees are ready to follow them.

Everything else being equal, the employees are ready to pay $p_1^S(x)$ $(\forall x > \widehat{x})$ and eventually pay $p_0(x) < p_1^S(x)$. The firms capture that rent and add it to their profit and deduct from the salaries $\delta_p = \int_{\widehat{x}}^{x_S} p'^S_1(x) - p'_0(x)\,dx$ which is positive.

Also, the employees enjoy different amenities once they relocate. The firms make up for the loss that corresponds to the difference between the average dispositions to pay on $[0, \widehat{x}]$ and on $[\widehat{x}, x_S]$, that is

[6] The only activites for wich the historical environment can prevail are those of head offices. We can notice that they are almost the only ones to remain in majority concentrated in the cores of the great cities (Abu-Lughod, 1999)

$$\delta_v = \int_0^{\widehat{x}} v^a \left[y_1 - t_1 x, p_1^C (x), a (x) \right] dx - \int_{\widehat{x}}^{x_S} v^a \left[y_1' + t_1 x, p_1^S (x), a (x) \right] dx.$$

As we set a' as negative, δ_v is negative as well.

The services firms will chose to relocate to the suburbs if

$$\begin{aligned} \pi (0) &\equiv g_a (0) - y_1 + t_1 \frac{\widehat{x}}{2} \\ &\leq g_a (x_S) + g_d (x_S) - \left(y_1 - t_1 \frac{x_s - \widehat{x}}{2} - \delta_p + \delta_v \right) \equiv \pi (x_S) . \end{aligned}$$

The commuting costs of the firm is $t_1 \frac{x_S - \widehat{x}}{2}$ and will be greater or smaller than $t_1 \frac{\widehat{x}}{2}$ depending on whether the total surface occupied by the poor will be greater or smaller than the one occupied by the rich. The size of the poor population can be normalized so that the surface they occupy is equivalent to the one occupied by the rich. The condition for the firms to leave can be written as follows

$$g_a (x_S) - g_a (0) \geq -g_d (x_S) - \delta_p + \delta_v.$$

We verify that the agglomeration externalities are a hurdle to the suburbanisation of jobs since if $g_d = 0$ the condition is smoother.

So the existence of amenities for the households modifies the traditional equilibriums even in the absence of amenities for the firms. If the difference of the compensations linked to the different opportunity costs δ_p and δ_v overcome the effect of agglomeration externalities, the second term is negative and the condition is verified including for g_a constant.

At the core of this mechanism are the opportunity costs. We can easily verify it using equation (2) et (3) and keeping the assumption that $x_S = 2\widehat{x}$. Transportation costs are cancelled out in the new expression of δ_v.

$$\delta_v = \int_0^{\widehat{x}} \frac{q_1^C p'^C_1 (x)}{a' (x)} dx - \int_{\widehat{x}}^{x^S} \frac{q_1^S p'^S_1 (x)}{a' (x)} dx.$$

If the amenities are unevenly spread from the center, it translates in a' negative and increasing and δ_v positive. The compensation that makes up for the degradation of the households lifestyle is all the higher since the amenities decrease rapidly with the distance from the center. From the households point

of view, these are the expected mechanisms that lead the rich to concentrate in the center only if the amenities are high and unevenly distributed.

Despite their similarities, the conditions for the firms can be considered as less restrictive than the ones for the households. Indeed a firm that anticipates higher profits in the future configuration can move to the suburbs in order to provoque the new configuration although the households have not moved yet. To demonstrate it just turn back to the consequences of the mere introduction a productive sector on the residential equilibrium. We then consider the case when firms are indifferent to amenities i.e $g_a = 0$. In the absence of amenities and in order for the firms to move to the suburbs; we need the second term of the inequality to be negative. The sign of $-\delta_p + \delta_v$ depends on the relative value of $\frac{t_0}{q_0} - \frac{t_1}{q_1}$, $\frac{v^a\left[p_1^S\right]}{q_1} - \frac{v^a[p_0]}{q_0}$ assumed positive following Brueckner et alii (1999) and on $v^a\left[p_1\right] - v^a\left[p_0\right]$ which is negative. If the consumption of land by households is high enough relatively to the marginal indirect utility of amenities, then it is possible to obtain $-\delta_p + \delta_v < 0$. The lower the agglomeration externalities, the more easily this case will occur. It corresponds to the scenario where rich households live in the center and move to the suburbs because the firms have moved there.

Here we have reached an important point: the mere introduction of a strategic productive sector can lead households who live in the center to "follow the jobs". Firms that anticipate the relocation of the households can decide to relocate and take advantage of opportunity costs that are likely to increase to their own benefit.

What we show here is that even though rich households are located in the center due to important historical amenities, firms can nevertheless decide to move to the suburbs. The initial condition is all the easier to achieve since g_a increases sharply. It is the case if firms and households value the exogenous amenities differently and if the former especially value natural amenities. Firms will be more and more encouraged to leave to the suburbs since the natural amenities grow.

Proposition 2 *If firms value amenities so that $g_a' > 0$ or if the agglomeration externalities are balanced by high enough opportunity costs, then suburbanisation can involve first the jobs then the people.*

4 Configurations

There are two steps in the resolution of the model. In a first phase the households choose where to locate considering that the CBD is in the center. At that stage we are in the case described by Brueckner et alii (1999). In a second step, firms consider a relocation to the suburbs and anticipate how the households will react to the potential suburbansiation of their jobs. The firms decision is a backward resolution game: since each firm has to keep its human capital unchanged, we first settle the choices of the households according to the relocation plans of the firms and then figure out the decisions of a firm given those anticipations.

In that regard, eight outcomes are possible :

(1) the rich are in the suburbs and the firms stay in the center without impacting the households choices.

(2) the rich are in the suburbs and the firms stay in the center; which leads the rich to move to the center

(3) the rich are in the suburbs and the firms move from the center to the suburbs and the rich stay in the suburbs

(4) the rich are in the suburbs and the firms move from the center to the suburbs; which leads the rich to move back to the center.

(5) the rich are in the center and the firms stay in the center and the rich stay in the center.

(6) the rich are in the center and the firms as well but the rich finally decide to move to the suburbs.

(7) the rich are in the center and the firms move from the center to the suburbs but the rich stay in the center.

(8) the rich are in the center and the firms move from the center to the suburbs; the rich follow them to the suburbs.

Case 1 is the traditional American CBD model. Households value amenities but the advantage of the center is poor (a' slightly negative or even positive). The firms are kept in the center due to the modern amenities.

Case 3 is the model described in the literature illustrating that "jobs follow people" which affects all the western cities. It occurs when households value amenities in such a way that the rich move to the suburbs. The suburbanisation of employees enables the suburbanisation of jobs. In that case, the modern amenities that keep a firm in the center, although the employees would be more productive in the suburbs, is cancelled out by the change in the transportation costs. Usually a centripetal force, transportation costs

are here a major centrifugal force. So, even in the absence of amenities for the firms, the move from the CBD is possible.All the firms being the same, the CBD then leaves the center for the suburbs.

Case 5 is the historical model for Paris. It is characterised by strong central amenities valued by households, reinforced for the firms by a massive lock-in phenomenon incurred by modern amenities.

Case 7 is the atypical Silicon Valley model with a technopole around a historical city. Central amenities are strong enough to keep households in the center even after the firms leave the CBD. The firms are more sensitive to natural amenities than to modern amenities so they decide to leave despite the negative opportunity costs and the potential lock-in phenomenon. Note that in the long run, this case is not necessarily stable: the only reason that makes the firm ready to pay for the commuting costs of remote employees is the link between a single employee and the human capital it represents. It thus could be interesting to consider the influence of the rate of turn-over on the pertinence of the case.

Case 8 is the model according to which "people follow jobs". Firms proceed similarly as in case 7 but it results here in having the households follow the jobs to the suburbs. Employees do not value the center enough to resist the opportunity to leave for the suburbs and stop being penalized by lower net salaries. The move is anticipated by the firms and makes it all the more likely for the them to relocate to the suburbs. Most of the metropolitan area face such dynamics. It partly corresponds to the case described inintroduction.

Let us note that case 4 occurs only if the CBD consumes a lot of space or produces negative amenities (pollution, congestion,...) so that its relocation leads to the eviction of the households from the suburbs. The scenario is quite unrealistic for services firms. Finally case 2 and 6 are absurd.

5 Conclusion

The model presented here highlights how the pursuit of a certain lifestyle and working environment can impact the urban equlibriums (poulation pattern and CBD location). Its orignality resides in the introduction of a productive sector in addition to the households. It takes for granted the results of Brueckner et alii (1999) and specifies the conditions under which a strategic location choice for firms including amenities valuation of both firms and

households changes the traditional equilibriums.

This general approach allows us to list the potential dynamics and the population patterns they lead to. Among others, we consider the "people follow jobs" versus "jobs follow people" alternative and consider as possible to have firms choose suburbanisation before the households either because they favour natural amenities or because the opportunity costs related to the anticipated relocation of households are enough by themselves to have the firms relocate.

More than the multipolarisation of cities the model helps understand the spreading of jobs. Indeed the firms are unable to coordinate their actions. They can never provoque a move of the CBD, nor anticipate a shift in the modern amenities distribution: that would be characteristic of a suburban cluster model rather than of a suburban spread model. Therefore the model explains why some firms chose to leave the otherwise highly valued central cities (inner Paris, Manhattan) in spite of their level of historical amenitiies is high and despite they are favoured by high agglomeration externalities.

This paper is obviously not an attempt at explaining how the greater Paris area transitioned from a centralized jobs model to a suburbanized employment model. Of course the relocation of big industrial firms or the building of massive infrastructures (New towns, airports) have favoured the spreading and the reorganisation of employment around Paris. But what lies behind the recent relocation of otherwise traditionally central services firms is not captured by those models since the firms do not always locate close to the big clusters. Employment outside the economic clusters has incrased by 35% over the last thirty years and today it represents more than 20% of all jobs in the greater Paris area.

The model presented here aimed at only a part of the demonstration. The link between these results and the models where a planner organises the development should be considered. It would enable to combine dynamics leading to a spread out suburbanisation and those leading to moultipolar cities. Such a model could for instance integrate the effect of the suburban densification of a developed area on the level amenities it conveys. When all agents make the same choice, the households and the firms who have left the center to enjoy a more pleasant environment often find themselves stuck in a degraded environment that no longer meets their expectations.

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