TECHNOLOGY AND THE (RE)LOCATION OF FINANCIAL ACTIVITY

A EUROPEAN PERSPECTIVE*

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TECHNOLOGY AND THE (RE)LOCATION OF FINANCIAL ACTIVITY
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Samenvatting
Technologische veranderingen in met name informatietechnologie hebben productieprocessen in de financiële dienstverlening ingrijpend gewijzigd. Deze ontwikkelingen, met name het Internet, maken nieuwe manieren van produceren mogelijk waardoor afstand minder belangrijk zou kunnen worden. Sommigen beargumenteren zelfs dat afstand volkomen irrelevant is geworden. Heden ten dage zijn echt goed functionerende financiële internet-applicaties echter nog dun gezaaid, vooral in Europa. Empirische onderbouwing van de stelling dat afstand er niet langer toe doet, is derhalve lastig. Gebruikmakend van met name non-parametrische methoden, wordt in dit paper de ontwikkeling van de verdeling van de productie en werkgelegenheid in 117 regio’s in Europa geanalyseerd. Daarbij wordt rekening gehouden met de mogelijke effecten van thuismarkten, centrum-periferie effecten en (veranderingen in) de toezichtsomgeving. De voorlopige conclusie is dat er tot op heden (nog) geen verschuiving van productie heeft plaatsgevonden.

Trefwoorden: technologie, Internet, locatie, financiële diensten, bank- en verzekeringswezen;
JEL-code: G20, G21,R12;

Abstract
Technological change, especially in information technology, has brought profound changes to services sectors like the financial sector. Two decades ago, closed-system communications methods like faxing had yet to break through. Presently the internet, with its open architecture, makes new ways of communication and production possible, changing the way banks operate. Some even argue that this makes geographical constraints irrelevant, i.e. "Geography doesn't matter".
To date, however, working internet-applications are few and far between, especially in Europe. Empirical validation of the, on theoretical grounds attractive, notion that distance is quickly becoming irrelevant, is thus very difficult. We therefore turn to the natural experiment of changes in other communications-methods like faxing and (cellular) phones in the past two decades. Use of these methods has also been increasing substantially. We analyse, using mainly non-parametric methods, the development of the distribution of production of, and employment in, financial services in 117 regions in Europe. We consider the possible effects of home markets, centre-periphery effects, and – changes in – regulatory environment. We find that, except for some minor exceptions, there have not (yet) been large shifts in production and employment in financial services. If there are discernible effects, these tend to point in the opposite direction: increased concentration makes distance even more important. This might lead to the conclusion that a measurable effect of the internet, as a centrifugal force on the location of financial services, is still some way off.

Keywords: technology, Internet, location, financial services, banking and insurance.
1 Introduction

Information has always played a very important role in financial intermediation. An important function of financial intermediaries is, for instance, overcoming asymmetric information problems. Another is the transformation of funds in space and time. Both these functions require banks to process information efficiently. It is therefore not surprising that the Information Technology revolution has brought some profound changes to the financial sector. Marketplaces have become disembodied, as for example the electronic stock market Nasdaq. More recently, the emergence of electronic communication networks (ECN’s) has created virtual marketplaces. More areas of banking have been touched by IT. Backoffice operations, for example, can now be located at some distance in lower costs areas.

(Internet based) technology has made it possible to transmit large volumes of information and to access it from remote locations at low cost. This has two possible effects on banking. On the one hand, the external market environment could change: actual markets could become virtual marketplaces. On the other hand, the production process of financial services could become even more digitised.

As this might reduce the importance of distance and place, the question arises what the effect could be on the location of financial activity. Will geography become irrelevant, as argued by O’Brien (1992)? Or does place still matter, but do different places matter for different financial activities, as argued by Tschoegl (2000)? In the absence of other determining factors, we would in the first case see a complete dispersion of financial activity whereas in the second case, activities would be separated geographically, leading to concentrations in a few places.

However, long-term data on internet applications, necessary to analyse a sticky process like financial sector relocation, are not yet available. Therefore, we turn to the "natural experiment" of the last two decades. "Normal" communication technology has not only improved rapidly, but has become cheaper and more widely available as well. The telex, with its rather rigid infrastructure, has for instance been superseded by the fax. Voice-communication has increased. Growth has not been limited to fixed lines but also
mobile communication has shown impressive growth rates\(^1\). For financial institutions, this development offers the possibility to supply services along different, lower cost channels. Figure 1, for instance, shows that the costs of a payment transaction using modern technology is significantly lower.

**Figure 1** Cost of a payment transaction (in dollars)

![Cost of a payment transaction (in dollars)](image)

Source: Booz, Allen & Hamilton, 1998

Although the internet differs fundamentally, in its openness and fundamental larger reach, from other channels, it is similar in the sense that it makes communication easier and cheaper. We argue therefore that developments in the past two decades will give us a first-order approximation of the effects of improved communication technology.

In this paper, we investigate the “Geography Doesn’t Matter” or GDM-hypothesis, which says that the production of financial services could take place anywhere and geography has become irrelevant. To this end we analyse the location of financial activity, looking for a relocation of financial activities leading to a more even distribution of activity across space. Technology is, of course, not the only factor influencing the location of financial activities; numerous other (centripetal and centrifugal) forces play a role as well. A subject not analysed in this paper is how technology has influenced each of these other factors separately. Instead, we focus on the

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\(^1\) It should be noted that developing and transition economies may directly adopt the ‘newer’ technologies, i.e. the internet and mobile communication, passing over preceding technologies (‘leap-frogging’). This subject is analysed in detail by Stijn Claessens e.a. (2001).
GDM hypothesis. Generally, financial activity is measured by market turnover, which is an appropriate measure for activity on for instance exchanges. However, by looking at turnover as a measure for financial activity the scope is limited to those activities that take place on markets. We take a broader perspective and analyse gross value added and employment in the financial sector. This enlarges the scope as it also includes services like, for example, financial advice. From a political economy standpoint the development of employment, an important determinant of voting behaviour, is of interest. Since relocation is a slow process we use the longest possible time series (1980-1995) and we will limit ourselves to a European perspective.

In analysing the impact of technology on the geography of finance, we touch on the question what a financial centre is. Many definitions have been provided, but there is no universally accepted definition of an international financial centre (See Dufey and Giddy (1978), Nadler (1955), Wasserman (1963), Kindleberger (1974), and Scholtens (1992)). Generally, financial centres can be considered as an aggregated collection of activities which differ in many respects. In this paper, we define a financial centre as a geographical concentration of activities of credit and insurance institutions. Moreover, since our data is on the regional level, the activities in what we term a "centre" will not be as concentrated as is usually envisioned.

The set-up of this paper is as follows. In order to analyse the impact of technology on the location of financial activity, we first take a look at the forces that drive concentration and dispersion of these activities in theory. Then, we give a description of the data, followed by an empirical analysis. In this analysis, we first examine the changes in real gross value added and then turn to the development of employment across regions. Additionally, we will, using the data on production and employment, consecutively, analyse whether production has converged to regions with an efficient workforce. Finally, some concluding remarks are given.

2 Of course, different types of activities can be concentrated in different centres. A leading centre for Forex-trading, for instance, does not necessarily imply a strong position in options-trading. Different activities are performed within different centres, which has led researchers, as for instance Scholtens (1998, p. 299), to conclude that in ranking financial centres, 'the geography of finance is not as strictly tripolar as generally assumed' (See also Tschoegl (2000), p. 8).
2 Review of the literature

The study of the spatial concentration of economic activity goes back to Alfred Marshall (1920), who presented the seminal economic analysis of the phenomenon. He identified three main agglomerating forces, which are generated by positive externalities at the level of the firm. These forces include labour market externalities, the availability of intermediate inputs, and technological as well as informational spillovers. These three forces can be applied to the financial sector as well. In the following, we discuss the factors driving spatial concentration - and the countervailing forces of dispersion - of financial activity.

In the literature, the forces influencing the location of financial activity are divided into two groups: centralising or centripetal forces and decentralising or centrifugal forces (Gehrig, 1998, Walter, 1998). Whereas centripetal forces contribute to spatial concentration of activities in a few places, centrifugal forces cause geographical dispersion. The location of activities in particular places is likely to be the outcome of the interplay of these factors and is likely to be changing over time.

Important centripetal forces are economies of scale, which for example can be realised in the payment system and the clearing and settlement of transactions. Kindleberger (1974) states that centralisation of all payments in a single centre creates the most efficient settlement system for a given number \( n \) of financial centres. Without centralisation, \( n(n-1)/2 \) communication channels are needed to effect payments, whereas with a single centre \( n-1 \) channels suffice. Although economies of scale increase the pressure for clustering of certain activities, these activities do not necessarily have to take place within a defined geographical area. For example, payment systems are run by computers which are part of electronic communication networks. However, the location of these computers is not relevant for achieving the desired scale economies. The same holds for currency trading, which is performed within computer networks as well (Gehrig, 1998). Access to a trading network enables a financial agent to trade from any place in the world. These examples indicate that for certain activities, concentration of

\[ \text{We turn to the importance of path dependency later on in this paper.} \]
participants seems to be important because of economies of scale in the transaction technology. However, the concentration takes place within one single electronic network and the particular location of activity and participants is not relevant, except for possibly regulatory reasons (Gehrig, 1998).

In contrast to these economies of scale within a single electronic network, a different situation arises when external economies are present. In that case, participants benefit from the presence of other participants at a certain location, strengthening the importance of physical proximity. We will turn to such external economies now. First, we discuss the externalities arising from the general forces identified by Marshall for the financial sector. Then, we analyse some factors which are important for financial activity in particular.

Regarding Marshall’s first factor, labour market externalities, a concentration of activities in the same place allows a pooled labour market which offers a constant, deeper market for skill. This externality stimulates concentration from the demand side of labour as well as from the supply side, especially when skills are highly specialised. Employers will resort to locations where they are likely to find a large choice of workers with the special skills they require. Employees go to locations where many employers, needing such specialised skills, are established because there they will find a ‘deep market’ for their services. The importance of the labour market for the location choice of financial activities is underlined by the fact that finance generally requires highly skilled and often specialised labour forces. As pointed out by Kim (1990), a large labour market provides better expected job matches, which means that a large pool of labour offers more protection against idiosyncratic employment shocks. Therefore, financial agents might tend to locate in centres with large and liquid labour markets, as this may mean a quicker filling of vacancies for highly skilled labour. Rauch (1991) considers the average level of human capital as a local public good. He states that by centralisation of finance in cities with higher levels of human capital, human capital externalities can be gained which may result in lower costs for the industry as well as in a possibly higher quality of the services. Begg (1991, p. 338) argues that ‘the availability of a labour pool is an inducement to firms seeking to relocate’. 
The second point stressed by Marshall, the availability of intermediate inputs, can also be a factor contributing to the concentration of financial activity. As financial intermediaries are users of services like accounting and legal advice, locating near suppliers of such services could be advantageous since they are often needed timely. If, for example, a corporate finance deal needs to be put together quickly, it is a practical matter to have the necessary lawyers and accountants available in one place. Stuart (1975) has shown that for cases where face-to-face contact in the negotiation and purchasing process is required, a concentration of suppliers diminishes the clients’ search costs and increases the market size for every supplier. The work of Gaspar and Glaeser (1996) suggests that telecommunication technologies may be complement, or at least not a substitute for face-to-face interactions. Recently, Porter (1998) has argued that the enduring competitive advantages in the modern, global economy arise from concentrations of, among others, related businesses, institutions and competitors institutions.

The last force identified by Marshall, technological spillovers, states that the local spillover of knowledge among firms may give rise to concentration. This may be a major factor for an industry like the financial sector, where technological innovation plays an important role. Product innovations could generate positive externalities since the diffusion of new products can take place rapidly when spatial concentration is high. This is especially the case because financial innovation is generally poorly protected by patent law.

Another particularly relevant externality arising from the concentration of financial activities is the spillover of information. Financial agents may benefit from the presence of other agents at a given site as it enables them to benefit from their information. By locating at that site, access to the information flow is maximised. The value of information, however, depends not so much on its quantity, but especially on its quality and timeless. According to Porteus (1996), this makes face-to-face contact and other localised information sources important as means of rapid information diffusion. He recognises that improvements in telecommunication technologies have made access to
information more equal regardless of location, but argues that a distinction according to the type of information has to be made. *Standardised* financial information (like price quotations) can be transmitted quickly and at low cost over computer networks. In contrast, for the electronic transmission of *unstandardised* information, the quality may decline when the distance between the user and the source of information increases. He illustrates this with the example that a firm specific rumour may spread rapidly through a network, but that for agents further from the source it is more difficult to confirm and interpret the information in order to exploit it usefully. ‘*Information has value to users only in its context, against a background in which it can be correctly interpreted*’ (Porteus, 1996, p.8; see also Thrift (1988)). However, because this informational background cannot be easily standardised and transmitted across computer networks, it is more difficult to evaluate the information. Agents located near the source may have a better and quicker insight in the value of the new information, which gives them a temporary informational advantage. The importance of physical proximity to generate such a temporary informational advantage is also stressed by Gehrig (1998), who states that this is particularly important for informationally complex and sensitive products. A related argument is that because information has become more widely available, the incentive to find unexploited information has increased. This has the countervailing effect on agents to gather closer to sources of information. According to Scholtens (1992), the concentration of financial activity can be considered as a means to cheaply distribute available information as well as a means to lower the cost of acquisition of information.

Having discussed Marshall’s three, more general factors influencing location decisions, we now turn to some factors that particularly apply to the financial sector.

Gehrig (1998) points out that for the financial sector in particular, a factor driving concentration is market liquidity. In liquid markets, individual transactions cause no significant price fluctuations whereas in illiquid markets even small transactions may cause considerable price movements. As the risk of price fluctuations is lower in liquid markets, risk averse investors will prefer to trade in markets where liquidity is high. As a consequence, liquid markets will attract more trading volume, which gives rise to big,

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4 See Keller (2001) for empirical evidence that R&D expenditures generate local spillover effects. Moreover,
concentrated markets. However, thanks to technological developments like electronic trading and the recent emergence of Electronic Communication Networks (ECN’s) in the United States, physical proximity seems no longer necessary to achieve high levels of liquidity. Therefore, the argument of market liquidity is more likely to be an economy of scale within the electronic system as opposed to an externality at the level of the firm.

Also, structural changes in the financial sector have influenced the concentration of activities. The growing role of fund managers in financial markets has attracted significant amounts of capital into the hands of some big players. Fund managers prefer to be close to markets and to each other for the above mentioned externalities (Porteus, 1996).

In contrast to the above discussed centripetal forces, some decentralising or centrifugal factors can be identified. Obviously, locating in financial centres involves high cost and congestion problems. Because of the first reason, back-office functions have increasingly been decentralised to low cost locations. According to Rosen and Murray (1997), the decline of the share of employment in the financial sector in New York was partly caused by the relocation of back-office functions. McKillop and Hutchinson (1991) found some evidence that in the United Kingdom also a dispersion of head offices can be observed, besides the decentralisation of back office activities.

The cost of market access constitute another centrifugal force. This subject is analysed by Pagano (1989). As market access involves costs, investors have to decide which market to enter. In order to choose the optimal market to enter, they will compare the expected utility of market participation net of the cost of entry. The expected utility depends, for reason of the liquidity externality, on the participation of other agents. When access costs are symmetric, concentration will always take place in one market. However, when access costs differ across markets, fragmentation may exist. Furthermore, the spillover of information (a centripetal force) can also be used to argue that agents concentrated in one location are less able to take advantage of non-local information. When the value of non-local information increases, this could give rise to geographical dispersion. Different time zones are another factor favouring decentralisation (Scholtens, 2000).

Language seems to be an important determinant of the speed of technology diffusion.
Differences in time zones give rise to the emergence of financial centres, spread around the globe, among which trading is possible twenty-four hours a day (Thrift and Leyshon, 1988). Finally, a factor that influences the location choice is that financial service suppliers tend to follow their major (international) clients in order to serve them optimally (Towey, 1974; Champagne, 1992). The continuation of servicing already established client relationships has been put forward as a motive for the internationalisation of financial intermediaries (Bryant, 1987, Casson, 1990). In this sense, financial activity follows real activity. Buch (2000) finds a strong and positive correlation between the foreign activities of German banks and the foreign activities of German firms, concluding that this finding supports the hypothesis that German banks follow their customers abroad. Kindleberger (1983), however, argues that there is no easy way to determine whether banks follow or lead international business. According to his opinion, banks lead and industry follows when banks are aggressive in building world networks and when industry concentrates on single projects. Under the opposite conditions banks follow and industry leads.

Besides the above described centripetal and centrifugal forces, also some more general factors affect the location of financial activity. Examples include path dependency, politics and regulation. A path dependence process can be described as a non-ergodic sequence, or one in which the initial conditions determine subsequent outcomes (Porteus, 1996). In this situation, historical, locational events may have cumulative consequences in the long run. Martin (1999) refers to Krugman (1991) and Arthur (1994), who argue that because of the existence of some uncertainty in industrial location and agglomeration, several alternative equilibria are possible. Which particular equilibrium pattern of activity occurs, is to a large extent determined by history and does not always have to be strictly superior to the alternatives. However, once the initial pattern is established it becomes rather rigid as forward and backward linkages and self-fulfilling expectations reinforce this pattern (See also Fujita and Thisse (1996)).

Politics can both facilitate as well as impede the development of a financial centre. The emergence of London as centre for the Eurodollar market serves as an example for the case in which politics clearly influenced the emergence of a financial
centre. In contrast, the lack of financial centres in the Eastern Mediterranean and the Balkan, is also largely caused by politics (Jones, 1992).

The financial sector is generally considered as one of the most heavily regulated. Therefore, the regulatory and fiscal environment (tax policy and prudential supervision) affects the locational behaviour of financial agents. Scholtens (1992) distinguishes two contradictory forces which are relevant in this context. On the one hand, financial agents may take advantage of the credibility and reputation of their regulatory authorities. Agents who comply well with the strict and adequate rules of a respected regulator, may gain a reputation compared to agents which are subject to less strict rules. On the other hand, operating under lax rules and low taxes is less costly and therefore more profitable. Agents thus face a trade-off between the reputational advantage of a strictly regulated country (with higher costs) and the advantages of a less strictly regulated environment with a lower (or negative) reputation (with low cost). The choice for a location will differ per activity, depending on the relative importance of the reputation and cost dimensions.

The analysis so far has taken the macro-economic view based on markets or the products traded in them. A different strand of the literature approaches the conglomeration question from the point of view of the individual firms. In this line of research, expanding the seminal work of Coase, *The Nature of the Firm* (1937), the question of interest is whether a financial firm should internalise some action that was previously performed in the market. In line with this sort of research are the so-called “Least cost location theories” (Weber (1929), Isard (1960), and Smith (1981)) in which location is primarily driven by cost-factors. The largest cost element in banking is labour. Other important cost drivers are communication costs and cost of regulation. Reed (1981), for instance, shows that New York, London, Tokyo, and Hong Kong have all benefited from the nearby hubbing of communication networks. Regulatory costs are difficult to estimate but are thought to be substantial and to differ widely across centres.5

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5 Regulatory costs can be divided into direct and indirect costs. Direct costs are the costs of running the regulatory institution, if these costs are born evenly by market participants, and compliance costs. More important, however, are the indirect costs of regulation. Direct costs will lead to deviating prices which, in turn, lead to distortions in the markets. Supply might, for instance, be decreased, fewer products might be offered, and competition in financial markets might be reduced. Regulation might furthermore lead to regulatory arbitrage and distortions of a level playing field for banking.
A criticism of the least-cost location theory is that it does not take into account the demand side. Optimal location is analysed separately from potential sales in the different locations. Related to this argument is the follow-the-customer motive (Esparanca (1992)) and states that banks tend to follow the locational pattern of their major clients.

Summing up, we have described the major forces that influence the location of financial activity. Whereas centripetal forces, such as positive external economies of scale, give rise to a concentration of activities, centrifugal forces, such as high costs, cause a geographical dispersion. We now turn to our empirical investigation of the location of financial activity in Europe, in which we analyse if it has changed under the influence of technological developments.

3 Description of the Data

We analyse two measures of financial sector activity: Gross value added (GVA) and employment. Since, in the data at hand, GVA is a nominal value, it is transformed into real terms using the consumption price index of the IMF International Financial Statistics (line 64). The second measure of the location of financial sector activity is how much employment is generated in a region. For both measures, the financial sector covers both the credit and the insurance industry.

Data, covering 1980 through 1995, are taken from the Eurostat Regio database, which provides a standardised classification of regions in Europe at various levels (‘NUTS’). We use data on NUTS II-level - a classification with 174 sub-regions - as far as possible. If such regional data are not available, more aggregated data, on either NUTS I-level or national level, are used. However, some gaps in the data remained, which have been filled by data from national accounts or, in some cases, extrapolation. A detailed description of the data per country is given in the Appendix. Table 1 shows some key characteristics per country, i.e. the number of regions, and the average and the median real GVA and employment in the period 1980-1995. Differences between countries seem to be substantial, ranging from a low mean of 504 in Portugal to a high 10628 in Austria. However, part of this difference is caused by the unavoidable difference in the size of regions. In this respect, especially Austria and Sweden seem to be "too large". We will return to this issue in the analysis below. Data on employment cover a shorter period, i.e.
1980-1992, and fewer regions. Again, these data have been taken from the Eurostat Regio database. For some regions however, data were not available. In those cases we used data from the International Labour Organisation (ILO), which provides data on a national level (See Appendix, Table 2). The number of regions, average employment and the median are showed in Table 1. Countries for which only 2 observations were available have been excluded from the analysis. A remarkable feature is the high mean level of employment in Denmark compared with other countries.

Table 1  Key characteristics of Real Gross Value Added and Employment in the Financial Sector, per Country, 1980-1995.

<table>
<thead>
<tr>
<th>Country</th>
<th>Real Gross Value Added</th>
<th>Employment</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Regions</td>
<td>Mean</td>
</tr>
<tr>
<td>Austria</td>
<td>1</td>
<td>10628</td>
</tr>
<tr>
<td>Belgium</td>
<td>11</td>
<td>852</td>
</tr>
<tr>
<td>Denmark</td>
<td>1</td>
<td>2615</td>
</tr>
<tr>
<td>Finland</td>
<td>1</td>
<td>2951</td>
</tr>
<tr>
<td>France</td>
<td>22</td>
<td>2099</td>
</tr>
<tr>
<td>Germany</td>
<td>10</td>
<td>5998</td>
</tr>
<tr>
<td>Greece</td>
<td>1</td>
<td>1886</td>
</tr>
<tr>
<td>Ireland</td>
<td>1</td>
<td>2465</td>
</tr>
<tr>
<td>Italy</td>
<td>20</td>
<td>2196</td>
</tr>
<tr>
<td>Luxembourg</td>
<td>1</td>
<td>1771</td>
</tr>
<tr>
<td>Netherlands</td>
<td>12</td>
<td>971</td>
</tr>
<tr>
<td>Portugal</td>
<td>7</td>
<td>504</td>
</tr>
<tr>
<td>Spain</td>
<td>18</td>
<td>1647</td>
</tr>
<tr>
<td>Sweden</td>
<td>1</td>
<td>9120</td>
</tr>
<tr>
<td>United Kingdom</td>
<td>11</td>
<td>3748</td>
</tr>
</tbody>
</table>

Source: Eurostat, Regio database

4 Empirical Analysis

The central question in this paper is whether ‘Geography Matters’. Specifically, if technology has reduced the importance of geography, over time, the distribution of financial activity should become more even across regions. In the extreme case, distance no longer matters and the distribution of financial activity would become completely uniform.

To analyse the impact of technology on the geography of finance, we look at two measures of financial sector location: GVA and employment. The set-up of the analysis for each variable is as follows. First, we examine the development of the distribution, estimated non-parametrically, across time. The graphical evidence is then complemented
with more formal and parametric tests. Following this general examination we turn to three particular effects, discussed in the theoretical literature, that might influence location. Firstly, there is the effect of a home market. Might the choice of location not still be driven by the size of the local market? Secondly, we go deeper into the role of financial centres. Are financial centres governed by different "laws of motion" than adjoining or peripheral regions? Finally, the importance of regulation is looked into. Notwithstanding any effect of changes in information technology, (national) regulation might still be such a strong influence that its effects are swamped. We thus look at the effect of the 1992 "One Market" policy package and in addition, we examine the effect of borders. In the analysis of all three aspects, we first estimate the distribution non-parametrically and then turn to more formal measures.

5 Gross Value Added

A crude but often used graphic to reveal distributions is the histogram. A more sophisticated approach is to use a kernel density estimator. The difference with a histogram is, firstly, that the bins are allowed to overlap and, secondly, that the observations in the bin are given varying weights depending on the distance from the centre of the bin. These weights are determined by the kernel-function. The advantage of kernel density estimates is that they are smooth and independent of the origin. Density estimates are valuable because they are very well suited to reveal skewness, developments in the tail of the distribution, and – possible – multimodality. At this point we want to preclude a parametric approach to capturing densities in order to allow the greatest possible flexibility. Just like in the case of the simpler histograms, the estimates produced are sensitive to the chosen bin-width and, less importantly, the kernel. However, the results shown below do not change qualitatively under various combinations of kernels and bin-widths.

We estimate the distribution of the data in each year in the period 1980-1995. Graphical representations of the consecutive year are drawn in a single graph in figure 2.

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6 Other possible methods are one-way scatterplots, stem-and-leaf displays, and boxplots.
7 See Silverman (1986) for a detailed technical discussion of density estimation.
The left pane is the figure for the full sample while the two smaller figures show the distribution of the below- and above-median sub-sample.

**Figure 2 Kernel density estimation for GVA in European regions, 1980-1995**

The estimated distribution is highly skewed, as expected, and it does not seem to be changing much over time, except for an increase in range from around 40 to 16000, rising to 27000\(^8\). This implies that the dispersion has increased a little bit. The two smaller graphs show estimates for the below- and above-median subgroup. Both distributions largely do not change, except that the distribution below the median becomes somewhat smoother.

Although the density estimates shown are very useful for discovering general features of the distributions, no stronger conclusions can be drawn. Many, more formal, measures have been suggested to capture inequality or diversity (See Cowell, 1995, for an excellent introduction); The question how 'unbalanced' a distribution is, is quite relevant in for instance the analysis of welfare, inequality, and poverty. As we are dealing with a continuous distribution, we compute two well know measures: the Gini coefficient and the coefficient of variation. The Gini coefficient is defined as the average difference between all possible pairs of GVA in the population, expressed as a proportion of total

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\(^8\) Due to still unsolved technical difficulties in drawing the graph, this is not clear from the graphs. The top-right of the box shown should show zero density.
GVA (Cowell, 1995) and has a minimum value of 0 and a maximum of 1\(^9\). In the context of income distributions, the typical application of the Gini coefficient, the Gini-computation compares the actual distribution with a distribution where every individual has the same income. In our study this translates in to the GDM-hypothesis: as distance becomes less important the computed Gini coefficient should fall. However, as is obvious in table 2, the coefficients and thus the inequality seem to be rising, not falling.

### Table 2  
**Formal Measures of Inequality, 1980-1990.**

<table>
<thead>
<tr>
<th></th>
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<tbody>
<tr>
<td>Gini</td>
<td>0.60</td>
<td>0.61</td>
<td>0.62</td>
<td>0.64</td>
</tr>
<tr>
<td>Coefficient of Variation</td>
<td>1.40</td>
<td>1.51</td>
<td>1.54</td>
<td>1.70</td>
</tr>
</tbody>
</table>

As a second measure for inequality, we compute the coefficient of variation, which gives an indication for the dispersion within the population\(^10\). The range of the coefficient is given by \((0, \sqrt{n - 1})\) with higher values indicating more dispersion. In our sample, the computed coefficients seem to be rising.

We calculated other measures of inequality as well (not shown) but these all point in the same direction\(^11\). The more formal measures thus all seem to indicate that regions have become more diverse, not more uniform.

### 5.1 The Home Market

A criticism one could make of the data used is that the regions we compare are not equal. Some are larger, in terms of geographic area or population, than others. The analysis in this section shows that when we correct for a plausible "size" measure, the results remain unchanged.

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\(^9\) The formal definition is given by: \(G = 1 - 2 \int_0^\infty \phi(x) dF(x)\), with \(F(y) = \text{the proportion of the population with GVA less than or equal to } y = \text{GVA.} \) \(\phi\) implies that integration is performed over the entire range of \(y\), that is, over \([0, \infty)\) or, equivalently for \(F\), over the range \([0, 1]\).

\(^10\) This measure can be computed as \(c = \sqrt{\frac{V}{y^*}}\). Here, \(V\) is the variance and \(y^*\) the arithmetic mean RGVA.

\(^11\) In particular the relative mean deviation, standard deviation of logs, Mehran index, Piesch index, Kakwani index, Theil entropy index, and mean log deviation.
Producers of financial services not only produce for the world – or even the European – market. A sizeable part of the production is for local distribution. Ideally, we would like to divide a region's production into a local and an inter-regional part in order to investigate the impact of the home market. Unfortunately, such level of detail is not available in our data. Assuming that the number of inhabitants is a good indicator of the local market, we weigh the sample by population and re-estimate the densities through time. The results are shown in the following figure.

Figure 3  Kernel density estimation for Population-weighed RGVA in European regions, 1980-1992.


When we weigh the observations with a relative population weight, the overall density becomes more concentrated. This implies that home market effect is in existence: populous regions also have large production. Both distributions, real gross value added and population, are thus similar and work in the same direction. Splitting the sample in below- and above-median does not reveal substantially different patterns compared to the sample without weights.

We also computed the population-weighed densities for the centre, adjoining and peripheral subset (shown in figure 3). Except for the somewhat higher concentration on

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12 An alternative measure of the size of the home market might be income or disposable income.
13 A centre is defined as a country's region that makes the largest contribution to national GVA. Countries with only a single region, such as for instance Austria, are excluded, leaving a sample of 7 countries (total number of observations:1648). These are the Netherlands, Belgium, Germany, Italy, the United Kingdom, Spain and France.
the left-side of the spectrum, the graphs do no differ markedly from the figures to be discussed in the next section.

5.2 Centre and Periphery

A sizeable literature has emerged on the importance of hierarchy in the development of a financial sector. If rank is an important attribute of a financial centre then there might be some movement in a sub-sample that is concealed by larger developments in other parts of the distribution. We therefore continue the analysis on the level of centres, adjoining regions and periphery. The estimated distributions are shown in figure 4.

**Figure 4** Centres, Adjoining Regions, and the Periphery, 1980-1995.

The distribution of GVA in the 7 largest centres, i.e. the regions with the highest GVA values, seems to become less peaked. This would indicate that, in the league of centre-regions, the concentration is decreasing. A similar movement is discernible in the distribution of GVA in adjoining and peripheral regions. Since the centre-, adjoining-, and peripheral classification maps more or less directly into a classification based on size, there does not seem to be a large difference due to the importance of being a centre-region. Moreover, there seems to be no move of activities from centres to low cost, peripheral areas as predicted by the “Geography doesn’t matter” hypothesis.

5.3 Regulation

All in all, the estimated distributions do so far not show a tendency towards a more even distribution of activities across space. It seems that technology has not significantly

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regions contain respectively the cities of Amsterdam, Brussels, Düsseldorf, Lombardia, London, Madrid and Paris. Adjoining regions are those regions next to a centre region. All other regions are called peripheral.
influenced the location of financial activity. However, related effects could have an impact on location choice as well. These effects could for instance be any significant changes in the market environment or national effects, in particular regulation\textsuperscript{14}. We look consecutively into the effect of borders and the 1992 "One Market" policy.

5.3.1 Borders
To capture the effect of regulation, we test whether the subset of regions separated by a border behaves different from the subset of regions that are not separated by a border. Therefore, we calculated the correlations between all border regions (24 regions with 27 borders). The correlations between the border-regions are shown in figure 5A and these are generally positive, as expected. Striking is the difference in correlation between the Netherlands, Germany and Luxembourg, where correlations are generally high, and Spain, Portugal, and Italy, where correlations are low or even negative\textsuperscript{15}. This implies that the northern European markets are more integrated than the southern markets.

**Figure 5A** Correlation of Real GVA across borders, 1980-1995.

\textsuperscript{14} Differences between measured GVA could of course also be contributed to differences in accounting practices and definitions used.

\textsuperscript{15} Possibly the correlations are somewhat distorted due to the conversion into a common denominator: the euro. Presently, all values are first transformed into real values and then converted into euro. A more precise...
Do the computed correlations differ from the sample as a whole? The average correlation between all possible pairs in the sample is .25 while the average of the shown correlations is .39. This difference, however, is an overstatement since in the overall sample both regions that are close and further away are lumped together. We will map the regions more precisely and shortly and then compute comparable correlation averages.

Another interesting question is whether correlations have shown changes through time? To investigate this we plot a moving average (lag 8) of both the correlations of all regions and just border regions in Figure 5B\textsuperscript{16}.

**Figure 5B Moving average of correlations (lag 8)**

The interesting feature of this graph is that there is quite some movement in the correlations between the regions. Moreover, correlation between non-border regions tends to be higher, probably because within-country correlations, which tend to be higher, are included in this set. Presently we are still at a loss for an explanation for the dynamics in this graph.

\textsuperscript{16} Ideally we would like to compare the correlations between adjacent border and non-border regions. At present we have yet to classify the regions in this way. Therefore we take the shortcut of comparing adjacent border regions with the correlations between all regions. The latter is then probably an overstatement of the relevant correlation because regions further apart are likely to exhibit lower correlation.
5.3.2 One Market

As we investigate data over the period 1980-1995, the completion of the EC internal market in 1992 could be another factor that has influenced the development over time of the distribution of GVA across regions. An important regulatory change has been the implementation of the Second Banking Directive into national law, which had to be completed by the beginning of 1993 at the latest. As the exact moment of implementation varies across countries (for example, in Germany 1992 and in the Netherlands 1993, see Lang, 1999), one clear ‘breakpoint’ cannot be identified. We considered 1992 as breakpoint and estimate the distribution before and after 1992 (figures 6). At first sight, no significant change seems to occur. A more detailed inspection, however, shows that the behaviour of the data before 1992 seems to differ from that after 1992. Before 1992, the top of the distribution changes over time, whereas after 1992, it shows a stable pattern. Presumably, any changes due to the implementation of the One-Market programme had already taken place. Brülhart (2001) finds similar results for manufacturing industries.

Figure 6 Distribution of Real Gross Value Added before and after 1992

6 Employment

Our second measure of financial sector activity is employment in the financial sector. As in the case of the RGVA-framework, we consider the development over time of employment in the financial sector. The period considered, however, (1980-1992), is shorter due to data limitations (For a detailed data description see Appendix, Table 2). Again we estimate the distribution of the data in each year in the period 1980-1992.
Figure 7 shows the graphical representation, where the left figure represents the full sample and the 2 smaller figures show the distribution of the below- and above-median sub-sample. The overall distribution seems very stable. Looking at the below- and above-median subsets, however, we see a development towards a distribution that is slightly more spread out. Compared to the developments in the real gross value added variable, the movements in employment seem rather modest.

**Figure 7**    **Kernel density estimation for Employment in European regions, 1980-1992**

6.1 The Home Market

Similarly to the RGVA-variable, we examined whether the size of the home market, proxied by population, influences the distribution. In figure 8 the estimates for the full-sample and the below- and above-median sample are shown consecutively. Again, similarly to the earlier case, the effect of the home market seems to intensify the centrality of the distributions.

**Figure 8**    **Kernel density estimation for Population-weighed Employment in European regions, 1980-1992, Full, below- and above-median.**
6.2 Centre and Periphery

Does the centre-periphery chasm show up in the employment data? Whereas we saw some – minor – differences in the developments of the distribution of the various sub-sets, the distributions of the sub-sets shown below are rather similar. We will not show the equivalent population weighed graphs because the developments are remarkably similar.

Figure 9 Employment in Centre, Adjoining and Peripheral Regions, 1980-1992

6.3 Regulation

Since our data on employment end in 1992 we would be hard pressed to investigate the employment effect of the one market policies. Moreover, following the discussion in section 5.3.2, it could be argued that 1992 would be too early a date to expect any changes in employment patterns due to One Market or the Second Banking Directive/Basle Capital Accord implementation.

6.3.1 Borders

As discussed previously, the existence of borders might very well influence the location of financial services. Moreover, different borders might have different effects. To examine this effect, we have, similarly to the RGVA-analysis, computed the correlation across all available border-regions. Compared to the value added data the correlation across borders is generally higher. This conclusion gains in strength after a sensitivity analysis of various coefficients. Especially the two values found for the correlation between the south of Spain en the south of Portugal (-0.02 and –0.01) are sensitive to the length of the sample-period because the underlying variable shows extremely low
variance. The higher correlations might indicate that co-movement of “financial sector activity” is indeed underestimated by the estimates shown in figure 17.

Figure 10 Correlation of employment across borders, 1980-1992.

7 Efficiency

After looking at the development over time of value added and employment individually we can also look at the combined picture. This would give us more insight into the development of efficiency in the financial sector, since output per employee for the sector is an often used proxy (notwithstanding the well-known problems with measuring productivity in services).

The variable of interest, EFFI, is simply RGVA divided by employment. Estimates of the densities over time are shown in figure 11. This variable is less skewed but seems to exhibit double peakedness. The latter feature does not become clear from the figures below but does clearly show up on single-period density estimates. So far, a good explanation for it is lacking. Especially in the more efficient regions, our measure of efficiency seems to have become more concentrated.

17 Underlining the need to consider the effect of the exchange rate as already noted in Footnote 15.
Especially in efficiency we would expect really strong differences between the centre, the adjoining, and the peripheral regions. Although we do see some movement in the middle of the sample-period the distributions in the three subsets seem to have returned to their previous location.
8 Conclusions

In this paper, we have investigated whether technology has reduced the importance of geography in the financial sector, leading to a changed distribution of financial activities across space. After reviewing the centripetal and centrifugal forces identified in the literature, we approached this question empirically and analysed the development of the distribution of gross value added and employment for various European countries and regions.

We recognise that technology is just one of the numerous factors that influence the geographical pattern of financial activity. Because appropriate data is not available, we have not analysed if and how technology has changed the importance of the other forces, so that a good explanation of the final outcome is still lacking. From our analysis we conclude, however, that technology by itself has not (yet) been so powerful that significant changes in the estimated distributions can be observed. Alternatively one could conclude that either there has been insufficient change in – the use of – technology or all other factors combined exactly counter the effects of changed use of technology.

The distribution of financial activity, measured by GVA, has not moved significantly over the horizon 1980-1995. A relocation of activities from centres to low cost areas, although technically feasible, cannot be observed. Also data on employment show no significant changes. The consideration of the effects of regulation and the completion of the internal market do not indicate a change in location either. With regard to efficiency there does seem to have been some movement, but at the end of the sample the distributions have taken up their old shape again. These results indicate that technology has not (yet) led to a changed spatial dispersion of financial activity. All in all, we find no evidence for the hypothesis that technology has eliminated the importance of geography completely as predicted by the ‘Geography doesn’t matter’ hypothesis.

Concerning regulation, we tested whether regions separated by a border, behave differently from those not separated by a border and noted that the correlation of RGVA between border regions in the northern regions was rather high, whereas in southern
regions correlations were low or even negative. Moreover, looking at the development of correlation through time we noted that border regions did not start to behave differently in the end. In addition we noted that there seems to be some movement in the levels of correlation between the regions.

A criticism of our analysis with some merit is that our data pre-dates the coming of age of the internet and that the internet will make completely new ways of production possible. We do not disagree, but propose that the internet will have an impact that is as least as strong as the impact of the other recent innovations in communication technology. Since recent data on internet applications are not yet available in sufficient quantity and quality, our data are the next best thing.

A number of issues have not been resolved. Among these is the issue of the appropriate weight to use in order to take into account the home market effect. Possibly the size of other sectors in a region or the purchasing power of the population would be better proxies. Another issue is the computation of within country correlations. These require additional work. Finally the underlying data on especially employment could be improved, both in quantity as in quality.
## Appendix

### Table 1: Description of Eurostat data for gross value added at market prices (GVA mp) or at factor cost (GVA fc), per country, 1980-1995

<table>
<thead>
<tr>
<th>Country</th>
<th>Geographical level</th>
<th>Number of regions</th>
<th>GVA</th>
<th>Comments</th>
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<td>Mp</td>
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<td>National</td>
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<td>Mp</td>
<td></td>
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<td>Germany (west, exc. Berlin)</td>
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<td>10</td>
<td>Mp</td>
<td></td>
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<td>Greece</td>
<td>National</td>
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<td>Mp</td>
<td></td>
</tr>
<tr>
<td>Spain</td>
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<td>Mp</td>
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<td>Mp</td>
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<td>Mp</td>
<td></td>
</tr>
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<td>Italy</td>
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<td>Fc</td>
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<td>Mp</td>
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<td>Mp</td>
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</table>

**Total**: 119

**Source**: Eurostat, Regio database

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18 The Eurostat sectoral classification ‘NACE 17’ contains regional data of 17 branches and 5 groups of services. Category B69 provides data on GVA added by credit and insurance institutions. The difference between GVA at market prices and GVA at factor cost, being that the first includes indirect taxes and subsidies and the latter does not, is ignored.

19 In the case national accounts data showed a few gaps, these have been filled by linear interpolation. Gaps at the beginning or the end of a series have been completed by applying the growth rates of the EU aggregate GVA of the branch.
Table 2  Description of data on employment, per country, 1990-1995.

<table>
<thead>
<tr>
<th>Country</th>
<th>Geographical level</th>
<th>Number of regions</th>
<th>Comments</th>
</tr>
</thead>
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<td>ILO data</td>
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<tr>
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<tr>
<td>Greece</td>
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<tr>
<td>Luxembourg</td>
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<td>1</td>
<td></td>
</tr>
<tr>
<td>Netherlands</td>
<td>National</td>
<td>1</td>
<td>National office for statistics (CBS). Employment is measured by the number of jobs (full- and part-time) in the financial sector and not by the number of employees, as for the other countries.</td>
</tr>
<tr>
<td>Portugal</td>
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</tbody>
</table>

Source: Eurostat, Regio database
10 References


