Bank Location and Financial Liberalization Reforms: Evidence from Microgeographic Data

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Abstract

We examine the effects of bank deregulation on the spatial dynamics of retail-bank branching, exploiting, much like a quasi-natural experiment, the context of intense liberalization reforms in Belgium in the late nineties. Using fine-grained data on branch network dynamics within the metropolitan area of Antwerp and advancing novel spatial econometric techniques, we show that these liberalization reforms radically shifted and accelerated branch network dynamics. Entry and exit dynamics substantially intensified, the level change in financial void grew significantly, and bank choice markedly declined. Moreover, all these changes consistently extended (even with greater intensity) after the liberalization peak. However, the immediate and longer-term spatial ramifications of the financial sector liberalization were very distinct. All immediate changes systematically, differentially impacted the poorer and wealthier neighborhoods, disenfranchising the poorer neighbourhoods and favoring their wealthier counterparts. The longer-term effects on spatial patterns of change no longer exhibited this systematic relationship with neighborhood income. We draw out the policy implications of our findings.

Keywords: Location, Retail-banking, Liberalization, Poverty, Spatial Statistics

JEL codes: G21, L1. L22, O16, R12

1 Introduction

The past twenty years have witnessed a dramatic change in the geography of Belgium's retail-banking landscape. Belgium's branch network shrunk by over forty percent, from more than 8,000 branches in 1985 to less than 5,000 branches in 2004 (Goddard et al., 2007). Consumer choice over retail banks likewise dwindled during this period. These trends give evidence of the overall profound retail-banking transformations that swept through Belgium, led by concurrent liberalization reforms and technological innovations in the financial sector. But they do not convey the intensity of change in branch network dynamics over time, nor capture the remarkable spatial heterogeneity of these changes. Making use of new, unusually fine-grained data on branch dynamics, this paper revisits the periods before, during and after the liberalization peak of the late nineties in more detail. It explores the "on the ground" distinct ramifications of intense liberalization reforms.

We exploit the context of the metropolitan area of Antwerp in Belgium to make several contributions to our understanding of retail-banking liberalization, market structure and consumer welfare. We investigate the extent to which the financial sector restructuring during the late nineties effectively altered patterns of bank presence, entry and exit, on the ground. Also, we examine the consumer choice implications of any such changing retail-bank network dynamics. Further, we assess the divergences of bank liberalization experience across Antwerp's different neighbourhoods.

We advance three main empirical results. First, the liberalization reforms and the technological innovations introduced in the late nineties radically shifted and accelerated the retail-branch network dynamics. Entry and exit dynamics substantially intensified, the level change in financial void grew significantly, and bank choice markedly declined. Second, all three changes in branch network dynamics also consistently extended (even with greater intensity) into the five-year period after the liberalization peak. Third, the immediate and longer-term spatial ramifications of the financial sector liberalization were very distinct. All the immediate changes systematically, differentially impacted the poorer and wealthier neighborhoods. During the liberalization peak, branches were consistently more likely to exit the poorer neighborhoods and enter their wealthier counterparts. Also, the level of financial void spread unevenly, with poorer neighborhoods experiencing a sudden, significant increase in bank desert and sharp decline in bank choice. Interestingly, the spatial patterns of change following the liberalization peak, which is when banks began to reap the cost and revenue advantages from consolidation, no longer exhibited this systematic relationship with neighborhood income.

Apart from these substantive results, we also contribute to the methodological literature on spatial processes. The methodological advances we make yield novel measures of branch presence, entry, exit and choice, which minimize the discretization that which commonly affects traditional count measures, and unlike the measures from a pure point pattern approach (e.g. Marcon and Puech, 2003; Duranton and Overman, 2005), can be reliably linked to discrete neighbourhoods. And so our measures combine the best of both worlds, if you will.

This paper explores the spatial characteristics of the aggregate branch network and its evolutions, not of the individual branch location decisions that could lead to the patterns observed. In doing so, we sidestep the methodological challenges involved with the study of interrelated discrete decisions like the choice over branch location (Draganska et al., 2008; Seim, 2006). Effectively, branch location decisions are quite complex and typically involve the consideration of a number of demand, cost, and competitive (strategic) factors. Theoretical analyses of location choice frequently yield very different predictions depending on the assumptions made about transportation costs, the availability of outside options, the number of competitors, and the shape of the product space. Furthermore, adding to the complexity – but also the fragility - of these models, location decisions are often also tied with decisions over product characteristics and price. Our aim therefore is not to lean too heavily on particular predictions, which can be dependent on modeling specifications. We simply seek to motivate the following intuitive propositions: (i) greater competitive pressures brought about by liberalization reforms can measurably perturb the spatial dynamics and configuration of branch networks; (ii) in the event of which aggregate patterns of change are likely to diminish overall bank availability and choice, and in a first instance, more severely so in the poorer neighborhoods. More specifically, econometrically speaking, by focusing on aggregate patterns and change, missing information about the unobserved branch characteristics or the strategic, complex interactions between rivaling branches within a neighborhood can be treated as classical, zero-mean, measurement error in the dependent variables, With the aggregate approach, we are also able to more directly identify the net effects of liberalization reforms on local customers (in terms of branch availability and choice), which is coherent with the focus of our paper. Again, this implies that our econometric model can be simply seen as a "reduced form" specification summing of all the different actions individual branches may take (enter, exit, stay, not enter).

To test whether the peak in liberalization reforms and technological change in the late nineties distinctly affected the spatial dynamics of branch networks, we simply contrast the characteristics of these dynamics over three five-year windows – before liberalization peaked, coinciding with the liberalization peak, and after the liberalization peak. We constructed our own panel dataset about the dynamics of bank branch networks within the metropolitan area of Antwerp between 1991 and 2006, and matched these data with detailed and remarkably fine-grained residential data. This has allowed us to shed light on the spatial dynamics of branch networks in relation to the banks' private customer base. Interestingly, the great majority of the empirical literature in Belgium (but not just in Belgium) has been studying bank organization, lending relationships (including their geographical aspects), and bank competition in relation to the banks' commercial customer base – in particular, small and medium enterprises instead (Degryse, Laeven and Ongena, 2009; Degryse and Ongena, 2005, 2007). And yet, transactions with private customers constitute a far from trivial share of overall bank revenues. For example, of all credits granted by banks in 2006, 37.3 % were granted to private persons, and 33.9 % to businesses (Febelfin, 2006). The economic significance of the private customer market thus renders shifting focus, as we do with this paper, to understanding bank behaviours in relation to the private consumers particularly relevant.

This paper adds new empirical insight to a large literature on spatial competition and market structure. Dick (2006) finds that the Riegle-Neal branching deregulation in the US in the 1990s led to increased concentration at the regional level, but left the structure of metropolitan markets nearly unaffected. Our focus is on changes within the metropolitan market of Antwerp, and so compared to Dick's study is at a more disaggregate level. Perhaps our work is most closely related to the works by Waldfogel and co-authors (2003, 2006, 2007) investigating how demographics (in particular consumer preference heterogeneity) impacts a consumer market's structure and geography. They empirically analyze a wide range of markets, including the market for radio stations, newspapers, television and restaurants. Interestingly, the banking sector shares an important characteristic with these other markets namely its lumpiness – that is, the high fixed cost relative to market size of operating a branch. At the same time, contrary to those markets, for a bank, "not all private customers are equal"[1] from a profitability perspective – or put differently, the marginal expected benefit and costs of servicing a new client strongly covary with the client's income profile. And so, when overall competitive pressures intensified as they did in the late nineties, aggregate branch reconfigurations are expected to likewise covary with income profile of neighborhood markets. And this is precisely what we find.

There are several studies that empirically examine the geography of banks (e.g. Morrison and O'Brian, 2001 [New Zealand]; Damar, 2007 [Turkey]; Avery et al., 1999 [US]; Greve, 2000 [Japan]; Leyshon and Thrift, 1996 [UK]), though none with such high statistical precision and at such disaggregated level.

Our paper also contributes to the vast body of literature on financial exclusion. Leyshon and Thrift (1996) argue, drawing on the experiences of the UK, that one of the most pressing symptoms of growing financial exclusion is the closure of branches in low-income neighbourhoods. Leyshon, French and Signoretta (2008) provide more recent evidence for the UK that the closure of banks and building society branches can have significant consequences for customers, who may have to incur additional traveling costs to undertake transactions or obtain face-to-face advice, in addition to engendering a sense of loss and abandonment within local communities. Chakravarty (2006) argues the importance of physical presence for the quality of information on which loan decisions are made, provided staff working in the branch have relevant loan processing, credit analysis and decision-making authority. More generally, having little or no access to formal bank services or, relatedly, making little use of such services, can lower consumer welfare via its negative impacts on consumer spending, saving and more broadly household finance management (Bertrand, Mullainathan and Shafir, 2006; Thaler, 1990, 1999; Lusardi, 2002).

The remainder of the paper is structured as follows. Section II provides a brief historical background and gives an overview of the data. Section III discusses our methodology. Section IV presents the results, and Section V concludes.

[1] Consider the low depository and borrowing power of the poor, the fact that the poor are more likely to fall behind on bills, and thus the more processing costs that poor clients involve for banks, and the fact that the poor have less money to save. Furthermore, banks derive a significant portion of their profits from mortgages and managing investment portfolios, which are both services of little interest to the poor. Collectively, these observations help explain why banks would disproportionately close down branches in poor neighbourhoods when pressed to undertake cost-saving measures.

2 Historical background and Data

In this section we discuss some essential features of retail-banking in Belgium and the data that we have specially collected to be able to shed new light on how retail bank networks evolved on the ground over time, in particular during the liberalization peak in the late nineties.

2.1 Retail-banking in Belgium between 1991 and 2006

The restructuring of Belgium's retail-banking has been on-going for many years, spurred on by a sustained legislative drive at the EU level since the late-1970s. It came to fruition most markedly so over the past two decades. Regulatory change aimed to make retail-banking 'leaner and fitter' by encouraging competition. To illustrate, measures like the launch of Europe's Financial Services Action Plan[2] and the introduction of the Euro, both in 1999, sought to help remove barriers to the integration of financial services markets. Even though (intuitively) such barriers may well be particularly onerous in retail-banking,[3] Belgium's retail-banking landscape did fundamentally transform, particularly since the late nineties. This section contains more detail on aggregate-level changes in retail-banking in Belgium as a whole, whereas we expose the reality of those changes within the metropolitan area of Antwerp in the rest of the paper.

We advance three remarkable and, for our purposes, significant observations. First, the rising trend in the 'index price of banking services' in Belgium, as plotted in Figure 1, experienced an abrupt break between 1996 and 2001, precisely when liberalization reforms culminated. This is consistent with the economic logic that the competitive pressures unleashed by reforms eroded, albeit only temporarily, profit margins in retail-banking. The index value rose again, and very steeply so, after 2001 – that is, after the massive wave of mergers and acquisitions in Belgium's retail-banking landscape, which plausibly gave way to price increases once again.[4]

Second, the temporal pattern of Belgium's banking sector's Herfindahl Hirschman Index (HHI) likewise took a sudden turn around 1996 (Figure 2). Between 1996 and 2001, market concentration as measured by the HHI almost doubled. Belgium evolved from a moderately concentrated banking market in 1996 (Alegria and Schaeck, 2008) to one of the most concentrated in Europe by 2001 (International Monetary Fund, 2006). Since 2001, Belgium's retail-banking industry has been dominated by a handful of large banks. Overall consumer choice nearly halved in the wake of Belgium's retail-bank consolidation wave, and overall branch network likewise starkly diminished.

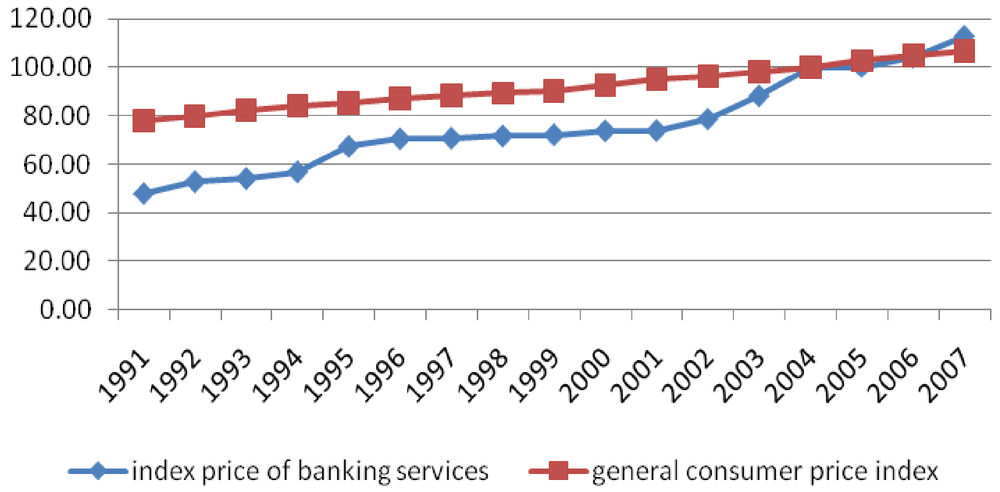
Third, in the immediate shadows of the massive, physical reconfiguring of Belgium's retail-branch networks, availability and usage of online banking surged. Classic banks began to boost their online portals, cross-selling products via their website in order to reach new clients and diversify their distribution channels (Arnaboldi and Claeys, 2008), and introduce home-banking. In addition, new pure internet banks, such as the Rabobank, started to launch their

[2] The Annex of the General Agreement on Trade in Services (GATS) specifically on financial services was also introduced around this time, in 1997 to be precise.

[3] Barriers may well be particularly onerous in retail-banking because of e.g. issues of consumer trust and confidence, causing depositors to prefer local or national banks to foreign banks and local bank's privileged access to information about a borrower's creditworthiness, creating a rent that is unavailable to foreign banks.

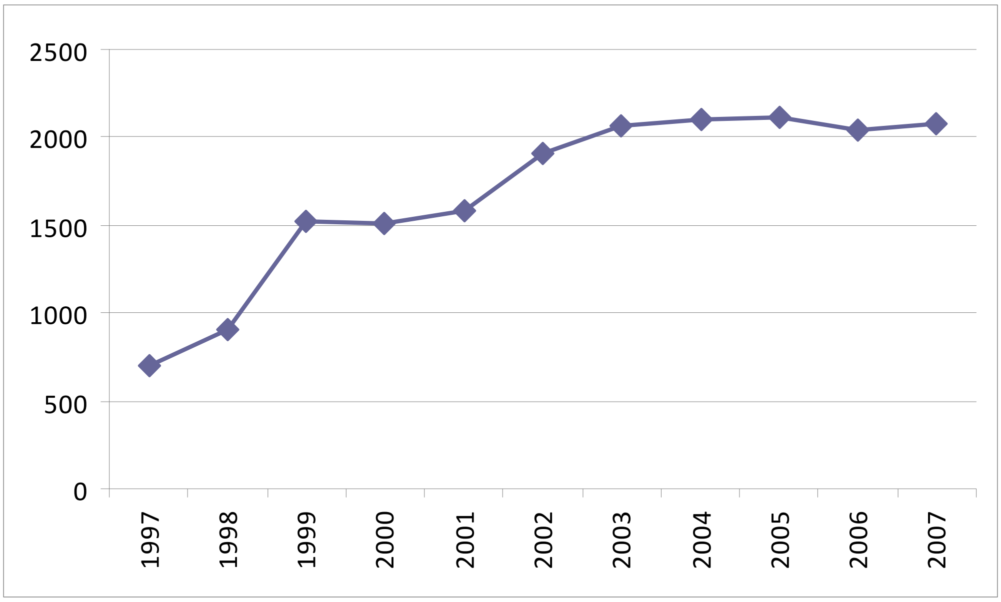
[4] Admittedly, these price increases may also have been commensurate to increases in service quality. However, we have no data to validate this.

Figure 1: General price index and index price of banking services, Belgium, 1991-2007



Note: The index price of banking services is defined as the costs of a package of financial services, which includes a bank card, the administration costs of a bank account, payment transactions, the Eurocheque-card (later replaced by the Maestro card), and the rental of a safe. The reference year is 2004.
Source: Febelfin.

Figure 2: Banking sector Herfindahl-Hirschman index, Belgium, 1997-2007



Source: European Central Bank.

services in Belgium from 2002 onwards. And with the rising demand for direct banking, banks sought to further curtail branch staffing (and hence the availability of face-to-face services). Between 2000 and 2007, employment in the banking sector in Belgium shrunk by 12 percent (ING, 2006).

Collectively, these observations suggest that the overall reconfiguring of Belgium's retail banking landscape – induced by the financial sector liberalization peak – spanned two phases. First, between 1996 and 2001, overall increased competitive pressures, in part due to the removal of entry barriers, obliged banks to compromise on oligopoly rents. Thus, price margins on fees being (temporarily) pressured, banks' best response was to raise profits by cutting costs, notably fixed costs first. In a free entry market, with high fixed set-up costs relative to market size, this is precisely what theories predict, both in the Structure-Conduct-Performance and endogenous fixed costs camps (Bain, 1956; Sutton, 1989, 1996).[5] And given that fees' profits are marginally decreasing with savings, it became more profitable to reallocate and shift to wealthier customers. Then, from 2001 through 2006, when through consolidating and rationalizing, banks were able to reinstate renewed market power, the price war subdued and prices started to mount once again. Simultaneously though, the demand for online-banking services accelerated, which rationalized a further reduction of branch networks and staffing. In sum, these observations substantiate the design of our panel, allowing us to contrast three five-year periods: 1991-1996; 1996-2001; 2001-2006. A discriminate analysis of financial service liberalization along temporal and spatial dimensions, to our knowledge, has not been empirically demonstrated before. This paper is the first to do so.

It is noteworthy that the structural changes in Belgium's retail-banking were far from representative of those in the EU as a whole.[6] In fact, there has been, perhaps not surprisingly so, great divergence in experiences across say the EU15 countries (Goddard et al., 2007). But this does not make the Belgian case less important. In fact, it is precisely the sheer scale of changes in Belgium's retail banking network that we exploit to show how branch network dynamics evolved over time and in space. Whereas most studies analyze the pace and extent of liberalization at the level of a nation state or larger geographical region, we look at these issues at a more disaggregated level, shifting focus to the very local level, which is arguably most relevant to the everyday consumer of bank services. In doing so, we are also able to discriminate the effects of bank liberalization by neighborhood characteristics, and thus shed light on the extent to which the liberalization peak had differential impacts on different consumer groups.

2.2 New Data on Antwerp's Branch Network by Neighbourhood over Time

In order to analyze how branch network dynamics evolved over time at a suitably local scale, we constructed a new panel dataset on Antwerp's 233 neighbourhoods. The dataset tracks these neighbourhoods every five years between 1991 and 2006, a period that neatly encapsulates the five-year regime during which deregulation peaked (1996-2001). Table 1 contains descriptive

[5] For a recent review of the empirical literature on market concentration and consumer welfare, see Van Hoose (2010).

[6] For instance, only in the Netherlands and Denmark did the branch network diminish to such great extents. Market concentration, as measured by the CR5 index, increased in the majority of EU15 countries, but in no country to such extreme degree as in Belgium.

Table 1: Summary statistics

Variable/year	**1991**	**1996**	**2001**
active/tot. pop.	0.63	0.61	0.61
	(0.06)	(0.06)	(0.07)
average income*	25537	24207	23177
	(4686)	(4569)	(4677)
non Belgian/tot. pop.	0.11	0.12	0.12
	(0.10)	(0.11)	(0.09)
old/tot. pop.	0.18	0.19	0.20
	(0.07)	(0.07)	(0.08)
Total population	1995.74	1953.15	19153.86
	(1263)	(1218)	(1167)

Note: standard deviation in parenthesis

*Real euros, reference year 2000.

statistics for the variables that we use in this paper and describe throughout this section. Appendix A contains more detail on the construction of these variables.

With its nearly half a million inhabitants, Antwerp is Belgium's second largest city (after Brussels). Three main features of the city make Antwerp a particularly suitable candidate for our analyses. First, Antwerp's neighbourhoods (even when we exclude those in green and harbor areas) vary substantially in size, population and average income - variation we are keen to empirically exploit. Second, the city is characterized by a high degree of residential segregation and large income and ethnic disparities, which are far more distinct than in any other Flemish city (Kesteloot et al., 2006). Third, there not only exists a strikingly high degree of residential segregation, but also a strong persistence in income and ethnic disparities over time. For instance, figure **3** and 4 show the average income per household in the 1994 and 2004 (classified by quintile), and the two maps are almost identical; the Spearman's rank correlation of the share of non-Belgian inhabitants across neighbourhoods in 1991 and 2004, respectively, is equal to 0.97; the same index for average income in 1994 (first available year) and 2004 is only slightly smaller (0.86).

Neighbourhoods are the smallest spatial units for which statistical data can be obtained in Belgium.[7] We combined neighborhood level data from various sources. We use population data from the Belgium's Directorate General Statistics. The income data are all official tax data, corrected for purchasing power (by means of the consumer index) and denominated in Euro. We use GIS to construct geographic measures, like a neighborhood's area or whether it should be included as part of the city's centre. Finally, we recorded the addresses of all active

[7]They were created for the Census in 1970, and revised in 1981 and 2001. Originally they corresponded to areas with uniform social, economic and morphological characteristics. Over time this within-neighbourhood uniformity somewhat diminished: although the neighbourhood borders were revised in 2001, changes due to evolutions in social, economic and morphological characteristics remained limited, in order to easy comparison over time. However, because the neighbourhoods are rather small (average area of 366,388 m2, which - if they were circular - would correspond to a radius of 341 m) very large within-neighborhood differences are rare.

banks in 1991, 1996, 2001 and 2006 using the National Telephone Directory, and converted those addresses into x-y coordinates with the help of specialized software (CRAB). These data in turn constitute the 'raw data' for our own neighbourhood-level measures of bank presence, exit and entry, and choice. In the next section, we carefully explain these new spatial measures.

3 Methodology and New Measures of Branch Network and Choice

A major concern with handling "point event" data, like our branch data, is that when mapping these data onto neighbourhoods, discretization bias slips in. This bias stems from the fact that distance is reduced to a binary variable (that is, in or out) and that arbitrary boundaries, here of the city's neighbourhoods, are simply imposed. In this section, we present several methodological advances, allowing us to generate new measures of bank presence, exit, entry, and choice, which both minimize this bias and can be readily and reliably linked to individual neighbourhoods.

3.1 New Spatial Measures of Bank Presence

The presence, exits, and entries of retail bank branches are essentially collections of "point events" in space, not defined by any meaningful spatial extension. Most of the time, data of this kind are aggregated into arbitrarily chosen spatial units, often by means of a simple count or density ratio. The spatial economics literature, however, has recently emphasized the bias originating from "taking points on a map and allocating them to units in a box", especially if the "boxes" (i.e., the spatial units) are heterogeneously shaped and sized (Duranton and Overman, 2005). This bias stems from the fact that distance is reduced to a binary variable, and arbitrary boundaries, which may not match real discontinuities in the spatial process under study, are simply imposed. Furthermore, since many banks in our study are located along a street which lies on the border of two neighbourhoods, allocating all the banks to one or the other would yield only a rough approximation of bank presence.

Recent contributions by Marcon and Puech (2003) and Duranton and Overman (2005) have stressed the benefits of using a "point pattern analysis" approach instead. Following the seminal contribution by Ripley (1976), various statistics based on a continuous definition of space have been proposed, and applied to the study of location decisions of manufacturing plants and patterns of industrial agglomeration. The approach has been shown to provide more precise evidence on the phenomena investigated, significantly improving comparable statistics based on discrete spatial units.[8]

However, in our context a 'pure' point pattern analysis approach is limiting, as its metric is difficult to interact with socio-economic variables measured at the level of discrete spatial units (here, neighbourhoods). Therefore, we advance a new approach, which combines the strengths of both Point Pattern approach and the traditional count measures, yielding measures of

[8] See for instance the comparison of the Duranton and Overman (2005) metric with the Ellison and Glaeser index.

Figure 3: Average income, Antwerp, 1994

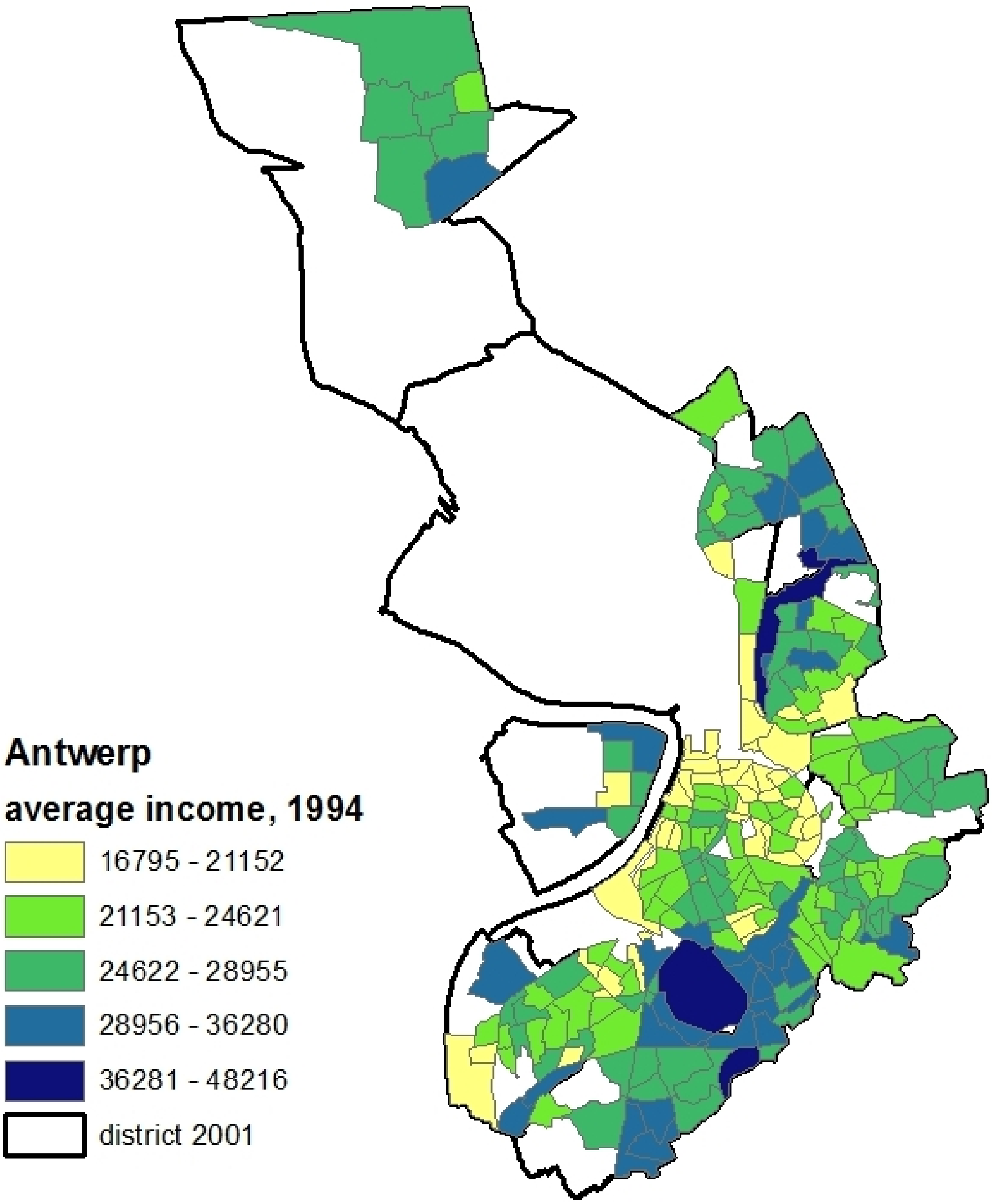
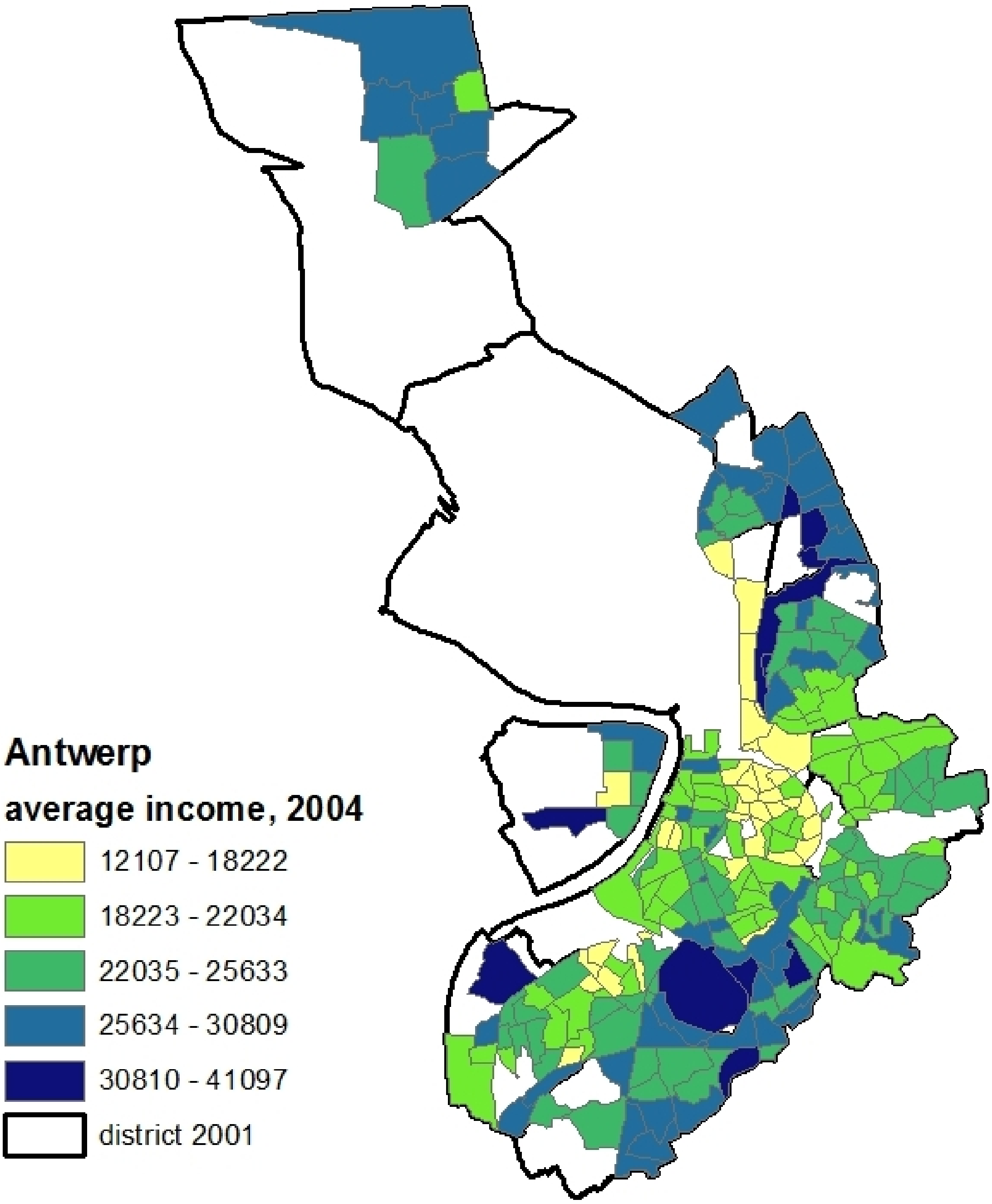


Figure 4: Average income, Antwerp, 2004



branch presence and network dynamics, which are more precise than a simple neighborhood count of bank events and still neighborhood-specific, and consequently easy to relate to other neighborhood-specific variables.

We constructed these measures as follows. We first classified all branches in our longitudinal database on banks in the metropolitan area of Antwerp's retail-banking between 1991 and 2006 as entering, exiting or continuing for each of the three five-year periods. We thereby applied simple and intuitive decision rules. For instance, if a bank was present in a certain year, but had disappeared five years later, we considered this bank as exiting; in cases where a bank was not present in a certain year, but appeared five years later, we considered this bank as entering within this 5 years period; finally, a bank which was present in both years was defined as "continuing" over that time interval. In addition, we also undertook several corrections to avoid that our measures overestimate entry and exit. Firstly, if a bank branch moved within a distance of 100 meters, then we considered this branch to be continuing.[9] We counted 132 such instances. Secondly, if a bank disappeared for a five-year interval, only to reappear in the subsequent period, we coded these banks as continuing, and so assumed that this was due to an inaccuracy in the archives. There were 8 such cases. Note that if the intermittence of a bank lasted for more than one period, no correction was carried out, and an exit and entry were recorded consecutively. Thirdly, as our second period coincided with a massive wave of mergers and acquisitions, we also coded branches as continuing whenever they only changed bank group but not location.

Next, we calculated a density function around each point event, which generated a highest value at the location of the event and reaches zero at a distance of 600 meters. We chose 600 meters because this roughly corresponded to the hypothetical diameter of the average neighborhood, as well as maps into the plausible maximum sphere of bank influence. Other distances only slightly affected the value of our measures.[10] Then, we imposed a grid of squares of 65 meters width onto our map. For each cell, we calculated the kernel smoothed sum of the values for our "point events", applying the quadratic kernel function described in Silverman (1986). This allowed us to come up with a continuous surface of branch intensity, exit and entry, covering the whole area under scrutiny. Our approach thus eliminates the "discretization bias", since the zonal statistic of a spatial unit now also depends on the presence of banks in the contiguous neighbourhoods, and generally increases the level of spatial precision.

Finally, to come up with a neighborhood-specific statistic of a "branch event", we simply summed up its value over all cells that lay inside the neighborhood's border. Figure 5 graphically illustrates the result for our measure of bank presence, which we henceforth refer to as the zonal statistic. We demonstrate the higher precision of our zonal statistic compared to a simple bank count by neighborhood in the appendix, where we re-estimate all econometric

[9] We thus assume that these moves were driven by forces other than the ones that we study. For instance, a branch may decide to relocate to a more suitable building nearby. These apparent moves may also have been the result of changes or consistencies in the addresses. We found 132 instances where the branch changed address but stayed within a distance of 100 meters. For those cases, we kept the original spatial coordinates throughout.

[10] When we recalculated our results with a distance of 300 meters, we obtained values for both level and flow statistics that were highly correlated with the results obtained with a distance of 600 m (correlation coefficient of 0.95 and 0.93 respectively). We also repeated all subsequent analyses (in next section) with these other values, and all results held true.

models substituting the zonal statistic metric with the bank counts per neighborhood. The methodology has been easy to apply using GIS software.[11]

3.2 New Spatial Measures of Bank Void and Bank Choice

To complement the set of spatial statistics defined so far, we also developed original measures of branch mix and branch accessibility.

The measure of branch accessibility aims to capture the degree to which a given neighborhood experiences a financial void (or financial desert). The measure essentially quantifies the average area of the map that needs to be covered for any given neighbourhood in order to meet a first bank. More intuitively, it reflects how far one should walk to find the nearest bank branch, starting from a random point in the neighbourhood. We constructed the measure in four, simple steps. First, we created a regular grid of points at a distance of 100 meters apart, covering the whole area under analysis. Next, we drew progressively larger circles around each point until a first bank was reached. Third, we calculated the number of grid points that lay within the minimal circle necessary to comprise at least one bank. Intuitively, the higher this number is, the greater the extent of financial or branch abandonment at that point. Finally, we computed the average value of these numbers across all points which laid within any given neighbourhood, giving rise to a neighbourhood-specific statistic. This constituted our final measure. Figure 6 provides a graphic illustration of the methodology.

Though related to computations of average shortest distance to an event (here, the first bank) used elsewhere, our newly developed measure realizes several improvements. First, we are able to use a quadratic function of the distance to the first bank, rather than a linear one, and thus allow for quadratic transportation costs. Second, by aggregating the number of grid points within the circle, rather than simply relying on the circle's area, we are able to better control for edge effects, i.e., for the fact that neighbourhoods close to the border of the map need a relatively bigger distance (circle radius) to find a given number of banks within a given distance than do central neighbourhoods (given that the point grid covers only the area of the map, the number of points approximate the number of potential locations of banks).[12]

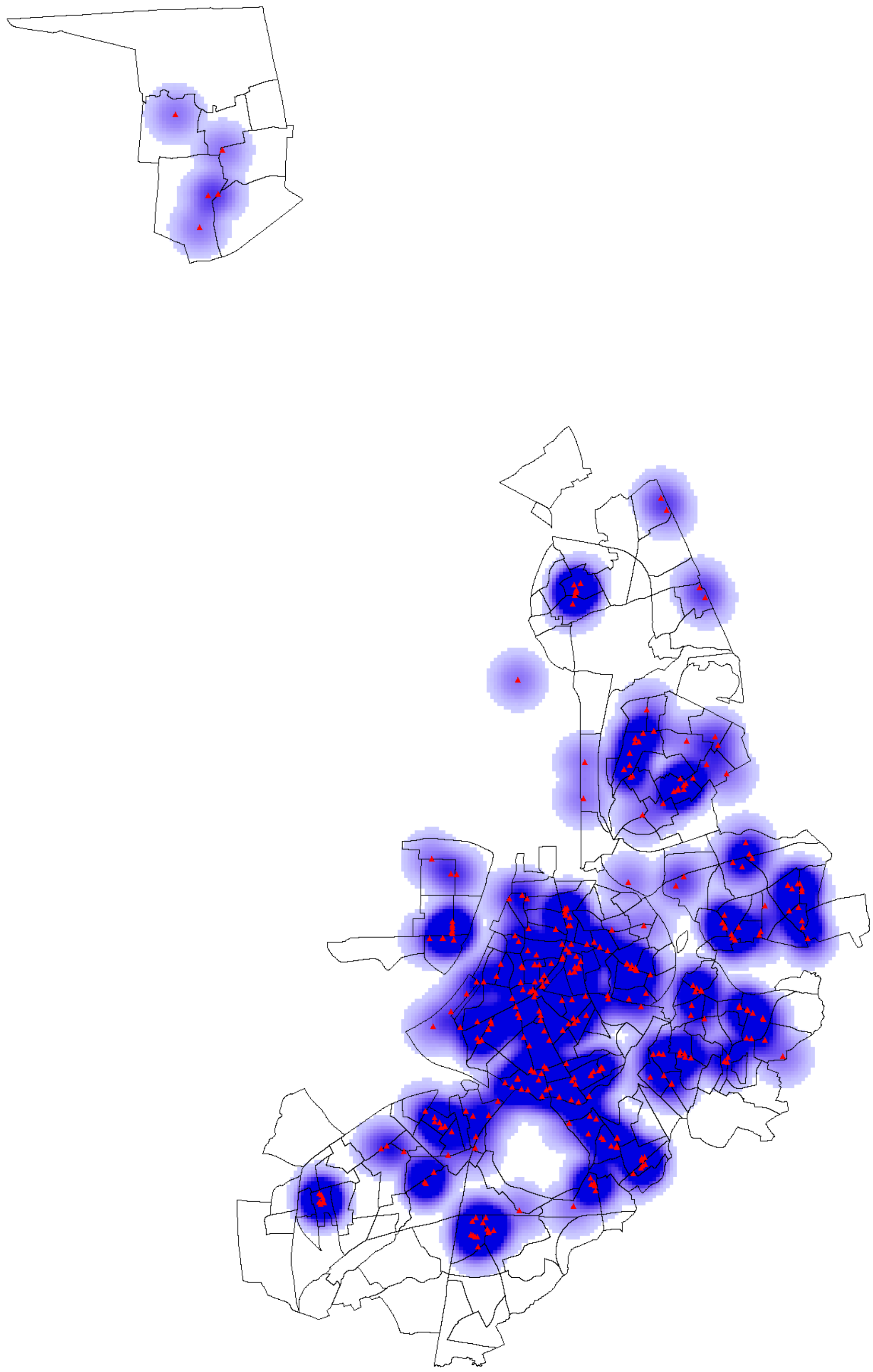
Our measure of branch mix or variety aims to quantify the degree of bank diversity, or choice available to customers in a given neighbourhood. Arguably the most immediate procedure to obtain such measure would be to compute a standard diversity index, like the Herfindahl index, at the neighbourhood level. However, such an index would still be prone to the discretization bias we highlighted before; furthermore, the neighbourhoods' size, position, or the characteristics of other contiguous neighbourhoods would not be taken into account. Hence, we developed a new index which overcomes those shortcomings.

Our measure of branch mix is conceptually simple and similar to the one we adopted for the "bank desert". We used the same grid of points 100 meters apart, and drew progressively larger circles around each point until branches belonging to (at least) three different bank groups were met. The rest of the calculation was the same as the one used for the measure of bank desert: we calculated the total number of points of the grid that lay within the largest

[11] More precisely, we used two tools available in ESRI ArcInfo: the kernel smoothing tool, and the zonal statistic.

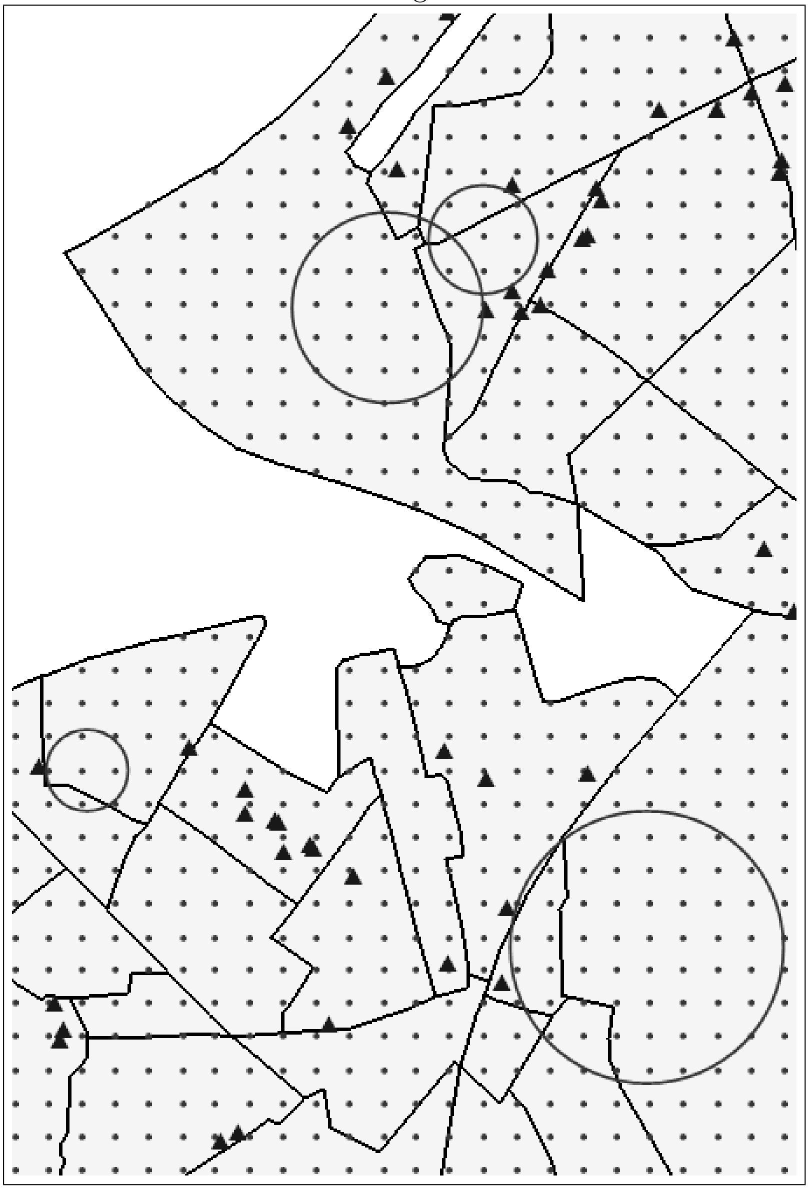
[12] Marcon and Puech (2003) report a detailed discussion of edge effects in point pattern analysis.

Figure 5: The zonal statistic



Note: the figure reports the city of Antwerp under analysis, in year 2001. The small triangles represent banks, the polygons are neighbourhoods, and the dark surface is the zonal statistic.
Source: Authors' elaboration.

Figure 6: Measure of bank choice



Note: the figure reports the city of Antwerp under analysis, in year 2001. The small triangles represent banks, the polygons are neighbourhoods, the points the grid; the circles correspond to the area to be covered to reach the first bank.
Source: Authors' elaboration.

circle and then calculated the average for each neighbourhood. Again, the statistic is easy to interpret: a bigger average circle corresponds to a longer hypothetical multi-directional walk from a point of the grid to enjoy a satisfactory differentiation of the supply of retail banking services. The correlation with the Herfindahl index calculated at neighbourhood level is significant but small (the Pearson's linear correlation is equal to 0.2, and the Spearman's rank correlation to 0.17), suggesting that our measure is indeed capturing different information as opposed to more traditional competition measures.

It is worth noticing that both our measures are neighbourhood-specific, but at the same time they depend non-parametrically on the spatial structure of the data, as is the case with the measures of bank entries and exits. They are easily comparable across spatial units and time periods. Technically, the measures have been calculated with a simple function in Matlab developed by one of the authors (available upon request).

In table **2**, we report the summary statistics of our measures of branch presence, network, and choice. The table shows that over the 1991-2006 period, the average level of bank presence in Antwerp shrunk by over the 25%, while the average distance to the first bank increased by 35%, and the distance to meet three different bank groups increased by 41%.

Table 2: Measure of bank presence and choice

Variable/year	**1991**	**1996**	**2001**	**2006**
Zonal statistic	0.44	0.41	0.38	0.32
	(0.37)	(0.36)	(0.35)	(0.31)
Entry		0.08	0.10	0.08
		(0.10)	(0.13)	(0.11)
Exit		0.10	0.12	0.15
		(0.10)	(0.14)	(0.15)
Dist. to 1st bank	49.90	54.32	55.73	67.52
	(71.18)	(73.2)	(74.1)	(92.5)
dist. to 3 diff. groups	87.06	93.05	94.13	122.97
	(101.9)	(107.0)	(101.3)	(133.9)

Note: standard deviation in parenthesis

4 Empirics

In the next sections we present the empirical results on bank presence dynamics (4.1) and measures of bank void and choice (4.2) over time, and their relationship to neighborhood characteristics. Apart from the results, we also present spatial diagnostics and some robustness tests.

4.1 Retail-Branch Dynamics and Neighborhood Characteristics

We explore the characteristics of aggregate retail-branch patterns over time and in relation to the geography of the everyday consumer. In particular, we analyze the extent to which the liberalization peak affected these patterns. To this end, we estimate and contrast a series of regressions of the following form:

$$\triangle y^s_{t,t+5} = \sum_t \beta_t X^s_t + \sum_t \gamma_t W X^s_t + \tau_t + \delta^s + \tau\delta^s_t + \varepsilon_{s,t} \tag{1}$$

where $\triangle y^s_{t,t+5}$ is the change in the zonal statistic of the outcome of interest (the latter being either bank entry, bank exit or net bank presence as a combination of both entries and exits) over each five-year period, starting at year t, in neighbourhood s, X^s_t is a vector of neighbourhood-specific characteristics at time t, WX is a vector of those same characteristics but now spatially lagged,[13] δ is a fixed effect for each of the nine districts in the city of Antwerp, τ is a time fixed effect, and ε is a neighbourhood-time specific error term.[14] The coefficients of interest are elements of both β and γ, which we allow to change over time.

To minimize simultaneity bias, we always regress the aggregate change in retail-branching over a five-year time span onto neighborhood characteristics at the beginning of that period. In addition, because of the high degree of residential segregation in Antwerp and its persistent neighbourhood income disparities, concerns with reverse causality (a change in branch presence leading to a change in neighbourhood income) are unlikely to affect our conclusions. Henceforth, to ease our exposition, we will refer to the periods 1991-1996, 1996-2001 and 2001-2006, as respectively periods one, two and three.

4.1.1 Results

Table 3 presents results of estimating equation 1 using OLS for all 233 neighbourhoods of Antwerp's metropolitan area, with a limited selection of control variables – namely, neighborhood average income, log of neighborhood population, and a time period fixed effect. Overall, the evidence in Table 2 suggests significantly different dynamics in branching between our three time periods. We find that only in period 2, neighborhood income significantly and strongly predicted both net branch entry and net branch exit (and by extension net change). The magnitudes of these effects are remarkably high. To illustrate, one percentage point reduction in the average neighborhood income corresponds to more than one standard deviation increase in exit of bank branches. The effect of neighborhood income on the zonal statistic of net presence appears to extend to the subsequent five-year block, 2001-2006, though this relationship weakens (becomes only half as large) and underlying patterns of entry and exit dynamics are clearly distinct from those in period two.

In Table 4 we estimate equation 1 again, this time with additional control variables. In Table 5, we add these additional control variables as well as the spatially lagged versions of these

[13] We constructed the spatially lagged variables as follows. First, we created an inverse distance matrix including all the neighbourhoods within 2 km from the neighbourhood under consideration (distance is calculated at the centroid of the neighbourhood). We then created the lagged variables by pre-multiplying the matrix of explanatory variables by the row-standardized inverse distance matrix. The spatially lagged version of a variable is thus equal to the average of the values of this variable in the neighboring neighbourhoods, weighted by distance. In the tables, we indicate the spatially lagged variables with a "W" in front of the variable name.

[14] Since we are especially interested in assessing how the flows of bank presence relate to the stocks of the explanatory variables in different time periods, we do not include neighbourhood fixed effects as these would absorb most of the effect of the regressors, which generally show little variability across time.

Table 3: Regressions of zonal statistic, flows

VARIABLES	(1) Δ zonal statistic	(2) Entries	(3) Exits
Average income 1991	0.0284	0.103**	0.0750*
	(0.0395)	(0.0481)	(0.0387)
Average income 1996	0.152***	0.0662*	-0.0859**
	(0.0363)	(0.0393)	(0.0387)
Average income 2001	0.0716**	0.0546	-0.0168
	(0.0345)	(0.0414)	(0.0466)
Tot. pop. (log)	-0.0133***	0.0296***	0.0429***
	(0.00459)	(0.00663)	(0.00746)
dummy first period	-0.0866	-0.711**	-0.626***
	(0.225)	(0.274)	(0.223)
dummy second period	-0.760***	-0.483**	0.279
	(0.206)	(0.226)	(0.228)
dummy third period	-0.356*	-0.430*	-0.0760
	(0.194)	(0.234)	(0.263)
Observations	699	699	699
R^2	0.167	0.400	0.513

Heteroscedasticity robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

control variables. In particular, as additional control variables, we include several measures of consumer types to assess the extent to which different customer profiles motivated spatial dynamics of branch network. The centre dummy is meant to allow for differences in branching dynamics between neighbourhoods situated in the city centre (within the Ringway surrounding the centre of Antwerp), and those outside this area. We also include the natural log of the level value of the relevant zonal statistic in order to control for the pre-existing location of banks and for existing competition, and thus as a proxy for unobserved neighbourhood characteristics, which may affect the desirability from a bank's standpoint to locate a branch there. The time-district fixed effects included are meant to control for idiosyncratic shocks at the city and district levels, as well as unobserved factors such as the number of local businesses,[15] and road and public transport networks.

The results in Tables 4 and 5 show that the inclusion of more control variables affects the magnitude and significance of our income coefficients, but leaves unchanged the main conclusions on branch network dynamics and their relation to neighbourhood income. Furthermore, the finding that spatially lagged income in 1996 also significantly correlates with branch network changes reinforces our main finding so far: that is, both net entry and net exit of bank branching (and not only the net effect on bank presence) over period 2 bore systematic relationships with initial neighbourhood wealth in ways that not only disadvantaged the poor (with banks exiting from poor neighborhoods) but also distinctly advantaged their wealthier counterparts (with banks entering wealthier neighborhoods).

We find a systematic, positive relationship between the net flow of banks and the proportion of elderly living in the neighborhood both in periods 1 and 3, though we suspect for different reasons. The positive relationship in period 1, we conjecture, may have been driven by bank group's need to expand their customer base (see also positive coefficient on share of non-Belgian population in 1991), whereas in period 3, this effect may have been more of a consequence of the onset of new technologies (notably home-banking), which the elderly use far less.

4.1.2 Spatial Diagnostics

Spatial dependency is generally detected through evidence of spatial autocorrelation in the residuals, which may be due to three categories of spatial effects. First is the correlation between the spatially lagged regressors and the dependent variable (i.e., WX affects Y). For instance, banks may be entering a neighbourhood because contiguous neighbourhoods are becoming richer (and are obtaining more banks as well). In our empirical specification, we fully account for this effect by including the set of spatially lagged variables.

The second problem may be due to unobserved similarity in contiguous observations arising from factors which may or may not be correlated with the included regressors. In the former case, there is an omitted variable bias; whereas in the latter case, only the precision of the estimates is affected. To illustrate, banks might be entering a specific area because of a newly built road. Since we do not have data on roads, this is an unobservable factor to us, which may or may not affect the socio-economic characteristics of a neighbourhood. We partially

[15] Ideally it would be better to control directly for the diffusion of retail businesses by neighbourhoods, as they are likely to affect branch location. Unfortunately, such detailed data are not available.

Table 4: Regressions of zonal statistic, flows, further controls

VARIABLES	(1) Δ zonal statistic	(2) Entry	(3) Exits
Average income 1991	0.0968*	0.161**	0.0644**
	(0.0552)	(0.0659)	(0.0315)
Average income 1996	0.284***	0.174***	-0.110***
	(0.0526)	(0.0429)	(0.0329)
Average income 2001	0.0814	0.0931*	0.0119
	(0.0598)	(0.0516)	(0.0378)
Zonal statistic	-0.115***	0.196***	0.311***
	(0.0157)	(0.0143)	(0.0123)
Active/tot pop. 1991	0.152	0.330***	0.176
	(0.153)	(0.110)	(0.112)
Active/tot pop. 1996	-0.511**	-0.184	0.328***
	(0.202)	(0.160)	(0.119)
Active/tot pop. 2001	0.198	0.136	-0.0617
	(0.144)	(0.108)	(0.0931)
Tot. pop. (log)	0.00307	-0.00308	-0.00616*
	(0.00417)	(0.00426)	(0.00328)
Non Belgian/tot pop. 1991	0.254***	0.159*	-0.0945
	(0.0895)	(0.0886)	(0.0634)
Non Belgian/tot pop. 1996	0.162	0.130	-0.0322
	(0.110)	(0.0905)	(0.0706)
Non Belgian/tot pop. 2001	0.0258	0.0609	0.0345
	(0.117)	(0.0922)	(0.0844)
Elderly/tot pop. 1991	0.411***	0.352***	-0.0609
	(0.136)	(0.113)	(0.0947)
Elderly/tot pop. 1996	0.000818	0.156	0.155
	(0.162)	(0.162)	(0.110)
Elderly/tot pop. 2001	0.287**	0.173*	-0.114
	(0.122)	(0.0899)	(0.0826)
Centre dummy	-0.00320	0.0154	0.0186**
	(0.0148)	(0.0157)	(0.00837)
Time f.e.	YES	YES	YES
District. f.e.	YES	YES	YES
Time-district f.e.	YES	YES	YES
Observations	699	699	699
R^2	0.342	0.685	0.849

Heteroscedasticity robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 5: Regressions of zonal statistic, flows, further controls and spatial lags

VARIABLES	(1) Δ zonal statistic	(2) Entries	(3) Exits
Average income 1991	0.0551	0.106*	0.0513
Average income 1996	0.229***	0.167***	-0.0629*
Average income 2001	0.0479	0.0763	0.0286
zonal statistic	-0.115***	0.197***	0.311***
Active/tot pop. 1991	0.227	0.492***	0.263**
Active/tot pop. 1996	-0.421*	-0.150	0.273*
Active/tot pop. 2001	0.291*	0.0994	-0.192*
Tot. pop. (log)	0.00151	-0.00438	-0.00590*
non Belgian/tot pop. 1991	0.228**	0.274***	0.0458
non Belgian/tot pop. 1996	-0.0127	-0.0112	0.00247
non Belgian/tot pop. 2001	0.148	0.0938	-0.0554
elderly/tot pop. 1991	0.397**	0.438***	0.0396
elderly/tot pop. 1996	-0.0495	0.128	0.179
elderly/tot pop. 2001	0.312**	0.137	-0.175*
W average income 1991	-0.0205	0.123	0.144
W average income 1996	0.587***	0.0968	-0.491***
W average income 2001	0.0685	-0.0313	-0.0999
W zonal statistic	0.0655	0.0850	0.0195
W active/tot pop. 1991	-0.369	-0.707*	-0.336
W active/tot pop. 1996	-0.569	-0.865**	-0.299
W active/tot pop. 2001	0.0305	0.208	0.179
W tot. pop. (log)	0.0392	-0.0136	-0.0526**
W elderly/tot pop. 1991	0.585	0.117	-0.468
W elderly/tot pop. 1996	-0.218	-0.329	-0.114
W elderly/tot pop. 2001	0.0365	0.0664	0.0327
W non Belgian/tot pop. 1991	-0.217	-0.541*	-0.324
W non Belgian/tot pop. 1996	0.938***	0.420	-0.520**
W non Belgian/tot pop. 2001	-0.385	-0.280	0.107
Centre dummy	-0.00805	0.0160	0.0241
Time f.e.	YES	YES	YES
District. f.e.	YES	YES	YES
Time-district f.e.	YES	YES	YES
Observations	699	699	699
R^2	0.374	0.700	0.858

*** p<0.01, ** p<0.05, * p<0.1

Time, district, and time-district dummies included in all the specifications deal with this problem by including the district dummies.

The third spatial effect concerns the causal effect of the contiguous dependent variable on the dependent variable (WY affects Y). To illustrate, banks might be exiting a neighbourhood because a lot of banks are entering the contiguous neighbourhoods, thus raising competition pressures. We do not control for this type of spatial effect. To the extent that this effect is at play, it may be introducing a bias in our estimates. Indeed, from a theoretical ground, it is plausible that the net change in branch presence in one neighbourhood has true causal effects on changes in contiguous neighbourhoods. Models fitted to cope with this, called "spatial lag models", cannot be estimated using OLS because the spatially lagged dependent variable would then be endogenous by construction (this is also known as "you are your neighbour's neighbour" problem), and are thus generally estimated by maximum likelihood (Anselin, 1988). However, in a longitudinal setting, further complications arise and frontier econometric techniques need to be applied (for a survey of available methods see Elhorst, 2009). Avoiding these models, whenever they are not strictly necessary, is rewarding in terms of both efficiency and simplicity of estimates.

Table 6: Spatial diagnostics, p-values

Period	Dep. var.	LM error	LM error robust	LM sp. lag	LM sp. lag robust
1991-1996	net flow	0.50	0.28	0.27	0.16
	entry	0.31	0.12	0.07	0.03
	exit	0.18	0.73	0.19	0.93
1996-2001	net flow	0.76	0.66	0.66	0.58
	entry	0.79	0.63	0.69	0.57
	exit	0.87	0.07	0.68	0.07
2001-2006	net flow	0.54	0.97	0.51	0.80
	entry	0.55	0.07	0.94	0.09
	exit	0.54	0.06	0.84	0.08

Appropriate statistical tests show that more complex models are indeed unnecessary in our context. More precisely, we estimate model 1 again, this time in a cross-section setting (thus allowing all the coefficients to vary over time) and including a spatial autoregressive parameter in the error term. The error term then has the following structure:

$$\epsilon_i = \lambda W \epsilon_i + u_i \tag{2}$$

where λ is the spatial autoregressive parameter, W is a spatial contiguity matrix, and u is a vector of homoskedastic and uncorrelated errors. We then run a Lagrange Multiplier test on the significance of the λ coefficient, in both the standard and robust version (Anselin and Hudak, 1992). Subsequently, we estimate a spatial lag version of our model by adding a spatially lagged dependent variable on the RHS of the equation (ρWY). Again, we then run a Lagrange Multiplier test (and its robust counterpart) of significance of the autoregressive parameter ρ. The results of the test are reported in Table 6: none of the non-robust versions of the tests are significant at 5% level, and only one statistic is significant at 10% (LM spatial lag for entry in 1991-96). Considering that the robust tests should not be considered when the non robust versions are not significant (Anselin et al., 1996; Anselin and Florax, 1995), we can therefore conclude that, overall, the model reported in equation 1 does not omit significant spatial effects.

4.1.3 Robustness Checks

A massive wave of mergers and acquisitions (henceforth, M&As) swept through the Belgian banking sector during the period of analysis, and especially from the late '90s onwards. This might have affected branch closures in periods 2 and 3 in two ways. First, M&As are often followed by a general rationalization of the existing branch network; second, we may observe a number of closure of branches due to the fact that two contiguous banks belonging to different groups before the M&A became part of the same group after the M&A; as a consequence, one of the two closed. While the first factor is difficult to identify in the data (we do not know how many branches of the same groups would have closed in absence of the M&A), we can instead detect fairly precisely all the branches which closed for the second reason. We therefore decided to identify them, and to estimate the same OLS regressions reported in Tables 3-5, but now excluding the exits due to M&As.

Specifically, for every branch exiting in a given period, we checked whether this branch had become part of the same bank group as the one of another bank located within the range of 300 meters following an M&A, or whether there was another bank within the range 300 meters that had become part of the same group. If one of these two conditions was fulfilled, then we identified this exit as an exit due to M&As. It turns out that these M&A-exits account for about one third of all exits in the second and third period (we do not observe any M&A in the first period).

Subsequently, we re-estimated equation 1, this time without the exits due to M&As. Results, reported in Table 7 and 8 , reveal that, overall, excluding M&A-induced exits does not contradict our main results.[16] The estimated coefficients are less precise and smaller in magnitude, which suggests that the net M&A-related exits were correlated with the general trend of exits and that they were not randomly located in space.

A second concern for the robustness of our results relates to small bank-groups. Those may introduce noise into our measure of branch presence, as they may target specific customer groups and show peculiar location strategies. We therefore run the same regressions considering only banks belonging to the major five groups in Belgium: AXA, DEXIA, FORTIS, ING and KBC. The "big five" account for around two thirds of all branches in Antwerp. As compared to results from the whole sample, now in the regression of entries (column 2 of table 9) the coefficient on income for the second period is reduced, although still significant; and this obviously affects also the same coefficient in the regression of net flows (column 1 of 9). This implies that, in the immediate aftermath of liberalization, bigger bank groups were somewhat less reluctant to open branches in poor neighbourhoods. Apart from this, overall the results look extremely similar to the ones we presented previously.

[16] We omitted standard errors from Table 8 to ease readability; the full table is available from the authors upon request

Table 7: Regressions excluding exits due to mergers

VARIABLES	(1) Δ zonal statistic	(2) Exits
Average income 1991	0.0324	0.0710*
	(0.0395)	(0.0384)
Average income 1996	0.0893**	-0.0232
	(0.0362)	(0.0233)
Average income 2001	0.0404	0.0144
	(0.0284)	(0.0365)
Tot. pop. (log)	-0.00412	0.0337***
	(0.00451)	(0.00616)
dummy first period	-0.176	-0.536**
	(0.226)	(0.218)
dummy second period	-0.439**	-0.0431
	(0.201)	(0.143)
dummy third period	-0.210	-0.221
	(0.163)	(0.209)
Observations	699	699
R^2	0.064	0.498

Heteroscedasticity robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 8: Regressions excluding exits due to mergers, further controls

VARIABLES	(1) Δ zonal statistic	(3) Exits	(2) Δ zonal statistic	(4) Exits
Average income 1991	0.0772	0.0840***	0.0300	0.0764**
Average income 1996	0.236***	-0.0617**	0.200***	-0.0338
Average income 2001	0.0466	0.0467	0.0237	0.0528*
zonal statistic	-0.0281*	0.225***	-0.0320*	0.229***
Active/tot pop. 1991	0.0273	0.301***	0.145	0.345***
Active/tot pop. 1996	-0.328	0.145	-0.389	0.241*
Active/tot pop. 2001	0.122	0.0145	0.111	-0.0124
Tot. pop. (log)	-0.00178	-0.00131	-0.00392	-0.000470
non Belgian/tot pop. 1991	0.115	0.0438	0.181*	0.0928
non Belgian/tot pop. 1996	0.169*	-0.0392	-0.0236	0.0134
non Belgian/tot pop. 2001	-0.0142	0.0744	0.0247	0.0681
elderly/tot pop. 1991	0.206	0.144*	0.240	0.196**
elderly/tot pop. 1996	0.142	0.0141	0.00344	0.126
elderly/tot pop. 2001	0.241**	-0.0683	0.206	-0.0695
W average income 1991			-0.0207	0.144
W average income 1996			0.387**	-0.291**
W average income 2001			-0.126	0.0951
W zonal statistic			0.163**	-0.0784*
W active/tot pop. 1991			-0.835	0.129
W active/tot pop. 1996			-0.352	-0.516
W active/tot pop. 2001			0.0386	0.171
W tot. pop. (log)			-0.0108	-0.00265
W elderly/tot pop. 1991			0.242	-0.125
W elderly/tot pop. 1996			0.0626	-0.394
W elderly/tot pop. 2001			0.151	-0.0820
W non Belgian/tot pop. 1991			-0.535*	-0.00554
W non Belgian/tot pop. 1996			0.832***	-0.414**
W non Belgian/tot pop. 2001			-0.361	0.0824
centre	0.0145	0.000901	0.00142	0.0146
Time f.e.	YES	YES	YES	YES
District. f.e.	YES	YES	YES	YES
Time-district f.e.	YES	YES	YES	YES
Observations	699	699	699	699
R^2	0.171	0.797	0.211	0.804

*** p<0.01, ** p<0.05, * p<0.1

Table 9: Regressions of zonal statistic, flows, 5 biggest bank groups only

VARIABLES	(1) Δ zonal statistic	(2) Entry	(3) Exits
Average income 1991	-0.0131	0.0698**	0.0828**
	(0.0381)	(0.0346)	(0.0326)
Average income 1996	0.185**	0.0720**	-0.113***
	(0.0416)	(0.0324)	(0.0329)
Average income 2001	0.0497	0.0321	-0.0175
	(0.0341)	(0.0236)	(0.0331)
Zonal statistic	-0.0935***	0.0980***	0.192***
	(0.0141)	(0.00888)	(0.0101)
Active/tot pop. 1991	-0.0438	0.284***	0.327***
	(0.165)	(0.0843)	(0.122)
Active/tot pop. 1996	-0.300**	-0.139	0.161
	(0.132)	(0.0911)	(0.0940)
Active/tot pop. 2001	0.127	0.0670	-0.0597
	(0.139)	(0.102)	(0.0804)
Tot. pop. (log)	0.000102	0.00453	0.00442
	(0.00334)	(0.00238)	(0.00292)
Non Belgian/tot pop. 1991	0.159**	0.151***	-0.00798
	(0.0766)	(0.0507)	(0.0622)
Non Belgian/tot pop. 1996	0.0711	0.0419	-0.0292
	(0.0907)	(0.0596)	(0.0729)
Non Belgian/tot pop. 2001	-0.00784	0.0391	0.0469
	(0.0892)	(0.0532)	(0.0774)
Elderly/tot pop. 1991	0.178	0.314***	0.136
	(0.122)	(0.0758)	(0.0912)
Elderly/tot pop. 1996	0.0865	0.0454	-0.0411
	(0.114)	(0.0816)	(0.0838)
Elderly/tot pop. 2001	0.0942	0.0606	-0.0336
	(0.125)	(0.0848)	(0.0765)
Centre dummy	-0.00413	0.00186	0.00599
	(0.0101)	(0.00770)	(0.00830)
Time f.e.	YES	YES	YES
District. f.e.	YES	YES	YES
Time-district f.e.	YES	YES	YES
Observations	699	699	699
R^2	0.361	0.601	0.751

Heteroscedasticity robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

4.2 Bank Void, Bank Choice and Neighborhood characteristics

We analyze spatial patterns of bank void and bank choice using a very similar approach to the one advanced in the previous subsection. Technically, we estimate the same empirical specification as in equation 1. However, our measures of bank void and bank choice have different spatial properties than the zonal statistics, as they are (by construction) much more dependent on the value of the same variable in contiguous neighbourhoods - which, in passing, was exactly one of the aims of the statistic. The econometric consequence of this is that now the null hypothesis that a spatial autoregressive component for the dependent variable is insignificant cannot be rejected. Adding spatially lagged control variables to our model, as we did for the analysis of branch dynamics, would not solve the problem. The parameters of these spatially lagged controls would only reflect the nuisance in the data, instead of reflecting a causal effect of the controls on the dependent variable. Nevertheless, a spatial lag model is likely to absorb mainly this component, rather than a true causal effect on the dependent variable originating from its spatial lags. We, therefore, prefer to estimate equation 1 using OLS, also considering that alternative estimations - reported in Appendix B - based on spatial lag and spatial error models, gave very similar results.

Just like the zonal statistics in the previous subsection, our measure of bank void is a measure of bank location. Therefore, subsequent analyses with bank void as the dependent variable also serve as a robustness check of the previous results. Interestingly, the correlation between the change in bank void and change in zonal statistic at the neighbourhood level is about 0.2, which suggests that the two measures do capture distinct, albeit related constructs.

4.2.1 Results

Results in column 1 of Table 10 show that only in period 2 the net change in bank void was very strongly negatively correlated with average income. This finding is robust across the different specifications.

Column 2 of Table 10 provides evidence that only in period 2 the distance to at least three distinct banks increased significantly in people living in poorer neighbourhoods. Table 11 confirms that our results are robust to the inclusion of additional control variables.

Finally, the finding that in period three the proportion of elderly citizens (holding everything else constant) negatively predicts the net change in bank desert and choice is again consistent with our earlier finding that this also positively predicted net flow of bank. It also lends support to our earlier conjecture that the dynamics in period three were plausibly more strongly driven by technological innovations. The overall restructuring of bank networks (in period three) thus appears to show special concern for the elderly, who tend to lag behind in the adoption of home banking, and (no less) importantly constitute 'captured' clients of banks (Dell'Ariccia and Marquez, 2000).

4.3 Discussion

We analyzed five distinct measures of change, capturing the branch network dynamics, branch availability and bank choice, and they all support our main insights. The financial liberaliza-

Table 10: regression of bank "desert" and bank choice

VARIABLES	(1) Δ dist 1st bank	(2) Δ dist 3 groups
Average income 1991	1.966	22.53
	(11.24)	(16.62)
Average income 1996	-15.26***	-37.69***
	(4.802)	(13.90)
Average income 2001	24.08	41.54*
	(15.87)	(23.51)
Tot. pop. (log)	-4.240*	-5.725**
	(2.491)	(2.761)
dummy first period	24.55	-76.71
	(67.84)	(88.93)
dummy second period	115.8***	249.1***
	(35.92)	(80.45)
dummy third period	-87.99	-154.8
	(81.58)	(126.8)
Observations	699	699
R^2	0.070	0.133

Heteroscedasticity robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 11: regression of bank "desert" and bank choice, further controls

	(1)	(2)	(3)	(4)
VARIABLES	Δ dist 1st bank	Δ dist 1st bank	Δ dist 3 groups	Δ dist 3 groups
Average income 1991	-5.476	4.463	14.99	35.41**
Average income 1996	-20.21***	-11.88**	-39.60***	-29.83**
Average income 2001	1.919	18.83	13.51	2.068
Zonal statistic	1.311	2.943	0.593	-0.611
Active/tot pop. 1991	2.605	0.948	7.319	-88.51**
Active/tot pop. 1996	-36.58	-31.09	68.03	90.10
Active/tot pop. 2001	-108.0*	-129.5*	-71.30*	-184.9**
Tot. pop. (log)	-4.523*	-3.544	-5.020*	-5.235*
non Belgian/tot pop. 1991	-22.08	0.855	-15.97	-5.167
non Belgian/tot pop. 1996	-26.86	-9.862	14.93	29.08
non Belgian/tot pop. 2001	-92.48	-23.07	85.76	2.853
Elderly/tot pop. 1991	-31.73	-19.07	-55.63	-102.1**
Elderly/tot pop. 1996	-44.63*	-34.87**	37.45	45.51
Elderly/tot pop. 2001	-197.4***	-183.6***	-65.48	-181.2**
W average income 1991		-12.06		9.497
W average income 1996		-71.36**		-27.25
W average income 2001		-140.6*		251.2**
W zonal statistic			-70.87***	-37.11
W active/tot pop. 1991		-75.63		374.7**
W active/tot pop. 1996		-109.2**		-301.6*
W active/tot pop. 2001		292.5*		229.4
W tot. pop. (log)		-20.28*		-33.67
W elderly/tot pop. 1991		-241.0*		-185.8
W elderly/tot pop. 1996		-73.54		-277.6*
W elderly/tot pop. 2001		-330.2*		130.2
W non Belgian/tot pop. 1991		-11.48		199.6**
W non Belgian/tot pop. 1996		-75.50		69.73
W non Belgian/tot pop. 2001		-463.6**		617.0***
centre	-0.768	-3.031	6.496	-12.33
Observations	699	699	699	699
R^2	0.201	0.265	0.394	0.430

Heteroscedasticity robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

tion peak in the late nineties effectively accelerated and altered the spatial dynamics of bank branch networks. Its immediate effects directly and systematically disenfranchised the poor. Intensified branch dynamics persisted well beyond the liberalization peak, though then indiscriminately, showing no systematic relationship with neighborhood income. Indirectly though, since banks not only further rationed their branches but also hastened to curtail available face-to-face services, the branch network dynamics between 2001 and 2006 arguably also hurt the poor disproportionately more.

The finding that liberalization, in first instance, led to a greater reduction in proximity to, and choice over, banks in the poorest neighbourhoods brings some important policy implications. Admittedly, physical proximity is not the only dimension of bank quality that matters to consumers. For instance, people also care about the price and quality of bank service. In fact, with the overall growing use of internet services, one might expect physical distance to a bank branch and its rival to loose importance. Though important, these considerations do not undermine the significance of our results, not least because proximity is arguably still particularly important for the poor. First, the poor are much less likely to own a car. As a consequence, Dieleman, Dijiest and Burghouwt (2002) show that the poor in the Netherlands are relatively more likely to shop locally than the wealthy. Talukdar (2008) likewise finds similar differential price search patterns by poverty level and whether the household has access to a car. Second, internet penetration and usage is still far smaller amongst the poor, suggesting that the poor will continue to be more heavily dependent on face-to-face bank services than on internet services in the foreseeable future. But also, given that they also tend to perform worse on financial literacy tests, the poor are arguably also in greater need of additional, face-to-face support. Finally, Degryse and Ongena (2007) provide evidence that even small and medium enterprises in Belgium tend to consume bank services locally.

Consequences of having fewer banks to choose from or having to travel longer distances to reach a bank, as demonstrated elsewhere, can be wide-ranging. It may lead people to make less use of bank services, or even avoid banks altogether. Also, as Degryse and Ongena (2005) show for small and medium enterprises in Belgium, that physical distance between a private borrower and a bank and its rivals affects the loan conditions.

Our findings suggest a role for government to help buffer the revealed immediate, adverse implications of liberalization reforms for lower-income households. Possible, relevant interventions are wide-ranging: they could be as simple as lowering the (perceived) cost of travel for the poor say by improving the public transport infrastructure, or as structural as mandating financial literacy training in secondary school curricula, or as radical as pro-actively countering residential segregation by income say through the allocation of housing vouchers.

5 Conclusion

This paper has made three contributions to our understanding of the effects of bank deregulation on the spatial dynamics of branching, exploiting - much like a quasi-natural experiment - the context of intense liberalization reforms in Belgium in the late nineties.

Using new panel data on branch dynamics (within the metropolitan area of Antwerp) that we have collected from an archival source, our first contribution was to assess whether the liberalization peak measurably affected the dynamics of branch networks. We find that liberalization radically shifted and accelerated branch network dynamics (entries, exits and net flows), and that these effects were not only immediate, but also long-lasting.

Our second contribution was to investigate the influence of the liberalization reforms on bank choice for the everyday consumer. We find that bank choice initiated a marked decline between 1996 and 2001, which further continued over the five-years thereafter.

Third, the immediate versus longer-term spatial ramifications of the financial sector liberalization were very distinct. Using new neighborhood-level measures of aggregate branch entry and exit that we developed ourselves, we found that in the period coinciding with the liberalization peak, suddenly branches were significantly more likely to exit poor neighborhoods and enter their wealthier counterparts. Relatedly, the level change in financial void spread unevenly during this period, that is, the poorer neighbourhoods experienced a sudden, significant increase in bank desert. The dynamics in the aftermath of the liberalization peak exhibited no such systematic relationship with neighborhood income. Rather, they are consistent with patterns of change in technological innovations, notably the penetration and rise of online banking.

One limitation of the present study is its focus, due to data constraints, on the spatial dimension of branching dynamics in relation to the neighborhoods' socio-demographic characteristics alone. This focus removes the possibility to more directly assess the impacts of liberalization reforms, mediated by changes in branch network dynamics, on household finance and other consumer behaviours. Another limitation is that we do not have service price and quality data by branch. It would be interesting to explore whether they vary with neighborhood income, number of competing banks and distance to closest competitor. These are interesting areas for future research.

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Appendix A: Regressions using bank counts

This appendix reports the results obtained by using the simple counts of banks instead of the zonal statistic. Although the correlation among the two measures is quite high (see table 12), the results obtained using the simple count are overall much less significant, as expected.

We reach this conclusion after estimating the model of equation 1 with two alternative specifications. The first is a standard OLS, to ease comparability with the previous estimates. The second one accounts for the fact that with count variables OLS are inconsistent, and - also considering the large number of zeros present in the entry and exit variables - the most appropriate econometric model is a Zero Inflated Negative Binomial. In the latter case, the number of exits and entries are regressed on all the variables of the regression reported in table 4, while the zeros are a function of the zonal statistic at the beginning of the period and the area of the neighbourhood. The difference in the bank count between the end and the beginning of the period, instead, contains only few zeros; therefore, it has been linearly transformed to a non-negative variable (by adding four to all the observations), and is regressed by means of a Poisson model.

Results are reported in tables 13 and 14. In both the cases, the results obtained with the simple counts of banks are clearly less significant, which suggests that the dependent variable is considerably less precise. This is particularly evident when the dependent variables are the number of entries and exits (col. 2 and 3 of table 13 and col. 2 and 4 of table 14).

Table 12: Zonal statistic and bank counts: pairwise correlations

Pairwise correlation	Zon. st. flow	Zon. st. entry	Zon. st. exit
Δ bank count	0.74		
Entry count		0.66	
Exit count			0.71

Table 13: Regression of bank counts, OLS

	(1)	(2)	(3)
COEFFICIENT	Δ Bank count	entry count	exit count
Model	OLS	OLS	OLS
Average income 1991	0.421	0.522	0.125
	(0.61)	(0.57)	(0.25)
Average income 1996	1.231***	0.236	-0.210
	(0.45)	(0.34)	(0.31)
Average income 2001	0.666	0.300	-0.336
	(0.43)	(0.38)	(0.41)
Zonal statistic	-0.802***	0.707***	1.436***
	(0.14)	(0.11)	(0.10)
Active/tot pop. 1991	1.059	1.961**	1.012
	(1.33)	(0.97)	(1.07)
Active/tot pop. 1996	-3.054*	-1.203	0.306
	(1.58)	(0.78)	(0.91)
Active/tot pop. 2001	0.999	1.098	0.117
	(1.31)	(1.02)	(1.12)
Tot. pop. (log)	0.0460	0.0479**	0.0234
	(0.034)	(0.023)	(0.029)
non Belgian/tot pop. 1991	1.110	0.516	-0.650
	(0.89)	(0.78)	(0.52)
non Belgian/tot pop. 1996	0.534	-0.185	-0.404
	(0.86)	(0.61)	(0.66)
non Belgian/tot pop. 2001	-0.202	-0.329	-0.171
	(0.98)	(0.65)	(1.03)
elderly/tot pop. 1991	2.345*	2.129*	-0.0578
	(1.25)	(1.10)	(0.83)
elderly/tot pop. 1996	0.0402	-0.788	-0.434
	(1.30)	(0.83)	(0.87)
elderly/tot pop. 2001	1.026	0.691	-0.191
	(0.99)	(0.85)	(0.92)
Centre dummy	0.103	0.0830	0.0360
	(0.12)	(0.096)	(0.093)
Constant	-3.692	-4.978	-1.666
	(3.90)	(3.76)	(1.70)
Observations	699	699	699
R^2	0.14	0.21	0.42

Heteroscedasticity robust standard errors in parentheses
Time, district, and time-district dummies included in all the specifications
*** p<0.01, ** p<0.05, * p<0.1

Table 14: Regression of bank counts, zero inflated negative binomial

	(1)	(2)	(3)	(4)	(5)
VARIABLES	Δ Bank count	entry count	inflate	exit count	inflate
Model	Poisson	ZINB	ZINB	ZINB	ZINB
Average income 1991	0.112	1.482		0.531	
	(0.148)	(1.243)		(0.654)	
Average income 1996	0.316***	1.048		-0.424	
	(0.110)	(1.433)		(0.936)	
Average income 2001	0.177	0.845		-0.727	
	(0.112)	(0.777)		(0.599)	
Zonal statistic	-0.219***	0.902**	-13.86**	1.388***	-13.67***
	(0.0381)	(0.408)	(6.711)	(0.175)	(2.796)
active/tot pop. 1991	0.283	6.678**		3.007	
	(0.324)	(3.161)		(2.341)	
Active/tot pop. 1996	-0.780*	-4.285		3.343	
	(0.400)	(3.768)		(2.551)	
Active/tot pop. 2001	0.280	2.468		1.279	
	(0.343)	(3.407)		(1.779)	
Tot. pop. (log)	0.0128	0.293**		0.156*	
	(0.00836)	(0.135)		(0.0800)	
non Belgian/tot pop. 1991	0.294	1.167		-0.744	
	(0.213)	(2.371)		(1.508)	
non Belgian/tot pop. 1996	0.142	0.582		1.652	
	(0.206)	(2.900)		(2.005)	
non Belgian/tot pop. 2001	-0.0532	-2.946		-0.281	
	(0.258)	(2.368)		(2.082)	
elderly/tot pop. 1991	0.615**	6.987**		1.625	
	(0.297)	(3.507)		(2.268)	
elderly/tot pop. 1996	0.0152	-0.452		3.042	
	(0.319)	(3.584)		(2.648)	
elderly/tot pop. 2001	0.283	0.643		0.186	
	(0.260)	(2.649)		(1.678)	
centre dummy	0.0277	0.390		0.118	
	(0.0314)	(0.323)		(0.204)	
area			3.46e-07		-3.39e-07
			(4.35e-07)		(2.40e-07)
Constant	0.403	-17.82**	3.195***	-7.826**	3.317***
	(0.944)	(8.953)	(1.102)	(3.922)	(0.792)
Observations	699	699	699	699	699

Heteroscedasticity robust standard errors in parentheses
Time, district, and time-district dummies included in all the specifications
*** p<0.01, ** p<0.05, * p<0.1

Appendix B: Spatial econometric models of desert and choice variables

In this appendix we report the results of the regressions based on spatial econometric models of the specifications we discussed in section 4.2. The models we estimate are the spatial error and the spatial lag model described in section 4.1.4; to ease computation, we split the sample by each period - this, however, affects only the structure of the residuals and leaves unchanged the point estimates, which are therefore fully comparable with the corresponding OLS results reported in table 10. As it is possible to see in table 15, 16, and 17, the results do not change the general picture obtained from the OLS estimates. In particular, in the second period (1996-2001), the only one for which the coefficients on income are significant, the difference in the point estimates is minimal, especially as compared to the spatial lag model.

Table 15: Spatial regression desert and choice variables, 1991-1996

	(1)	(2)	(3)	(4)
COEFFICIENT	Δ dist 1st bank	Δ dist 3 groups	Δ dist 1st bank	Δ dist 3 groups
Spatial model	ERROR	ERROR	LAG	LAG
Average income	-3.165	16.67	-3.018	10.75
	(12.4)	(11.5)	(10.5)	(11.1)
Active/tot pop.	26.54	-20.48	24.25	-1.045
	(27.3)	(23.0)	(27.4)	(20.6)
Tot. pop. (log)	-0.935	-0.399	-1.125	-0.802
	(1.97)	(2.94)	(1.93)	(2.77)
non Belgian/tot pop.	-2.038	5.154	-7.943	-11.10
	(18.4)	(16.1)	(19.2)	(20.5)
elderly/tot pop. 1991	0.454	-38.38	-9.007	-48.77
	(27.0)	(27.8)	(30.2)	(32.3)
centre	-3.618	-7.600	-1.384	-0.477
	(3.33)	(6.77)	(2.49)	(4.08)
Constant	28.98	-48.61	23.15	-41.79
	(84.2)	(59.8)	(73.3)	(73.1)
Observations	233	233	233	233

Heteroscedasticity robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 16: Spatial regression desert and choice variables, 1996-2001

	(1)	(2)	(3)	(4)
COEFFICIENT	Δ dist 1st bank	Δ dist 3 groups	Δ dist 1st bank	Δ dist 3 groups
Spatial model	ERROR	ERROR	LAG	LAG
Average income	-10.66*	-35.06***	-14.04**	-34.34***
	(5.71)	(12.5)	(5.48)	(10.5)
Active/tot pop.	-12.74	86.24	-19.17	37.88
	(17.8)	(56.3)	(21.5)	(44.3)
Tot. pop. (log)	-1.120	-4.413**	-1.555	-5.542**
	(1.14)	(2.14)	(1.30)	(2.27)
non Belgian/tot pop.	-9.437	9.996	-17.52	0.975
	(15.0)	(28.7)	(17.6)	(27.0)
elderly/tot pop. 1991	-22.32	45.46	-31.04	15.64
	(14.7)	(50.8)	(20.1)	(45.7)
centre	-1.279	1.292	-1.586	-0.0244
	(3.54)	(7.50)	(2.85)	(4.45)
Constant	81.43**	149.1**	106.8***	200.0***
	(35.2)	(74.3)	(38.6)	(73.2)
Observations	233	233	233	233

Heteroscedasticity robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 17: Spatial regression desert and choice variables, 2001-2006

	(1)	(2)	(3)	(4)
COEFFICIENT	Δ dist 1st bank	Δ dist 3 groups	Δ dist 1st bank	Δ dist 3 groups
Spatial model	ERROR	ERROR	LAG	LAG
Average income	-3.165	16.67	-3.018	10.75
	(12.4)	(11.5)	(10.5)	(11.1)
Active/tot pop.	26.54	-20.48	24.25	-1.045
	(27.3)	(23.0)	(27.4)	(20.6)
Tot. pop. (log)	-0.935	-0.399	-1.125	-0.802
	(1.97)	(2.94)	(1.93)	(2.77)
non Belgian/tot pop.	-2.038	5.154	-7.943	-11.10
	(18.4)	(16.1)	(19.2)	(20.5)
elderly/tot pop. 1991	0.454	-38.38	-9.007	-48.77
	(27.0)	(27.8)	(30.2)	(32.3)
centre	-3.618	-7.600	-1.384	-0.477
	(3.33)	(6.77)	(2.49)	(4.08)
Constant	28.98	-48.61	23.15	-41.79
	(84.2)	(59.8)	(73.3)	(73.1)
Observations	233	233	233	233

Heteroscedasticity robust standard errors in parentheses
*** $p<0.01$, ** $p<0.05$, * $p<0.1$