Measurement of regional supply of banking services against the background of digitisation

ALEXANDER CONRAD, FABIAN RÖSCH

2018 edition
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1 Introduction

Low interest rates, increasing digitisation, a different user behaviour and demographic change form the argumentative basis for branch closures by (regional) banks. Almost every day regional media report on the displeasure of the local population with regard to the restriction of access to basic financial services. The boards of the regional banks have a different understanding of this situation. They interpret the declining number of users in the branches, justify their decisions with foresighted, responsible action and offer alternatives as an answer. One of these answers is the expansion of digital offerings, which could increasingly make the trip to the branch superfluous. According to this, the supply situation will not necessarily deteriorate due to the dismantling of the branches. Only the access route will change. Physical access will be replaced by digital access, and the quality of supply would remain the same despite the reduction in the number of branches. The prerequisites for this strategy to take effect are, firstly, that the two access routes are substitutes and, secondly, that the digital services are accessible. This requires, on the one hand, sufficiently good access to the Internet throughout the country and, on the other hand, a corresponding general digital education on the part of customers.

Indicators measuring access to financial services can be used to determine the extent to which this influences the supply situation of customers. To date, only physical access has been quantified using the indicators square kilometres per branch (geographical access) and population per branch (demographic access). Both indicators were used in a European comparison in order to make a statement on supply in European countries. Countries with below-average values (fewer inhabitants per branch, etc.) were subsequently described as overbanked and reference was made to a pending, necessary consolidation process (see Dombret 2016, Maisch 2017). However: With a view to an increasing diversification of access routes (mobile branch, advice at home, cash back systems, home banking, etc.), the shortcomings of the assessment of the supply situation via this very simple measurement approach are becoming more and more apparent and strengthen the demand for an adapted approach - as presented by Conrad et al. (2018) in their paper.

Against this background, the paper aims to test the application of the extended measurement approach according to Conrad et al. (2018) for different countries and to identify limitations. The aim is also to derive and compare values for the regional supply of banking services in different countries so that a statement can be made on the supply situation in the comparison countries.

The paper is structured as follows: Chapter 2 presents the state of the art in research and deals in particular with the extended measurement approach for the evaluation of regional supply of financial services from public savings banks and cooperative banks presented by Conrad et al. (2018). Chapter 3 shows how the measurement approach can be applied to different countries. The availability of regional and company-related data is discussed and it is shown how the measurement approach can be adapted against the background of data availability. Chapter 4 presents the results of the application of the adapted measurement approach and offers an evaluation. In the concluding chapter 5 the results of the contribution are summarized and open research questions are formulated.
Three research strands can be identified that deal with the evaluation of regional supply of financial services: (1) Approaches which, on the basis of simple indicators, allow a statement on the accessibility of financial services at (inter)national level. (2) Formal-theoretical and (building on this) multivariate analyses that look for factors influencing accessibility and (3) approaches that propose new indicators for evaluating regional supply. The state of research for these three strands of research is summarised below. The proposals for new indicators and above all the approach of Conrad et al. (2018) are discussed particularly intensively.

2.1. Indicators for evaluating supply

The article by Conrad et al. (2009) summarises the literature on the assessment of regional supply and examines the nationwide provision of financial services by the German banking system on this basis. The indicators of the range of financial services frequently used in (inter-)national studies are examined. Table 1 summarises the most important indicators. By linking regional and bank data at district level for the year 2005, the determinants of the geographical and demographic penetration of public-sector savings banks and cooperative banks operating regionally are then examined. Finally, the small-scale comparison reveals regional supply differences and enables the discussion of approaches of action.

Table 1 - Indicators to assess the scope of financial services

<table>
<thead>
<tr>
<th>Indicator</th>
<th>Operationalisation approach</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1) Current accounts per adult</td>
<td>Number of current accounts per adult</td>
</tr>
<tr>
<td>(2) Geographical branch penetration</td>
<td>Number of branches per 1 thousand Km2</td>
</tr>
<tr>
<td>(3) Demographic branch penetration</td>
<td>Number of branches per 100 thousand inhabitants</td>
</tr>
<tr>
<td>(4) Geographical penetration of ATMs</td>
<td>Number of machines per 1 thousand km2</td>
</tr>
<tr>
<td>(5) Demographic penetration of ATMs</td>
<td>Number of ATMs per 100 thousand inhabitants</td>
</tr>
<tr>
<td>(6) Demographic credit penetration</td>
<td>Number of loans per 1 thousand km2</td>
</tr>
<tr>
<td>(7) Credit-income ratio</td>
<td>Average loan amount to GDP per capita</td>
</tr>
<tr>
<td>(8) Demographic penetration of deposits</td>
<td>Number or amount of deposits per 100 thousand inhabitants</td>
</tr>
<tr>
<td>(9) Deposit-income ratio</td>
<td>Average deposit amount to GDP per capita</td>
</tr>
</tbody>
</table>

Source: Based on Conrad et al. (2009), S. 382.
2.2. Formal-theoretical and multivariate analysis

The purely descriptive analysis of the supply situation using indicators, as shown in table 1, is followed by studies that formulate and test hypotheses on the influence of demographic and regional economic factors on the presence of banks on the basis of formal-theoretical models. Conrad (2010) presents - based on a spatial competition modelling by Chiappori et al. (1995) - a corresponding regional bank model and examines the statements derived from it on the basis of data from the regions and regional banks of Germany. As a result, the influencing factors presented in table 2 - in the vast majority of cases conforming to the statements of the modelling - for the presence of the German regional banks (mainly savings banks and cooperative banks) could be worked out as relevant and significant. In particular, the population density, which provides information on the settlement structure, and the age structure in the region provide a particularly high explanatory contribution to the regional supply situation.

Table 2 - Factors influencing the reach of financial services provided by German regional banks

<table>
<thead>
<tr>
<th>Independent Variables</th>
<th>Dependent Variables</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Savings Banks</td>
</tr>
<tr>
<td></td>
<td>N =283</td>
</tr>
<tr>
<td>ln(branch per km²)</td>
<td>ln(branch per inhabitant)</td>
</tr>
<tr>
<td>ln(PD)</td>
<td>***0.73</td>
</tr>
<tr>
<td>ln(Buy)</td>
<td>***0.50</td>
</tr>
<tr>
<td>ln(Comp)</td>
<td>***-0.28</td>
</tr>
<tr>
<td>ln(Old)</td>
<td>***0.42</td>
</tr>
<tr>
<td>ln(Bal)</td>
<td>***0.52</td>
</tr>
<tr>
<td>Constant</td>
<td>***-12.22</td>
</tr>
<tr>
<td>R2</td>
<td>0.9</td>
</tr>
<tr>
<td>F-Test</td>
<td>***691.69</td>
</tr>
</tbody>
</table>

PD = Population Density; Buy = Buying Power; Comp = Competitor Branches per Savings or Cooperative branch; Old = Share of people 65+; Bal = average balance sheet total; Data are double-sided logarithmized OLS cross-sectional regressions; *** = p ≤ 1%; values for 2005.

Source: Based on Conrad (2010), S. 153.
2.3. New measurement approaches

In view of the results of the formal theoretical modelling and the examination of the hypotheses derived from it, it becomes clear that access to financial services is influenced by a large number of regional economic and demographic factors. The assessment of the supply situation should therefore be based on a multidimensional measurement approach.

Flögel and Gärtner (2018) make a proposal for assessing access to financial services on the basis of the two dimensions ‘operational distance’ and ‘functional distance’. The former deals with the physical proximity of customers to banking staff and thus with the instance responsible for service and advisory activities - i.e. direct customer contact. The functional distance is defined as the distance to the decision-making authority, i.e. to the authority that decides, for example, whether a customer receives a credit agreement. The use of the two distances then makes it possible to make a statement on regional supply quality, which is likely to be higher the smaller both the operational and the functional distance are. On this basis, the authors of the study compare the banking systems of Germany, Spain and Great Britain. The study shows that Germany’s regions benefit from particularly short distances (in both dimensions). The operationalisation of distance measurement is described below:

(1) Operational distance

Calculation: concentration index employees \( R_{KI}^p = \sum_j \left( \frac{b_{ij}}{B_i} - \frac{b_j}{B} \right) 0.5 \), with \( b_{ij} \), the employees in sector \( i \) of region \( j \), \( B_i \), the employees in in sector \( i \), \( b_j \) all employees in region \( j \) and \( B \), all employees.

Data: Labour market statistics of the countries surveyed; total employment and financial services sector employment (regional and national).

(2) Functional distance

Calculation: concentration index bank centers \( R_{KI}^f = \sum_j \frac{Z_j}{Z} \), as sum of the shares of the bank centers in the three most important financial centers of a country, with \( Z \) the number of bank centers and \( Z_j \), the number of bank centers at the financial center \( j \).

Data: European Central Bank and other national central bank data.

Conrad et al (2018) also present a proposal to assess access to financial services on the basis of two dimensions. On the one hand, they present an approach for measuring physical access as a function of travel time to the nearest branch. Demographic, settlement structural and topographic characteristics of the regions under consideration are taken into account in the calculation of the travel time. On the other hand, they also include digital access to banks’ financial services and focus on regional broadband availability.

On this basis, they determine the regional supply of financial services by public savings banks and cooperative banks. It turns out that rural areas in particular have both a comparatively long journey time to the nearest branch as well as below-average access to the Internet. Finally, on the basis of the analysis results, they formulate recommendations for the development of the physical presence with branches against the background of the advancing digitalisation. In the following, the modelling of the two dimensions (above all physical access) is presented.
Conrad et al. (2018) measure digital accessibility via the regional share of inhabitants with access to at least 16 Mbps (regardless of the technology). The broadband atlas, which is maintained by the BMVI, provides up-to-date data on a small-scale basis (cf. BMVI 2018). The average travel time $\hat{t}_j$ in region $j$, however, is defined as follows:

$$\hat{t}_j = \frac{d_j}{s_j} \frac{60}{\pi}$$

The average distance $d_j$ to the next store is calculated:

$$d_j = 0.68u_j \sqrt{\bar{O}_j}$$

With $\bar{d}_j$, the approximate average distance between any two points in a region $j$ with the average supply area $\bar{O}$ \(^1\) and $u_j$, the detour factor that takes up topographical differences (height above sea level) of the region in question $j$.

The average cruising speed $\bar{s}_j$ in the region $j$ is calculated:

$$\bar{s}_j = \frac{1}{\sum_{i=1}^{100} b_{ij}} \sum_{i=1}^{100} s_{ij} b_{ij}$$

With $\bar{s}_j$, the average cruising speed in the region $j$ depending on the average cruising speed $s_{ij}$ of the age groups $i$ in region $j$ and $b_{ij}$, the population $b$, of age group $i$ in region $j$.

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\(^1\) A circular region is assumed as part of the approximation. The supply area is obtained by evenly dividing the total area among the branches in the region $\bar{O} = \frac{O}{F}$ with $F$ the number of branches.
3 Transfer of the measurement approach

3.1. Data availability and operationalisation

With regard to the modelling of the measurement approach according to Conrad et al. (2018), the following data is required for the application to European countries, if possible on a small-scale level:

- Information on the area of the considered regions
- Information on the regional age structure
- Information on regional population figures
- Altitude of the region above sea level
- Number of bank branches per region
- Internet accessibility / broadband availability

Data on area, population density and population by age group are available at Eurostat at NUTS 3 level. Data on the regional elevation profile, however, are not available at Eurostat. For example, geonames.org provides country-specific elevation data. However, these have a different regional delimitation than the one stored in Eurostat for the NUTS 3 level. As a result, the allocation of elevation data to NUTS 3 regions would have to be done manually with considerable effort, which is why $u_j$ is assumed for further simplification.

In addition, data on the regional bank branches are needed. These are, however, not available outside Germany on a small scale. To be able to draw conclusions about accessibility anyway, Section K (Financial and insurance activities) of the statistical classification of economic activities in the EU, NACE, has been included approximately. Section K contains information on the number of permanent establishments of the following economic activities: Financial service activities, insurance, reinsurance, pension funds (excluding social security funds) and activities auxiliary to financial and insurance activities (see Eurostat 2008).

For the survey, this means that a very broad spectrum of financial service providers is included in the survey. This means that it is no longer possible to focus solely on banks. Moreover, the information from Section K at NUTS 3 level is not available for all EU countries. Therefore, the measurement approach cannot be applied to all countries of the European Union, but is only applied to the following countries: Netherlands, United Kingdom, Spain, Switzerland, Germany and Austria.

On broadband coverage at EU level, the European Commission has published the comprehensive report ‘Broadband Coverage in Europe 2016 - Mapping progress towards the coverage objectives of the Digital Agenda’ (see IHS Markit 2017). Although it considers broadband coverage at NUTS 3 level, it does not make any statements on broadband availability in Mbps. Statements regarding sufficient bandwidths to carry out banking transactions would therefore only be possible to a very limited extent. For this reason, digital access will subsequently be ignored and the focus will be solely
3.2. Approaches to in-depth presentation of results

Conrad et al. (2018) present the analysis results in a four-field matrix (X-axis physical and Y-axis digital access). The regions are sorted into the matrix and differentiated by colour according to their belonging to the category rural or urbanised / high-density region. Finally, depending on the assignment to one of the four fields and the colouring, fundamental approaches to action are presented. An in-depth description / disclosure of regional supply differences is lacking. For this reason, two evaluation approaches are discussed below, which can be used to uncover regional differences within and between countries.

Boxplots are particularly useful for comparing country results: In the boxplot it can be clearly displayed to which area (quartile) a region can be assigned with regard to a certain characteristic (e.g. travel time to the nearest financial services provider). The display is also compact because the box plots of all countries can be displayed on a scale. The analysis using the box plots also enables a statement to be made on under- or oversupply, if this is defined using those regions that can be assigned to the lowest or highest quartile (the worst or best 25 %).

A concentration measure such as the Gini coefficient can also be used for a more in-depth evaluation. If, for example, the travel time to the nearest branch of a financial service provider is interpreted as travel expenses, it can be determined which share of the population or regions must bear which share of the total travel expenses of a country (or sub-region). A Lorenz curve is used to show how the regional travel expenditure is distributed within the country, i.e. which part of the regions bears which part of the total expenditure. For the international comparison, the Gini coefficient is formed so that the distribution can be expressed and compared as a numerical value.

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2 The project “Mapping of Broadband Service in Europe by TÜV Rheinland Consulting” (cf. TÜV Rheinland Consulting 2018) indicates that detailed data on broadband availability will also be made available for the European level in the course of 2018. (As of 11/2018)

3 Under the assumption that every minute of travel time is connected with costs, the regional travel expenditure results as product from average travel time and number of inhabitants of the region.
4 Results of the Transfer

4.1. Boxplot Diagrams

The boxplots of the individual countries on distance and travel time provide an almost identical picture. There are minimal differences between the years considered. A look at the box plots at travel time (see figure 1) up to the nearest financial services provider (hereinafter FSP) suggests a similar supply situation for Germany (DE), Spain (ES), Austria (AT) and the United Kingdom (UK). In this respect, these countries can be merged into one group. AT has the lowest travel time overall, but at the same time has a relatively low dispersion.\(^4\) At the same time UK shows extreme outliers and thus refers to regions with very high travel times.

Switzerland (CH) and the Netherlands (NL) form the second group. The travel times are distributed here more evenly and at the same time altogether clearly lower than with group one. The latter is shown (e.g.) by the deviation from the mean value.\(^5\) The distribution of financial service providers by area (see figure 2 / above) is largely homogenous apart from NL. The distribution according to inhabitants (see figure 2 / below), on the other hand, shows some conspicuous features: The low dispersion of the values in country group 1 (AT, DE, ES and UK) suggests that the number of financial service providers in these countries depends on the number of inhabitants. In country group 2 (NL and CH), however, this number fluctuates more strongly.

As expected, the separate analysis of rural and urban areas shows that the travel time in rural areas is higher (see figure 3). Particularly high times result for UK. Apart from that, the distribution is again rather homogeneous. In urban areas, only DE and UK show larger distributions. Overall, it becomes clear that there is no clear correlation between travel time and the number of financial service providers per inhabitant or square kilometre. This result underlines the relevance of the use of multidimensional measurement approaches when considering supply situations.

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4 Including the detour factor, the speed of travel is expected to increase further in countries with a high altitude profile.

5 Switzerland has on average approx. 29 % shorter travel times, the Netherlands even approx. 66 %. 
Figure 1 - Country comparison travel time

Travel time to next FSP 2015

![Chart showing travel time comparisons between countries.]


Figure 2 - Distribution of financial service providers

FSP per Inhabitant 2015

![Chart showing distribution of financial service providers per inhabitant.]

Results of the transfer

**Figure 3 - Travel times in different types of regions**

*Travel time to next FSP 2015 (Urbanized and agglomerated)*

*Travel time to next FSP 2015 (Rural)*

4.2. Gini Coefficient

Taking concentration measures into account, the supply situation in the countries under consideration is not quite as homogeneous. The number of undersupplied (lower quartile) persons sharpens the view of the distribution of travel times (see figure 4). In UK and DE slightly more than 15% of the population can be assigned to the worst served quartile of the regions. This result is relevant in so far as it concerns two very populous countries. In ES, also a populous country, this affects only about 7% of the inhabitants. Although CH has the highest population shares in the worst quartile, the supply situation is so much better overall that the poorly supplied Swiss still have shorter travel times than, for example, many inhabitants in DE.

Figure 4 - Undersupply in comparison with other countries

This can also be seen when considering the Lorenz curve and Gini coefficient (see table 3 and figures 5 and 6): DE has the highest value (after CH), i.e. the highest unequal distribution - closely followed by UK. With regard to DE, it is particularly striking that the last 10% of the regions in particular account for a very high proportion (over 30%) of the total travel expenditure of the entire country. The lowest Gini coefficient is AT.

Table 3- Gini coefficients for the distribution of travel expenses

<table>
<thead>
<tr>
<th>Year</th>
<th>AT</th>
<th>CH</th>
<th>DE</th>
<th>ES</th>
<th>NL</th>
<th>UK</th>
</tr>
</thead>
<tbody>
<tr>
<td>2014</td>
<td>0.2</td>
<td>0.5</td>
<td>0.4</td>
<td>0.3</td>
<td>0.3</td>
<td>0.4</td>
</tr>
<tr>
<td>2015</td>
<td>0.2</td>
<td>0.5</td>
<td>0.4</td>
<td>0.3</td>
<td>0.3</td>
<td>0.4</td>
</tr>
</tbody>
</table>

Source: Eurostat 2018a/b/c, own calculation.
Results of the transfer

**Figure 5 - Exemplary Lorenz curves – DE**

Distribution of Travel Expenses among Regions - DE

<table>
<thead>
<tr>
<th>Share of Regions</th>
<th>Share of Expenses</th>
</tr>
</thead>
<tbody>
<tr>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>10%</td>
<td>10%</td>
</tr>
<tr>
<td>20%</td>
<td>20%</td>
</tr>
<tr>
<td>30%</td>
<td>30%</td>
</tr>
<tr>
<td>...</td>
<td>...</td>
</tr>
<tr>
<td>100%</td>
<td>100%</td>
</tr>
</tbody>
</table>

- Equal Distribution
- Expenses 2014
- Expenses 2015


**Figure 6 – Exemplary Lorenz Curves – UK**

Distribution of Travel Expenses among Regions - UK

<table>
<thead>
<tr>
<th>Share of Regions</th>
<th>Share of Expenses</th>
</tr>
</thead>
<tbody>
<tr>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>10%</td>
<td>10%</td>
</tr>
<tr>
<td>20%</td>
<td>20%</td>
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<tr>
<td>30%</td>
<td>30%</td>
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<tr>
<td>...</td>
<td>...</td>
</tr>
<tr>
<td>100%</td>
<td>100%</td>
</tr>
</tbody>
</table>

- Equal Distribution
- Expenses 2014
- Expenses 2015

The aim of the article was to show whether and how the multidimensional approach of Conrad et al. (2018) for the evaluation of the supply of financial services on a small-scale, regional level can be transferred to different European countries. For this purpose, the first part of the article gave an overview of relevant measurement approaches. Subsequently, the measurement approach was explained in detail by Conrad et al. (2018).

In the following section, the possibilities of transfer, transfer problems and solution approaches were presented. Finally, as far as possible, the measurement approach was applied to individual countries and the results of the evaluation were presented. The transfer of the measurement approach to other European countries is currently only partially possible. The reason for this is the limited availability of data (especially in the area of digital coverage). The lack of information prevents an analysis or leads to inaccuracies. In the following it is therefore explained in summary how the data problems could be compensated:

1. The presentation of broadband coverage is a relevant part of the discussions on the provision of financial services on a nationwide basis, but so far it has not been possible to present it or only to a very limited extent. The reason for this is that no data is available at NUTS 3 level outside Germany. However, this problem is dealt with in the project ‘Mapping of Broadband Service in Europe’ by TÜV Rheinland Consulting. If useful results are published here, the contribution can be substantially expanded to include the aspect of digital coverage.

2. The consideration of sector K instead of bank branches implies that there is a demand for any financial service provider, which is an unrealistic assumption. Banking and insurance services are only marginally substitutable or not substitutable at all.\(^6\) In this respect, the combined view only leads to a higher number of permanent establishments, which in turn leads to lower travel times and thus to the assumption of a good supply situation. The comparison of the results of Conrad et al. (2018) with the results of this article clarifies this point.\(^7\)

3. Also not included in Eurostat are the regional elevation profile data required to calculate the detour factor. Although geonames.org provides country-specific elevation data, the regional coding is different from Eurostat’s NUTS 3 level. A key for the translation of the coding is not freely available at present and would have to be produced in order to integrate the data into the measurement approach.

4. Inaccuracies can be corrected by making individual assumptions about motion speed for all countries, which was not done in this paper. Motion velocities are based on the assumptions of Conrad et al (2018). Detailed assumptions of this kind were not available for the countries considered, but could be collected within the framework of country-specific quantitative and qualitative studies and integrated into the measurement approach. This would further increase

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\(^6\) The substitutability depends, for example, on whether the bank is a universal finance provider. Then, for example, insurance or building society products compete with those of insurance companies and building societies.

\(^7\) According to Conrad et al. (2018) the average travel time to the next branch of a savings bank or cooperative bank is about 10 minutes. With reference to European statistics and sector K, however, the average travel time to the nearest financial services provider (to the nearest permanent establishment) is around 3 minutes.
Implications and outlook

the significance of the measurement.

With regard to the application of the measurement approach (albeit with limited data availability), the following statements can finally be made: A detailed examination (above all by including concentration measures) revealed differences in supply between the countries that would not have been apparent if mean values and box plots had been considered. The Netherlands and Switzerland are particularly well supplied compared to the countries included. There are regional differences in these countries as well. However, these differences are less significant than in the comparison countries. Germany and the United Kingdom have medium to high travel times overall.

The distribution (according to concentration measure) also shows that relevant parts of the population are undersupplied: A high proportion of country-specific travel expenditure is accounted for by around 15% and 7% of the population respectively (DE and UK). While in Great Britain the rural population is more likely to be affected, in Germany there are also long travel times in the cities. In Austria, travel expenses are distributed much better than in all other countries, which could indicate a different strategy for dealing with rural areas.

As mentioned above, all results have to be considered under the aspect of limited data availability. However, it becomes clear that an in-depth analysis, which goes beyond simple indicators such as branches per inhabitant or per square kilometre, is necessary in order to be able to make statements on the supply situation in a comparison of different countries and also to better understand regional disparities within a country. After all, this is the basis for targeted action approaches.
We would like to thank the promotion of science of the Sparkassen-Finanzgruppe for its financial support.


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Measurement of regional supply of banking services against the background of digitisation

The paper deals with the evaluation of the regional supply of financial services. Digitisation and the associated reduction of branches are taken into account. The previous measurement approach (branches per square kilometre or per inhabitant) will be critically examined and an extended measurement approach will be presented. This approach addresses demographic, topographical, settlement structural and infrastructural (Internet) aspects. It is been used by Conrad et al. (2018) for public savings banks and cooperative banks in Germany at a small-scale level. A comparison of the supply level within Germany was carried out. But a comparison with the results for different countries could not be made.

This paper therefore discusses how the new approach can be applied to other European countries. It will be shown that the transmission is only partially successful because important data is missing. The data set problems are discussed in this paper and finally the results of the measurement and comparison of the supply situation of five European countries - based on the available data - are presented. Using the extended measurement approach, on the other hand, a more differentiated picture emerges.

For more information

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