Digitalisation and (De)Centralisation in Germany - a Comparative Study of Retail Banking and the Energy Sector

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Abstract

The paper in hand compares retail banking and the electric energy sector to investigate how digitalisation influences (de)centralisation. Structural similarities of both industries like the direct competition of large international companies (Deutsche Bank and RWE) with locale providers such as savings banks and municipal utilities (Stadtwerke) motivate this comparison. Our findings suggest that digitalisation affects (de)centralisation differently. Despite scale economies inherent to processes of digitalisation, small entities must not be on the losing side. Cooperation tends to play a key role for regional companies to profit from digitalisation. Interestingly, digitalisation of the first and second transformation affects (de)centralisation of both industries diametrically (though, it is too early for final conclusions about the second digital transformation). The geographical properties of the businesses in question (i.e. the distance dependence of soft information respectively the physical properties of electricity transmission) and (regulatory) context factors tend to influence the relationship between digitalisation and (de)centralisation. More research is needed to enhance our understanding of digitalisation on (de)centralisation of the economy. As this discussion paper indicates, sector comparisons tend to be useful to contribute to such an understanding.

Key words: (de)centralisation, digitalisation, energy transition, retail banking, FinTech; EnergyTech, Digital Transformation

Part I: The Retail Banking Sector

1. Decentralised Banking, its Rationales and Development

For long, the banking industry stands for shifting spatialities in business conduct caused by major "digital" innovations (O'Brien 1992). Nearly three decades ago, Richard O´Brien (1992) declared "the end of geography". Over the course of the development of information and communication technologies (ICT) and deregulation, "geographical location no longer matters in finance, or matters much less than hitherto" (O'Brien 1992: 1). Local banking and financial markets were important in the past, because co-location was vital for the communication and transmission of information. However, with the advancement of ICT and the abolishment of strict regulatory boundaries, the importance of co-location

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decreased, and a global financial market arose. Particularly, small and regional banks have disappeared since O'Brien's (1992) prediction (Flögel and Gärtner 2018, Schmidt 2018, Flögel and Beckamp 2020), whereas financial centres are becoming even more influential (Therborn 2011, Gärtner 2013b, Dörry 2015, overview: Cassis and Wójcik 2018). Precisely determined by the exodus of regional banks, the academic (Klagge 1995, Martin 1999, Verdier 2002, Klagge and Martin 2005, Gärtner 2011, Gärtner and Flögel 2013, 2017) and political (Cruickshank 2000, Greenham and Prieg 2015, CDU/CSU and SPD 02/07/2018) interest in decentralised banking systems continues to gain momentum.

Among other reasons like the general call for diversity in banking (Ayadi et al. 2009, 2010, Schmidt 2009, 2018, Haldane and May 2011, Kotz and Schäfer 2018), regional banks and the local banking markets are associated with better access to finance, especially for small and medium sized enterprises (SME) (Stein 2002, Pollard 2003, Berger et al. 2005, Gärtner 2008, 2009, Alessandrini et al. 2009b, Flögel 2018a). On the one hand, the ability of regional banks to slow down capital drains from the periphery to the core regions suggests that regional banking might make a difference when it comes to access to finance in peripheral regions and, hence, stimulate more balanced regional development (Chick and Dow 1988, Dow and Rodríguez-Fuentes 1997, Klagge and Martin 2005, Gärtner 2008). On the other hand, geography or, rather, distance still matters regardless of the advances in ICT when it comes to information processing for lending decisions. From a theoretical point of view, lending in proximity to borrowers is associated with reduced information asymmetries and reduces credit rationing, especially when lending to SMEs (Stein 2002, Pollard 2003, Berger et al. 2005, Gärtner 2009, Alessandrini et al. 2009b, Lee and Brown 2017, Zhao and Jones-Evans 2017, Flögel 2018a). The relevance of difficult-to-transmit so-called soft information in lending to informationally opaque SMEs restrains decision-making at larger distances such as in financial centres and works more efficiently in a decentralised banking system, in which banks' head offices and decision makers are located in proximity to their clients. Due to short distances and profound knowledge of their regional market, small and regional banks are considered to be better at processing private and soft information and are therefore more suitable for lending to informationally opaque SMEs (Berger et al. 2005, Alessandrini et al. 2009b, Alessandrini et al. 2009a, Behr et al. 2013).

However, advances in ICTs may reduce the stickiness of soft information in lending and potentially overcome the needs for short distances to reduce information asymmetries (Papi et al. 2017, Flögel 2018, 2019). The introduction of rating and scoring systems by modern banks and, more recently, the introduction of FinTech innovations like peer-to-peer lending may explain the shrinking of regional banks, as technology diminishes the advantages in short distance lending. The German banking system still is decentralized significantly, especially in international comparison (Flögel and Gärtner 2018). More than 1,200 regional savings and cooperative banks exist alongside large banks. Banks from all three pillars—consisting of public savings banks and Landesbanken, cooperative banks as well as private commercial banks—compete for customers in almost all market segments, including SME lending (Gärtner 2009, Hackethal et al. 2006, Klagge 2009, see figure 1).

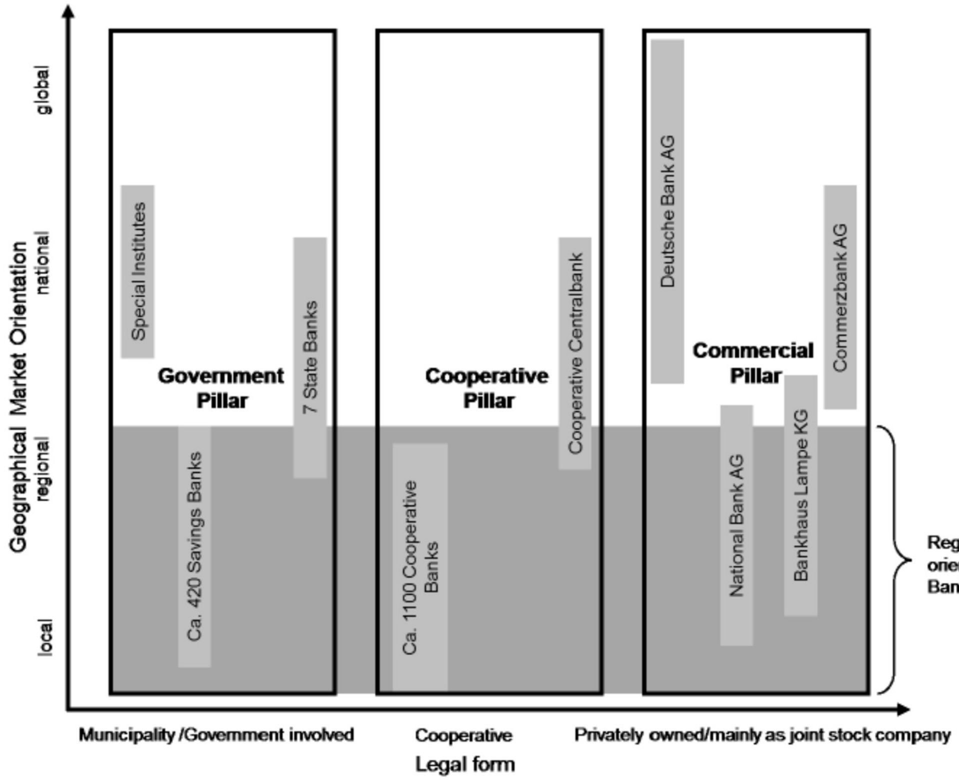

Figure 1: Decentralisation and legal form (Source: Gärtner and Flögel 2014: 6)

All banks are subject to the same banking regulations. However, specific laws hamper mergers & acquisitions between banking pillars, protecting the relatively small banks of the public and cooperative pillar from being acquired by large private competitors (Schmidt et al. 2014). Furthermore, the so-called regional principle, enacted in the savings banks laws of the Länder, accounts for the regional market segregation of German savings banks, preserving the nationwide presence of independent regional institutes (Gärtner 2009, Gärtner and Flögel 2014). Most cooperative banks apply similar regional market segregation measures on a voluntary basis (Bülbül et al. 2013). Therefore, two regional banks, one savings bank and one cooperative bank exist in almost all German NUTS 3 regions (Flögel 2019). As universal banks, regional German banks offer diversified retail business to local private, business and public clients. They are strongly linked to the associations and specialised (wholesale) banks of their pillar. This cooperation within the banking group allows the independent regional banks to offer competitive products and services and enables access to advanced bank-ICT, regulatory expertise etc. (Flögel and Gärtner 2018, Flögel 2019, Flögel and Beckamp 2020).

The above-mentioned market regulation and structures lead to strong competition between the pillars and foster cooperation within the pillars. In terms of lending to business, the regional savings and cooperative banks accounted for over 50 % of all lending in 2018 (€666 billion in total) and have increased market shares steadily from 35.5 % in 1999 (Deutsche Bundesbank 2019). However, regional banks decline in number since the German unification in 1990 from 4,265 to 1,260 in 2019 due to mergers within the regional banking pillars (Deutsche Bundesbank 2019). Within the same time frame, the number of national and global operating banks increased, which is mainly explained by the establishment of new branches of foreign banks in Germany (Deutsche Bundesbank 2019). According to the market share gains and reduction in number, regional banks in Germany become consistently bigger, which gives rise to the question, if German regional banks may lose proximity advantages in case this trend continues.

2. Rating Systems and the First Digital Transformation

Banks were early adopters of ICT, dating back to the 1960s. Today, ICT costs account for 15–20 % of all costs, constituting the second largest cost factor after labour (Puschmann 2017). Hence, retail banking has been shaped by ICT for a considerable time, concerning products and services as well as risk management methods. In particular, rating and scoring systems have been debated when they were introduced on a large scale in the 1990s due to centralisation effects of credit decisions (Leyshon and Thrift 1999, Leyshon and Pollard 2000). Rating systems evaluate multiple aspects of information and systematise them into a single rating score, which classifies a borrower's/firm's probability of default (Flögel 2018a). When banks delegate decision-making power to such rating systems, e.g. by defining a rating score cut-off limit when lending is proscribed, the actual lending decisions are centralised and delegated to the rating system and its algorithm. The following section discusses the development of the rating systems and bank ICT of the German savings banks in order to illustrate the long history of digitalisation in banking. We then turn to the question as to what extent rating systems are able to consider and transfer soft information in SME lending. The observations and results presented here are taken from an ethnographical participant observation in a regional savings bank (Flögel 2019).

1.1.1 The Development of Rating and Scoring Systems of the German Savings Banks

SME rating systems developed from private credit scoring (which was in use as early as the 1950s) and spreadsheet software used to analyse borrowers' financial statements (Udell 2009). In the 1990s, several German savings banks developed and utilised more or less advanced rating systems on a voluntary basis, sometimes cooperatively (Flögel and Zademach 2017). At the same time, the international conversation on banking regulation advanced the idea of accurately determining the risk of all bank assets, which implies the rating of SME credits. This conversation eventually led to the Basel II recommendations, which were implemented in 2007 (Paul 2011). At a national scale, the so-called *Mindestanforderungen an das Kreditgeschäft der Kreditinstitute* (Minimum requirements for the credit business of credit institutions) (MaK) regulation was debated in the 1990s and was introduced in 2004. MaK promoted the application of rating for SMEs. As all banking associations participated in this regulatory conversation. In turn, it stimulated the internal conversation of the Savings Banks Finance Group concerning the common development and implementation of a SME rating system (Flögel and Zademach 2017). The SME rating system was developed and tested by selected savings banks in the late 1990s and rolled out for obligatory use in the over 400 German savings banks in 2002. The introduction of this SME rating system also marks the birth of the the Sparkassen Rating und Risikosysteme GmbH, a company of the Savings Banks Finance Group located in Berlin, that is responsible for all rating and scoring systems of the financial group.

The rating systems, which are software programs for the applying bank employees, are interconnected with OSPlus, the integrated banking ICT system of the savings banks. The browser based OSPlus contains numerous modules, which allows adaptation to the business policies of each savings bank. OSPlus is used for almost all tasks in retail banking of the savings banks from customer advisory, account management and payment transactions, credit calculation, back office work (e.g. contract creation) to risk and portfolio management. At the time of research in 2014, the interviewed experts of the savings banks and also the interviewees from competing large banks considered the ICT systems of the savings banks to be very competitive in terms of industrial standards in retail banking (Flögel 2019).

In light of the description on the ICT use of all savings banks, it becomes clear that digitalisation is not new to regional savings banks. Modern regional banks rely heavily on competitive ICT to conduct business lending or, using the words of a SME customer advisor of a savings bank: "If the PC is offline, you can go for breakfast. Yes, it is just like that, you need the current loan values, you need the current account balances" (Flögel 2019: 174).

1.1.2 Have Rating Systems changed the Business Model of Regional Savings Banks?

In SME finance, soft information encompasses assessments of the firm (e.g., the competitiveness of its products, the prospects for the business strategy) and its managers (e.g., their honesty and expertise) and is typically collected by bank employees through personal contacts with the borrower over time. The Savings Banks Finance Group puts substantial effort into the consideration of soft information by the development of its SME rating systems, explicitly aiming at the use of soft information advantages (Theis 2009: 85). The SME rating consists of different modules, where soft information is inserted into the qualitative rating module. Here, customer advisors answer questions about the qualification of management, planning and timeliness of reporting etc. However, the influence of soft information on the rating score is very limited, especially for smaller clients whose hard facts, like account behaviour and financial ratios, determine rating results (Flögel 2019).

Two additional facts explain the limited influence of soft information on rating results. Firstly, soft information is often very context- and firm-specific and thus, resists evaluation by rating algorithms, because of unclear, i.e., non-linear impact on actual firm default. Secondly, the consideration of soft information by rating and scoring systems is prone to manipulation. As the verifiability of soft information is by definition restricted to the actor, who has produced it (Stein 2002), a high weight of soft information makes rating algorithms prone to manipulation. This susceptibility to manipulation is shown to be a critical aspect of rating and scoring systems in general. The more power banks dedicate to rating scores, the more worthwhile it is to manipulate the rating results (Róna-Tas and Hiß 2008; Svetlova 2012, Berg et al. 2013, Carruthers, 2013, Flögel 2015). Accordingly, the more influence a rating or scoring system has on lending decisions, the more likely it becomes that users start manipulating the input. Such manipulation is not restricted to soft information but applies for all inputs of the ratings. Yet, as soft information cannot be validated by anyone other than the producer, manipulating soft information is less likely to be detected in comparison to hard information, which can be verified easily.

To assess the influence of savings banks' rating systems on the business practices, the lending to SMEs of a savings bank has been compared to lending practices of a large German bank with ethnographical methods (Flögel 2019). Though both banks use rating systems to inform lending decisions and allocate decision making authority to different hierarchical levels, only the large bank applied a strict cut-off limits, i.e. a minimum rating score below which new lending is prohibited. The observed savings bank did not rely on ICT. Rather, bank employees (customer advisors, credit officers and supervisors) and clients create and verify soft information in personal interactions when it comes to lending decisions for firms with critical hard information (Flögel 2019). Overall, the comparison shows that the business models of the regional savings bank and the large bank still differ, notwithstanding both banks use rating systems for SME lending (in line with bank regulation requirements). In conclusion, our empirical observation suggests that the introduction of ICT-based rating systems did not fundamentally alter the business model of regional (and large) banks, at least not at time of empirical inquiry in 2014.

3. FinTech and the second digital transformation[2]

Despite the long use of ICT, the banking industry is currently in excitement because of FinTech, which can be seen as the second digital transformation of the industry as "FinTech covers digital innovations

[2] Parts of this section are published in Flögel and Beckamp (2020).

and technology-enabled business model innovations in the financial sector." (Philippon 2016: 2). According to Philippon (2016) new technological and business innovations are):

- cryptocurrencies and the blockchain
- new digital advisory and trading systems
- artificial intelligence and machine learning
- peer-to-peer lending, equity crowdfunding
- mobile payment systems

Although FinTech includes activities of the incumbent financial service providers, for example banks, it is mostly associated with the activities of start-up companies, such as N-bank and no-bank competitors like Google Pay (Dapp 2015, Puschmann 2017). Therefore, numerous authors perceive FinTech as a challenge for established banks (Dapp 2015, Brandl and Hornuf 2017, Jagtiani and Lemieux 2017, Philippon 2016, Puschmann 2017, Tang 2019). With respect to SME finance, FinTech is perceived with both hopes and fears. On the one hand, there is the expectation that FinTech will foster innovation for banks, i.e. online credit applications, data analysis, payment transactions, and generate new competitors to established banks, especially with peer-to-peer lending, both of which would positively influence the supply of finance for SMEs (Alt and Puschmann 2016, Jagtiani and Lemieux 2017, Philippon 2016). On the other hand, the banking industry's reactions to FinTech – for example a reduction in the number of branches, the acceleration of bank mergers and acquisitions – tends to threaten the supply of finance for firms in affected regions, most of which are peripheral (Burgstaller 2017, Conrad et al., 2018).

In Germany, several peer-to-peer lending platforms exist, like auxmoney and Smava that currently have increased lending rapidly. To give an example, auxmoney has increased lending by 2.3 % between 2012 and 2017, matching loans of €315,98 million in 2017 (Auxmoney 2017). Lending is used for private purposes like holidays (4.23 % of all loans) and business purposes like start up finance (11.82 % of all loans). Loans are provided to rather risky borrowers (in terms of the banking industry standards) while the loan amount is rather small. Dorfleitner et al. (2016) report an average loan size of just €5,030 with an average duration of 36.72 months for loans matched with auxmoney between 2008 and 2013, though likely the average loan amount and duration increased in recent years. While business lending was not initially the focus of interest of German peer-to-peer lenders (Schmitt and Huesig 2016), it has recently become more popular. For example, Lendico has shifted its focus exclusively to business lending since 2016 (Lendico 2019, p2p-banking 2017). In 2019 auxmoney just started to target business clients with loans up to €750,000 (Auxmoney 2019a). Therefore, peer-to-peer lenders now directly compete, especially with regional banks, for smaller, rather risky/informational opacity (business) clients.

Originally, peer-to-peer investors conducted lending decisions based on borrowers' loan proposals under consideration of the information provided by the borrower (e.g. written exposés of projects), which tended to contain soft information. Like eBay, early lending platforms were largely passive and utilised the crowd's "swarm intelligence" for lending decisions on the basis of the information provided (Balyuk and Davydenko 2019). Recently however, many platforms have become more similar to ordinary banks (Balyuk and Davydenko 2019, Ryan and Zhu 2018). Platforms like Prosper, LendingClub, and auxmoney offer portfolio diversification to investors, which has always been the raison d'être of banks (Diamond 1984), and provide automated investment services, gradually shifting lending decisions from the investors to the platforms themselves (Balyuk and Davydenko 2019). To do so, most platforms have developed individual scoring systems to predict the probability of credit default for the offered loans (Balyuk and Davydenko 2019). In the context of this shift to active screening of peer-to-peer lending platforms, researchers are debating the extent to which alternative and soft information is represented in lending decisions considering scoring algorithms (Iyer et al. 2016). Jagtiani and Lemieux (2017) document that LendingClub's scoring system uses alternative information to the credit bureau data (such as insurance claims, electronic records of deposits, withdrawal transactions and utility payments) and applies machine learning, which has caused a gradual increase of prediction validity in recent years. Balyuk and Favydenko (2019) report that Prosper is gradually withdrawing private and soft information from its algorithms (among other reasons to prevent discrimination), relying on credit bureau data and limited hard information, such as employment status and credit history at Prosper. Interestingly, Prosper advertises its lending system as being fully automated and functioning without human assistance (Balyuk and Favydenko 2019). Whereas the development of Prosper suggests transaction banking tendencies, LendingClub tends to rather emphasize innovative scoring systems, which include alternative information (Jagtiani and Lemieux 2017).

Concerning soft information, several studies confirmed the impact of soft information in peer-to-peer lending decisions (Dorfleitner et al. 2016, Jagtiani and Lemieux 2017). However, no "real" soft information from trust by experience, but rather alternative information (to financial statement and FICO/SUFA), tends to be used. This may not be surprising as FinTech companies tend to face similar challenges considering soft information within ordinary rating and scoring systems. The following table recalls the challenges associated with the consideration of soft information by rating systems and answers the question of whether FinTech delivers better results.

Table 1: FinTech-based consideration of "real" soft information: Can FinTech do better?

Limitation	FinTech
1. **Context specificity** of soft information	Machine learning may mitigate this problem due to its ability to identify nonlinear /complex relations (Bahrmmizaee 2010)
2. **Verifiability** of soft information	Questionable, because of the problem of susceptibility to manipulation (probably cross-validation with "very" big data). More likely: crowding-out of soft information by machine learning

Source: Flögel and Beckamp 2020: 12

As the table makes clear, machine learning may be an appropriate way to deal with the context specificity problem of soft information (though banks could also use machine learning), although problems related to manipulation incentives are difficult to overcome. Therefore, it appears more likely that soft information – or, more generally, any human input to the scoring process, which is not easily verifiable – gets systematically crowded out in the process of scoring development, in case the scoring becomes of tremendous importance for lending decisions. Here, the manipulation of soft information in ICT pays off. However, that is not to say that FinTech, i.e. peer-to-peer lenders, lack the ability to compete with regional banks due the lack of soft information. Quite the opposite is the case: peer-to-peer lenders tend to be highly competitive for lending smaller amounts to informationally opaque (business) clients. This fact does not simply derive from big data/alternative information and machine learning, which can also be applied by banks (though banking regulation may prevent unsafe use of data). Rather, their key advantage is lower operational costs considering the banking standards in terms of staff, branches salary and bonuses. Furthermore, banks must fulfil banking regulations in terms of process organisation, reporting standards and equity capital requirements, giving them a profound disadvantage compared to their new competitors from the FinTech sector.

As we have argued elsewhere in more detail (Flögel and Beckamp 2020), only the future can tell, whether FinTech, especially peer-to-peer lending, will make the short distance-based business model of regional banks superfluous. Both technological developments (the implementation of soft information in digitalised decision making processes and in ICT) and social tendencies (e.g., regulation of FinTech, funding preferences of firms, reaction of regional banks) will influence the future development of the decentralised banking system and regional banks' position in SME finance. While the first digital transformation did not alter the structure of Germany's banking system (the three distinct pillars and regional banks still exist in their previous forms), new FinTech competitors have the potential to make the established regional and large banks obsolete, as they aim to replace old-fashioned financial intermediation. Enhanced competition from FinTech will likely fuel the concentration and hence centralisation of the banking industry further.

Part II: Energy Sector

The German energy system features analogies to and connections with the financial sector: both are fundamental sectors for the economy, featuring large international as well as small decentralised, geographically dispersed and municipally integrated companies. Exchanges and their prices are central for the retail market of both sectors, as for example EURIBOR and EEX/EPEX influence retail prices and profitability. Similarities do by no means occur only on a macro level, as developments such as market liberalisation, digital transformation and national energy transition deepen parallels and connections on company level likewise. While banks have always been intermediaries between savers and borrowers, energy providers' long-established roles as producers, distributers and suppliers of electrical power commence to change and tend to become intermediaries (Brauner 2016: 172, Doleski 2016). Especially the energy transition leads to a more decentralised energy production and new encounters for energy companies: as returns in energy generation revenue decrease, new infrastructural challenges arise, novel actors and business models enter the markets, sectors converge, digital technologies allow innovative solutions and administrating and accompanying services become more important. Analogous to banks offering services about money and credits, energy companies start offering services instead merely selling electricity as a product (Brauner 2016: 172, Doleski 2016). In the following chapter, aspects of digitalisation within the energy sector, paralleling the developments in banking, will be depicted exemplarily.

4. Decentralisation in the German Energy System

The German energy system underwent two incisive changes in the last decades. First, the liberalisation of the energy system since 1998 opened the previously oligopolistic market for new actors. Second, an (ongoing) shift from fossil-nuclear energy production to renewable energy production – known as energy transition – leads to a decentralisation on several levels of the energy sector. Decentralisation especially starts to play an important role in energy generation, which can be depicted as horizontally as well as vertically decentralised: Renewable generation units are dispersed geographically and throughout various grid levels (Bauknecht et al. 2015, Ropenus 2017). This process is accompanied by a closely connected decentralisation when it comes to ownership-structures, as new actors in form of private prosumers, energy cooperatives and new firms arise (Hall et al. 2016, Klagge and Schmole 2018). Both changes lead to shifts in market shares: the combined market share of the incumbent operators E.ON, RWE, Vattenfall and EnBW – often depicted as "big four" – dropped from 80 % in 2009 to 68 % in 2012 (Monopolkommission 2015). While missing strategies for a liberalised market and the energy transition are seen as the main reasons for the decline in market shares, especially municipal utilities (Stadtwerke) emerge as rivals to large international companies due to the remunicipalisation efforts in grid operation in the last decades (Bontrup and Marquardt 2015, Wollmann 2018). In the following section, we briefly describe the development of liberalisation, energy transition and remunicipalisation and their connections to decentralisation.

Liberalisation

Prior to liberalisation, the German energy sector was organised centrally and dominated by (vertically) integrated companies and their subsidiaries, which covered the whole value chain from energy production to distribution. Liberalisation started in the 1990s with the European Union's aim to create a single European energy market as one of the main drivers (Bontrup and Marquardt 2011: 13). During the process, regulation led to unbundling – the separation of supply, generation and grid operation – and the establishment of the Bundes Netz Agentur (BNetzA) as a regulatory authority in order to facilitate competition (Bontrup and Marquardt 2011: 29–33). Vertically integrated companies were split, as they had to unbundle energy production, distribution and supply – at least formally – which resulted in a de-oligopolization (Clausen and Mono 2017a: 119). With liberalisation and unbundling of generation and supply, energy exchanges became a significant feature for producers to sell energy to suppliers to procure energy for their customers.

Following liberalisation, incumbent actors still dominated the energy market, though new competitors entered the market. Due to the already established structures, existing generation units and strategies to slow down new entrants, liberalisation did not lead to a thoroughly equal market (Bontrup and Marquardt 2011: 401, Berlo et al. 2017). In addition the large companies reacted to liberalisation with several mergers and acquisitions and expanded internationally (Bontrup and Marquardt 2011). Unbundling also applied to the municipal utilities, however, smaller utilities were excluded from this form of vertical disintegration. The liberalisation process led to substantial changes of and challenges for municipal utilities. While large firms expanded their influence, the number of energy supply companies initially decreased by 20 % in the years following the liberalisation. Many public sector utilities changed their legal form in order to enable new possibilities of shareholding (Bontrup and Marquardt 2011: 76).

Energy Transition

While liberalisation led to severe changes in the organisation of the energy system and opened the market for new actors, especially large and long-standing companies kept a large share of market power and influence. This started to change in the last decade, when the politically promoted energy transition and the associated nuclear phase-out started challenging the profitability of conventional thermal power plants of the large incumbent companies (Haipeter 2016: 291). The Erneuerbaren-Energien-Gesetz (engl.: German Renewable Energy Sources Act) (EEG) with a guaranteed feed-in tariff opened the way for new, small-scale technologies of energy generation with lower marginal costs. While the large scale nuclear-fossil generation required large investments with a long amortisation, which only big, financially liquid companies could handle, renewable generation technologies are now affordable for smaller firms, energy communities and even individuals (prosumers). The decentralised banking system supports such small-scale energy production as it offers adequate scaled finance for the investment needed (Hall et al. 2016). Thus, while conventional energy generation units are mainly in the hand of established companies and their spin-offs, renewable energy generation, which makes up a share of 37.8 % on gross electrical consumption in Germany in 2018 (Bundesministerium für Wirtschaft und Energie 2019), has a more diverse ownership structure. Therefore, the energy transition not only leads to a more decentral generation (geographically as well as concerning the grid level of infeed). It simultaneously leads to a decentralisation when it comes to the ownership structure as the increasing share of energy produced by generators classified as *other infeed* (as a demarcation to the conventional *powerplants for general supply*) in figure 2 shows.

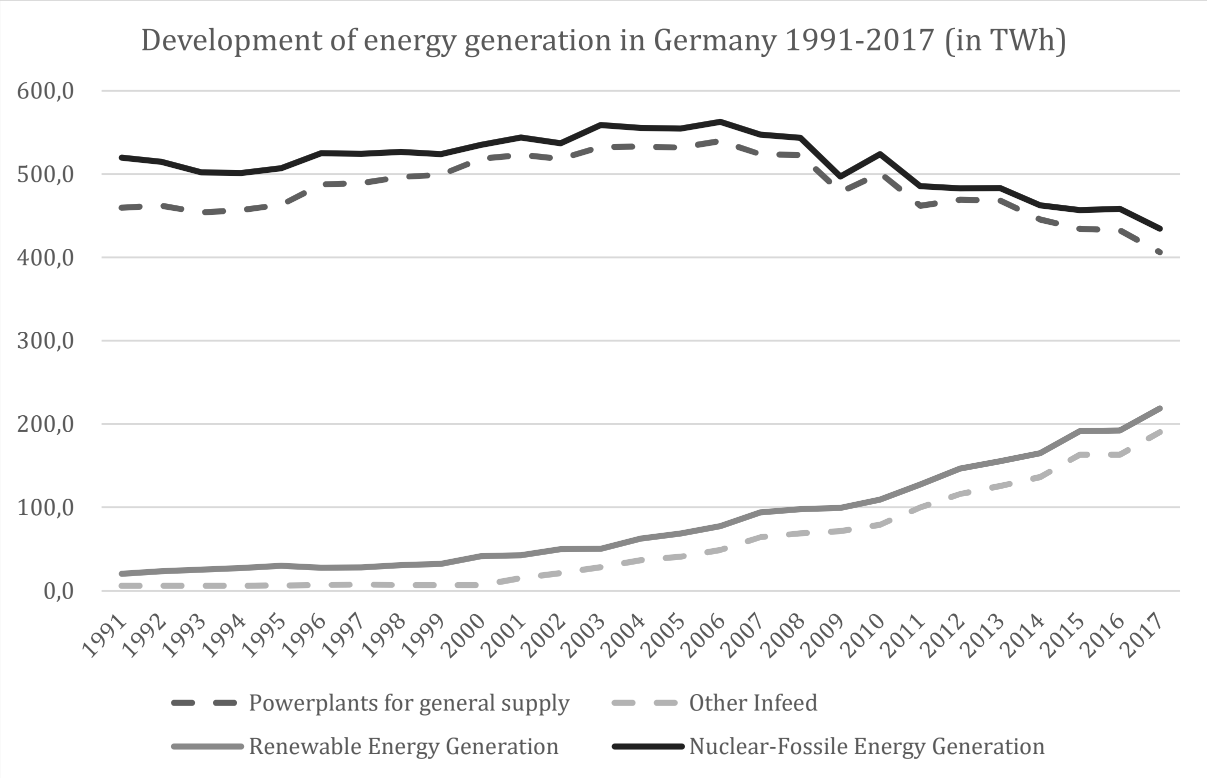

Figure 2: Changes in the structure of energy generation in Germany (own depiction according to Federal Ministry for Economic Affairs and Energy (2020)

The ongoing energy transition challenges the German energy system and opens up new demands for services beyond electricity production. The existing infrastructure was built on the requirements of a centralised energy generation system (Brauner 2016, Scheffler 2016). Energy grids were designed for top-down distribution, from large scale generation units through different grid levels towards the consumption of commercial and private users at the lower tier grids (Scheffler 2016). This distribution is now challenged by increasing decentralised generation.

Renewable energy generation is mostly connected to lower tier grids, while bottom-up distribution was technically not intended when the infrastructure was installed. Nowadays around 98 % of all generation units are connected to the lower tier grid (IAEW et al. 2014). Weather-related volatility of renewable energy production further challenges energy supply as it, in contrast to conventional generation, causes the need for energy storage and reserve capacities. Furthermore, the placement of renewable generation units is based on physical factors such as wind and solar radiation, while conventional power plants were often built in proximity to sites of large energy demand like cities and industrial areas.

Germany's geography, which offers beneficial conditions for wind energy in the coastal northern areas and a high demand for electrical power in the industrial centres of the South and North-Rhine Westphalia, demands energy transmission over large distances, for which the transmission grid is only slowly being expanded. In this context, the nationwide energy generation prices do not convey information about local or regional grid utilisation or congestion, but assume a "copper plate", i.e. frictionless distribution (Bauknecht et al. 2015, Löschel et al. 2013, Clausen and Mono 2017b), which is why there are certain national arrangements to cope with this shortcoming.

To prevent supply bottlenecks and to maintain the required power frequency throughout the country, the four German transmission system operators (TSOs) jointly procure and retrieve reserves and ancillary services. In 2018, the transmission system operators spent a total of around €1,881 billion on ancillary services, of which around 76 % were spent on network and system security. The costs for feed-in management (estimated at €635 million) and redispatches (€352 million) are particularly relevant here (Bundesnetzagentur and Bundeskartellamt 2020), since they are directly related to the generation structure that is decentralized due to the energy transition. While these two services mainly compensate power plants for altering their power feed to reduce network load, there are further services that are procured through special markets independent from the main power exchanges. In order to guarantee power frequency, TSOs procure various forms of balancing energy and interruptible loads through tenders. This allows reactions to deviation from the estimated energy infeed or demand due to station blackouts, unanticipated changes in demand or volatility of renewables. Here, (virtual) power plants and industrial energy users can place offers for predefined timeslots, in which they increase their feed-in (power plants) or decrease their energy demand (especially industrial users). As EU specifications require a prospective market-based provisioning of redispatches, which are currently organised cost-based and administratively, a further possibility to market energy flexibility will be established until 2022. Thus, compensation services and regulated secondary markets are in place to cope with challenges of the decentral, renewable energy generation and uniform market prices for electricity that do not convey information on regional congestion or grid utilisation.

Remunicipalisation

Remunicipalisation, especially of local energy grids, is a relatively new development of the last decade. While liberalisation first led to a phase of privatisation and a decline in municipal utility companies was predicted by some (Bontrup and Marquardt 2011: 76f), remunicipalisation formed a counter development to this phase of privatisation (Becker 2017, Wagner and Berlo 2015). Expiring concessions for grid operation, which were previously held by large companies, were often portioned to existing or newly found municipal utilities which led to a phase of remunicipalisation. Motivations for remunicipalisation are to regain control and fiscal revenues, cross-subsidisation, democratisation of the energy system, services for the public and fostering an active role in the energy transition (Wagner and Berlo 2015). While this gives back direct control over their local grids to municipalities and allows to generate revenues from grid operation, remunicipalisation did not proceed thoroughly uncontested by the previous grid service companies, as large energy companies in some cases opposed or tried to impede it with various strategies (Berlo et al. 2017). Speaking of a remunicipalisation as a specific trend, is however debated. Several other (non-municipal) energy businesses formed in the same period, so that remunicipalisation may fall into a general phase of increasing diversity in the ownership structures of the energy sector (Cullmann et al. 2016, Lichter 2015).

Remunicipalisation tends to affect decentralisation, because federal laws partly restrict municipality owned companies from conducting business outside of the territory of their municipality (*Örtlichkeitsprinzip*) and hinders business activities in areas not related to services of general interest. The precise extent of business restrictions is handled differently in the municipal codes of the German federal states. Nevertheless, municipal utilities and related companies tend to serve local tied markets, like the public savings banks. This practice strengthens a decentral structure. However, in contrast to the savings banks, publicly owned municipal utilities do not cover the whole of Germany and diverge in their duties and function (from quasi vertically integrated companies to utilities only focusing on single aspects such as grid operations). A closer look on shareholder structures of utilities and regional energy suppliers further shows that numerous municipal utilities are partially owned by larger energy companies such as E.ON, RWE and their subsidiaries and partially vice versa. Furthermore, various

networks for cooperation encompass both local utilities as well as large (international) firms. Therefore, a clear distinction of the company's active in the German energy sector similar to the banking sector does not prove fruitful even after the remunicipalisation processes in the last decades.
Several (recent) surveys and studies report that especially smaller energy companies and municipal utilities are prone to cooperation as a strategy to deal with change of situations in the energy sector (Sander 2011, Berlo and Wagner 2013, Edelmann 2016, 2017, Tremml et al. 2018, Growitsch et al. 2015). Various municipal utilities already followed strategies of cooperation and founded networks to stay competitive as a reaction to liberalisation (Bontrup and Marquardt 2011: 77f). Decentralisation and cooperation tend to go hand in hand as strategies to advance and stay competitive in the dynamic market environment of the energy sector. Specifically, the process of digitalisation embodies several opportunities for cooperation as fixed costs for the development, implementation and operation of digital solutions tend to be high and variable costs low. These economies of scale inherent to most digital technologies are the key reason why digitalisation is often associated with centralisation. In order to investigate this conjunction, we now turn to the digital transformations of the energy sector.

5. First Digital Transformation and the Generation of Data

The German energy business was one of the first civil sectors, in which computers were implemented in the 1960s. Applications mainly existed in the field of grid control, e.g. for process data compressing, compensation of measurement errors as well as voltage loss optimisation (Rehtanz 2015). Further elements of the energy system were digitalised, especially power plant control as well as communication with the energy markets (Brickwedde 2016). Since 2000, a dynamic system image based on real-time monitoring of parts of the grid is used to analyse the current status of the grid and to prevent disruptions (Rehtanz 2015). Today, algorithmic solutions become a more and more important feature in grid control, for example for cross-border flows of energy in the European energy system. Here, algorithmic models are used to compute required grid capacities for the next day, as flow-based market coupling uses data from day ahead, auctions as well as grid models (Bundesnetzagentur and Bundeskartellamt 2020).
While the transmission grid operators can rely on detailed real-time information about the status of their grids and trade is widely digitalised, distribution network operators (lower tier grids) lack detailed real-time data (Homann 2016: 163). When installing these grids in the past, communication technology has often been seen as "secondary technology" (Edelmann 2017). Most of the steering in the energy grids is currently based on Supervisory-Control-and-Data-Acquisition-interfaces (SCADA), which are partially incompatible with other common ICT-Network technologies according to Kottinger (2018).
Next to grid control, especially energy trade developed as a highly digitalised part of the energy sector. As liberalisation led to the introduction of energy exchanges, digital technologies were important for fast energy trade on supply and demand side. Due to growing complexity and speed of trading (e.g. today, intraday markets allow trading in 15-minute blocks up to 30 minutes prior to delivery (Bundesnetzagentur and Bundeskartellamt 2020), digitalisation in this sector developed rapidly. Low wholesale interest spreads, fast intraday trading, increased cross-market liquidity and transparency, increasing volatile energy generation and CO_2 prices enhance complexity and competitive pressure, which in turn promote the intensified use of automated, algorithm-based energy trading solutions (Kipp 2017, Masthoff et al. 2018, PricewaterhouseCoopers 2017). Software enables automated trading for energy producers and suppliers, which, nowadays, rely heavily on ICT to run business, as market conditions guides power plants operation etc. (for which energy companies run so-called optimizer

systems). In 2015, a medium-sized energy company relied on an average data traffic of 30,000 messages with a data volume of 1.6 Terabyte for process steering and communication (Bundesverband der Energie- und Wasserwirtschaft e.V 2015). Still, the process to utilize digitalisation – as an "instrument to deal with complex tasks is required due to liberalisation as well as regenerative power generation" (Becker 2016:29) – in the energy sector is far from being completed at this point. Although the energy sector exhibits a long history of computerisation as well as a high degree of digitalisation in different fields, a linkage of different elements is not yet accomplished (Heinrich-Böll-Stiftung e.V. (hbs) et al. 2018: 32f). During this phase of digitalisation, various digital instruments and solutions were introduced, mainly aiming at operations and connection to markets.

One of the most recent features of the digitalisation process is the introduction of smart meters, a technology allowing real-time metering of decentral energy consumption (and generation). Consisting of modern measurement devices and smart meter gateways, these intelligent energy meters are seen as a prerequisite for a successful energy transition, as they constitute a basic prerequisite for a flexible limitation of volatile energy in-feed as well as for flexible demand side management. While the introduction of smart metering was politically agreed on in 2016 by the *Act on the digitalisation of the Energy Transition* with the starting point being set to January 2017, a lengthy process of certification for the new technology delayed the roll-out until 2020. The roll-out of these devices – the replacement of the old meters with the new devices – is scheduled for the next decade, starting with high-demand energy users.

In the last years, especially smaller energy companies were reluctant to invest into smart metering (Roth 2018), amongst other reasons because the long process of certification led to fears to invest into the wrong technological solution. Even with the certification process being successful and first companies offering smart meters for the German market, there are still challenges. Currently, discussions on the allowance to use specific frequencies for the communication by these devices may pose a further hindrance for the roll-out, as it is considered to assign these frequencies for emergency services, which could imply an unavailability to use smart-meter devices for energy providers (Krempl 2020). Smart meters, in the way in which they are currently installed and integrated in energy system and markets, can be seen as an elaborated way of metering, which allow easier retrieval of energy demand data. Incentives for local demand side management or curtailment of local renewable units on household level are still missing. Therefore, currently only limited benefits result from the use of smart meters. Nevertheless, the effort to create and collect energy related data tends to be an important precondition for the second digital transformation in the energy sector.

6. Second Digital Transformation and the Rise of "EnergyTechs"?

Analogous to the development in the banking industry, we identify the second digital transformation of the energy sector to represent a rise of digital and technology-enabled business model innovation. Market entrances by external players and new energy start-ups, which could be analogical be coined as "EnergyTechs" characterise the second digital transformation. A shift from refining existing business models of established actors by means of digital technologies towards the development of new business models (originating in other fields, especially the ICT sector) challenges the roles of established large companies and municipal utilities alike. Previously unsolved challenges of the energy transition arising from the decentralised generation are increasingly targeted with digital solutions. Various companies and start-ups capitalise on potential brought by digital technologies to offer energy-related services. Aggregators operate virtual power plants to connect various agents such as renewable energy sources, storage systems and flexible demand to trade on different markets. Other companies connect regional producers and consumers of renewable energy or set up solar plants through crowd investing. Others offer cloud services for energy providers or smart meters that visualise private households' energy consumption. In this context, sectors converge, for example in the field of smart home technologies or through the implementation of ICT, based on new business models (e.g. virtual power plants) (Roth 2018: 41).

Aggregators, operating virtual power plants, have arisen in the last decade and operate various markets like energy exchanges and ancillary service markets. One established actor in this field, Next Kraftwerke, founded in 2009, pools 8,732 units all over Europe with an overall connected capacity of 7,560 MW in the last quarter of 2019, while they traded 15.1 TWh Energy in 2019 (Next Kraftwerke 2019). They do not own generation capacities, but virtually combine existing units for energy generation, storage and demand and are, thus, able to act as a large energy generator or consumer. Next Kraftwerke and other aggregators focus mainly on renewable energy and the solution of problems arising through volatility. Their power plant portfolio as well as their strategic orientation often differ fundamentally from that of conventional energy companies. Yet, they tend to compete with conventional energy generation companies as they also pursue their aims lawfully when identifying unfair advantages for conventional energy companies – for example, when it comes to market design for ancillary markets (Jehle 2019). The relevance of these energy companies without own generation units is steadily growing.

However, the second transformation does also arise from the implementation of new technologies by established companies like municipal utilities: A growing number of energy companies realise the potential of digitalisation (Edelmann 2018, Bundesverband der Energie- und Wasserwirtschaft e.V 2015) and especially smaller firms see the need to revise their strategies (Growitsch et al. 2015: 6). Digital platforms and services enable economies of scale to decrease marginal costs of previously manually organised services. At first appearance, large companies benefit in particular as they can pool customer processes in digital platforms while the development and introduction of these technologies is costly for smaller utilities with limited numbers of customers (Roth 2018: 41). Here, cooperation between smaller companies come into play as outlined above.

Regarding innovation, German municipal utilities also explore and exploit opportunities of digital technologies through pilot projects. Some partner with scientific institutions and universities for research and pilot projects, others incorporate start-ups or use innovative technologies as an addition to their day trade. The Talmarkt in Wuppertal aims on conscious energy use and transparency. The Wuppertaler Stadtwerke offer a blockchain-based local energy market, which integrates local, regenerative energy supply and demand, where consumers can retrace the location of the production site of their energy (Stadtwerke Wuppertal (WSW) 11/20/2017). The *Strombank* research project, which was conducted by MVV Energie, a regional energy company, in cooperation with the University of Stuttgart and the ads-tec battery company conducted research examining cooperative storage of energy by several prosumers following the concept of a classic "bank" in a test run. However, as a result it has been concluded that especially regulatory obstacles render the project unprofitable (Thoman et al. 2016, Eckerle and Mildenberger 2018).

Different municipal energy providers now offer prepaid, pay-as you go energy tariffs, for example Stadtwerke Düren or Stadtwerke Duisburg. In contrast to common German energy tariffs, users are not billed periodically, as a prepaid concept is used, mirroring prepaid mobile phone tariffs. The project is enabled by the implementation of smart metering as users figuratively load energy assets onto their meter and spend them until their prepaid energy resources are depleted. Taking the concept a step further, some energy companies try to react to the changing role of the customer with specific offers such as contracting models like *Mieterstrom.* Here roof spaces can be leased for renewable energy production in order to provide tenants with renewable energy, as feed-in and consumption are

in direct proximity and consumers therefore profit from lower network tariffs. These projects show exemplarily how the entrance of new actors into the energy business as well as cooperation between those and traditional energy firms lead to new business models, closely connected to those already existent in other sectors, such as banking and ICT. With the rise of E-mobility, more offers and firms will enter the energy sector on the interface of energy provision and mobility, leading to an additional opening of the energy sector to new business models and actors.
In times of decreasing revenue from energy generation (Roth 2018: 35), cooperative, service-oriented offers, in which utilities are considered as partners for their customers, enable energy companies' new forms of revenue, detached from energy quantities (Eckerle and Mildenberger 2018: 21). While the first digital transformation or computerization of the energy system simplified steering of energy production and distribution, the ongoing digital transformation facilitates new business models that react to the challenges of the energy transition. New services in the energy sector often utilize potentials and target challenges arising from the decentralization and volatilization of (renewable) energy production. Most projects, firms and digital technologies contribute to an energy system incorporating volatile energies and flexible demand. The aims here are to fulfil customers' increasing demand for innovative products (Tremml et al. 2018) and represent the ability of new business models to react to challenges the previously mentioned challenges. Overall, the second digital transformation tends to enable a decentralised and more volatile renewable energy system.

Comparison and Discussion

In our comparison of the banking and the energy sector, we identified similar original structures. Decentralised companies, such as regional savings and cooperative banks and regional, public utilities (*Stadtwerke)* as well as energy cooperatives co-exist alongside centralised companies, i.e. large (inter)nationally operating companies like the big four banks and large energy companies. This geographically diverse service provision by regional and national/international banks can be traced back to times, when spatial proximity was necessary to communicate and conduct business. Savings banks were founded to serve the poor and small local business while large banks like Deutsche Bank historically started as merchant banks (here, international presence was necessary to conduct trade). For the energy sector, infrastructure – that is the local distributions grid as natural monopolies and capital-intensive power plants – tends to be accountable for the geographical diverse structure. On the level of municipal utilities, territorial boundaries and the *Örtlichkeitsprinzip* explain the presence of local energy suppliers today. This regional principle also exists in banking and causes the regional market orientation of the savings banks, whereas most cooperative banks apply similar market delimitation on a voluntary basis.
Despite the similarity in origin and ownership structure, currently only the banking sector shows a clear three pillar structure with a nationwide presence of regional entities. Within the public and cooperative pillar, banks cooperate closely whereas competition between the pillars is strong. In contrast, no comparable structure exists for the energy sector. Here, large international companies and smaller municipal actors are partly intertwined, partly competing. Smaller utilities being shareholders in large companies, large companies holding shares in a multiplicity of municipal utilities and shared networks and associations with different purposes and overlapping membership exist. Extensive liberalisation processes account for the confusing market structure of the energy sector in terms of ownership structure and geographical decentralisation. In contrast to this, the savings banks' laws have likely preserved the coherent structure of the Savings Banks Finance Group with nationwide market presence of local and independent savings banks, as the law prohibits privatisation.

Digitalisation processes in both sectors are to be considered bipartitely. At first glance, digitalisation challenges the small decentralised companies as economies of scale tend to be unlimited for digital solutions. However, cooperation allows to realise scale effects also for small players and digitalisation potentially enables decentralisation of the energy sector. To simplify matters, digitalisation can be divided into two phases in both sectors, whereby both sectors where early adopters of ICT. In a first wave, computerisation accelerated an "internal" digitalisation enhancing operations and existing business models. A second (partly parallel proceeding) wave of digitalisation led to the emergence of new actors with new business models, which partly challenged long-established strategies and partly fostered cooperation with incumbent actors.
The decentralised savings and cooperative banks have managed the first digital transformation relatively successfully. They gained market shares from the large banks and were able to develop and use competitive ICT with the help of cooperation of other banking pillars. The superiority in the use of soft information, due to short distance and local decision-making autonomy, has been identified as one key advantage of regional banks, especially when it comes to SME finance. Also, the three pillars system and regional principle, explains the regional banks' persistence as it slows competition within the banking group (enabling close cooperation) and hinders acquisitions by large players. The first digital transformation of the energy sector is not yet completed, as especially the lower tier grids operate fairly analogue. Digitisation has been important for liberalisation and the creation of transparent markets (exchanges) for electrical energy and auxiliary services. Today, utilities heavily rely on real-time market data and algorithms to run their business and to guide energy generation and sales. The retail business of average savings banks is also oriented to price information from exchanges and (risk-performance) models, but the impact of such bank management on the ordinary credit business tends to be limited for savings banks (Flögel 2019). In sum, whereas decentralised banks coped fairly well with the first wave of digitalisation (most likely due to cooperation), the utility structure was strongly altered by liberalisation since the 1990s. Hence, the precise influence of digitalisation on the changes in the sector remain partly undistinguishable from that of other processes.
The second digital transformation is associated with new competitors (start-ups, tech companies) in both sectors. How the new FinTech solutions and companies affect decentralised banking is currently unclear. FinTech start-ups and non-bank competitors like Google Pay, enter the market with the ambition to make financial intermediation (of traditional regional) banks superfluous. Although we are sceptical about FinTech's ability to handle soft information, much lower operational cost (no branches, lower salary, lack of regulation) give FinTech competitors, like peer-to-peer lenders, additional competitive advantages in the business client segment. For the energy sector, it is too early to determine the effect of the second digital transformation on decentralisation. Here, "EnergyTechs" and digital solutions for incumbent companies offer high potential to cope with challenges arising from energy transition, i.e. decentralisation and volatility of renewable energy production. In fact, solutions like the Talmarkt in Wuppertal tend to create a specific local energy market. To summarise, the second digital transformation tends to challenge established companies and business models of both sectors. This potentially damages soft information based decentralised banking, whereas the second digital transformation tends to enable a more decentralised energy system and may even foster local energy markets as it targets current and long-term challenges in the sector.
Overall, our preliminary comparison of the retail banking and electrical energy sector demonstrates that digitalisation affects (de-)centralisation differently. Despite scale economies inherent to processes of digitalisation, small entities must not be considered on the losing side. Cooperation tends to play a key role for regional companies to profit from digitalisation. Interestingly, digitalisation of the first and second transformation tends to affect (de)centralisation of both industries diametrically

(though, it is too early for final conclusions about the second digital transformation). The primary geographical properties of the businesses in question (i.e. the distance dependence of soft information respectively the physical properties of electricity transmission) and (regulatory) context factors (market liberalisation and energy transition) tend to influence the relationship between digitalisation and decentralisation. Concluding this, it is important to highlight the explorative characteristic of this paper. We have taken the banking industry as blueprint for the comparison with the energy sector, which is why results concerning the energy sector tend to be less detailed. More research is needed to enhance our understanding of digitalisation on centralisation and decentralisation of the economy. As this discussion paper indicates, sector comparisons tend contribute to such an understanding.

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